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A Multivariate Causality Analysis between Health Expenditure and Economic Growth: Which Comes First for the Economy of Bangladesh?

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Abstract

There is always a problem in allocating resources among different sectors for a developing country, where resources are limited. The recent COVID-19 pandemic crisis has again raised questions on whether the health sector is receiving sufficient resources. A vital policy dilemma in this regard is whether to go first for economic growth or health expenditure. This paper applied multivariate causal analysis to examine the relationship between health expenditure and economic growth for Bangladesh using data from 2000 to 2017 to shed further light on the ongoing debate between economic growth and health expenditure. The stationarity test was executed first, followed by the test of cointegration. Next, the vector error correction model (VECM) was applied to examine long-run and short-run causality. Then some diagnostic tests were performed. Finally, the block exogeneity Wald test was applied for robustness. The findings suggest that spending on the health sector should go side by side to achieve higher economic growth as bidirectional causality between the variables is observed for the long run, while the results also highlight the need for different policies for different time horizons as unidirectional causality from health to economic growth is evidenced in the short run.

Keywords: Health expenditure, Economic growth, Cointegration test, Multivariate causality, Bangladesh

Introduction

Health is regarded as one of the basic needs of human life. According to Bloom and Canning (2003), "Health is both a direct component of human well-being and a form of human capital that increases an individual's capabilities" (p. 304). Thus, investing in health can have multifaceted impacts, both direct and indirect. Healthy people generally live a longer life and are more productive (Bloom and Canning, 2003; WHO, 1999). Providing health facilities, in general, is also required as out-of-pocket expenditure for health can significantly impact relatively lower-income people. For Bangladesh, the out-of-pocket expenditure for health

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as a percentage of relevant health expenditure is very high, with a value of 73.9 percent (WHO, 2019).

Although there is little difference in opinion on the importance of spending on the health sector (Van Zon and Muysken, 2005), it is not easy to allocate sufficient funds for the health sector for a developing country like Bangladesh, where resources are limited. On the one hand, there is an argument that spending on health can improve economic growth, while on the other, there is another opinion that increased economic growth can enhance the capability of allocating more funds for the health sector. This study aimed at empirically investigating which of these two policies should be prioritized for the economy of Bangladesh. Moreover, if there should be any policy difference between the short run and long run also need to be examined. This means if the different policies should be pursued for different periods. For example, whether a health-led growth strategy is beneficial in the long run, a critical query could be if the same policy is appropriate in the short run. Therefore, the objective of this paper is twofold:

(i) To examine whether spending is done on the health sector directly or achieved via attaining economic growth first.

(ii) To assess the necessity of adopting different policies for different periods.

According to our knowledge, literature on the relationship between health expenditure and economic growth in Bangladesh is limited. Sumi et al. (2015) analyzed the relationship between health and economic growth for 1990–2013. Applying the Granger causality analysis, the authors observed an indirect bidirectional relationship between health expenditure and economic growth based on the assumption that health expenditure caused the gross capital formation, which caused the fertility rate, which ultimately affects economic growth. In a separate study using data on Bangladesh's economy from 1995 to 2010, Roy (2014) applied the ordinary least square (OLS) regression technique to examine the dynamic relationship among healthcare expenditure, human capital, and economic growth. He found that per capita health expenditure played a crucial role in economic growth. The income elasticity value of 0.34 indicated that healthcare expenditure was not a luxury good in Bangladesh. In a cross-country study of twelve countries where Bangladesh was included, Maitra and Mukhopadhyay (2012) observed that spending on healthcare contributed to gross domestic product (GDP) growth in Bangladesh.

Empirical studies on the relationship between health and growth in other countries can be broadly divided into three categories: time series, panel study, and causal analysis. Time-series studies were generally country-based, where the relationship was estimated for a particular country. For example, Sulku and Cancer (2011) examined the relationship for Turkey for 1984–2006 and observed that the income elasticity of total health expenditures was less than one. They also observed that income elasticity was different for public health expenditures than private health care expenditures. In another study on Pakistan, Aurangzeb

(2001) investigated the same relationship for 1973–2003 using the Johansen cointegration technique and error correction model (ECM) and reported a positive relationship between GDP and health expenditure (Johansen,1991). Employing a similar methodology in Nigeria from 1970 to 2009, Dauda (2011) found a similar relationship between health expenditure and economic growth. In a separate study on Nigeria applying an integrated sequential dynamic computable general equilibrium (CGE), Odior (2011) suggested that reallocating funds towards the health sector was important for economic growth.

Various authors conducted panel studies on the relationship between health and economic growth. For example, in their study on 21 Organization for Economic Cooperation and Development (OECD) countries for 1975–2001, Dreger and Reimers (2005) concluded a long-run relationship among these variables. Similar studies were carried out on OECD countries with similar conclusions (e.g., Baltagi and Moscone, 2010; Hartwig, 2010). In another research, Barro (1996) applied the three-stage least squares estimation technique and observed that a 10 percent increase in life expectancy raised the economic growth rate by 1.4 percent per year. In another panel study where 12 developing countries were examined from 1960 to 2010, Ali and Padda (2014) concluded that an increase in life expectancy raised GDP and GDP per capita. Similar observations were made by Peykarjou et al. (2011) in their study of 15 member countries of the Organization of Islamic Conference (OIC) from 2001 to 2009, where they employed the fixed effects model.

Causal analyses to see the presence and direction of causality remain inconclusive from earlier works. Unidirectional causality from GDP to health expenditure was observed by Mehrara and Musai (2011) in their study on Iran between 1979 and 2008. In a recent work on a group of Latin American and Caribbean countries and for OECD countries for 1995–2014, Rodríguez and Valdés (2019) observed a unidirectional causal relationship from GDP to healthcare expenditure for both groups of countries. The opposite unidirectional relationship from health to economic growth was found by Aluko and Oluseyi (2015) for Zimbabwe using data from 1980 to 2013. A similar relationship was observed by Tekabe (2012) in a panel study of five low-income countries in Sub-Saharan Africa between 1970 and 2009. In another study on 20 OECD countries, Devlin and Hansen (2001) observed that healthcare expenditure caused GDP. Erdil and Yetkiner (2009) observed different relationships for different income groups. Specifically, growth-led health expenditure was evident for low- and middle-income countries, while the opposite relationship was true for high-income countries. In a very recent study using a large dataset of 161 countries for 1995-2014, Rana et al. (2020) also observed variation in a relationship for different income groups with higher health expenditure for high-income countries than low-income countries.

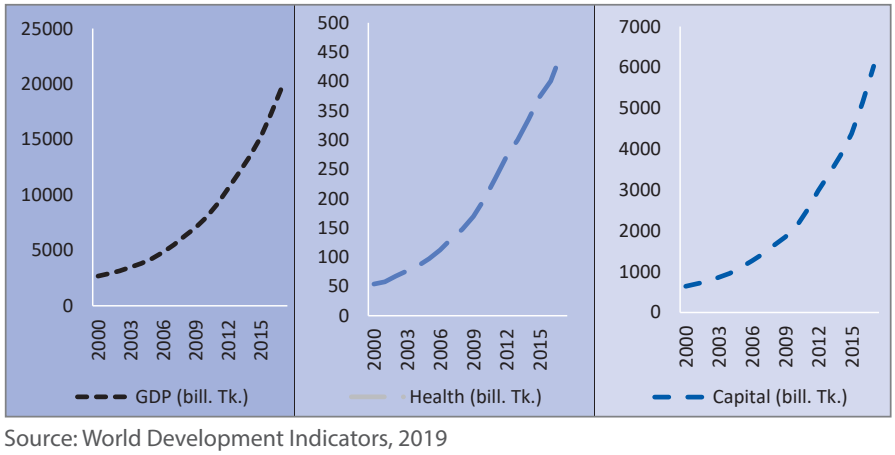
Another possibility of bi-directional causality was reported by Tang (2010) and Elmi and Sadeghi (2012) in their respective studies on Malaysia and developing economies. A similar relationship was observed by Amiri and Ventelou (2012) in their analysis of OECD countries where they applied the Toda-Yamamoto approach. Kumar (2013) applied system generalised method of moments (GMM) and panel Granger causality in his analysis. Using data from 1960 to 2007, Kumar found bi-directional causality between healthcare expenditure and GDP.

Data

This study took data on economic growth, health expenditure, and capital investment from 2000 to 2017. These data were taken from the World Development Indicators (2019). Unfortunately, a more extended time series could not be obtained due to the unavailability of data.

This paper aimed to analyze the causal relationship between health expenditure and economic growth for Bangladesh. The multivariate approach was applied. In addition to the main two variables of interest, gross capital in local currency was included since it can impact health and economic growth. Capital as an additional variable was also included in previous studies (e.g., Islam et al., 2007; Adebola and Bello, 2011). All the variables were measured in the current local currency, but the natural logarithm of these variables was used for estimation purposes. Figure 1 shows the GDP, capital, and health expenditure in the current Bangladeshi taka from 2000 to 2017.

Figure 1. Economic growth, capital, and health expenditure for the economy of Bangladesh for 2000–2017 (in billion Taka)



Source: World Development Indicators, 2019

From Figure 1, a very similar growth pattern can be observed for GDP, health, and capital. For all three variables, the first ten years had a slow but steady increase. In the second half of the study, these variables experienced steady growth again at a higher rate. If observed more minutely, it can be seen that while GDP experienced a growth of around 7.4 times during this study period, health expenditure experienced an increase of approximately 8.5 times while capital investment saw a rise of almost 9.5 times.

Methodology

As mentioned before, this research aimed to fill up the gap in the existing literature on the relationship between health expenditure and economic growth in Bangladesh, particularly during the COVID-19 pandemic. On the one hand, this paper used more powerful econometric methods (the VECM and the block exogeneity Wald test) than previously used for estimation and robustness check. On the other hand, the inclusion of capital and applying the multivariate causality analysis made the findings more general than the bivariate analysis and expected to shed a more accurate light on the issue (Islam et al., 2007). Another advantage of multivariate causality is that it can help avoid spurious correlations and test the general validity of the causation test (Lütkepohl, 1982; Stern, 1993).

In this causality analysis, Augmented Dickey-Fuller (ADF) tests of stationarity and the Johansen cointegration test were conducted first. Stationarity property could be investigated with the help of unit root tests. The Augmented Dicky-Fuller (ADF) unit root test on the GDP series could be done with the following equation:

$$\Delta(GDP_t) = \beta + \delta(GDP_{t-1}) + \alpha_i \sum_{i=1}^{m} \Delta GDP_{t-1} + u_t \qquad (1)$$

Here, GDP_t = gross domestic product, u_t is was a pure white noise error term and $\Delta GDP_{t-1} = (GDP_{t-1} - GDP_{t-2})$, $\Delta GDP_{t-2} = (GDP_{t-2} - GDP_{t-3})$ and so on. The general rule for stationarity was that if the absolute computed value of the t-statistic was more significant than the absolute critical (theoretical) value, then the series was stationary. Similarly, if the absolute computed value of the t-statistic was smaller than the absolute critical value, then the series was nonstationary.

Similarly, the ADF unit root test on the health and capital series could be applied with the following two equations:

$$\Delta(H_t) = \beta + \delta(H_{t-1}) + \alpha_i \sum_{i=1}^{m} \Delta H_{t-1} + u_t \qquad (2)$$

$$\Delta(K_t) = \beta + \delta(K_{t-1}) + \alpha_i \sum_{i=1}^{m} \Delta K_{t-1} \qquad (3)$$

Here, H= health and K= capital. If all these series were nonstationary but were integrated of the same order, they may be cointegrated. This could be investigated using the Johansen cointegration test (Johansen, 1991). It should be noted that Johansen's methodology was typically used in a setting where all

variables in the system were integrated of order one, which meant that the variables became stationary after differencing once (Österholm and Hjalmarsson, 2007). In such a scenario, the simplest form of Johansen cointegrating regression equation was as follows:

$$\Delta Y_t = \pi Y_{t-1} + \sum_{i=1}^{p-1} \lambda_i \Delta Y_{t-i} + u_t \qquad (4)$$

Here, the rank of the coefficient matrix matrix π represented the number of cointegration vectors. A long-run relationship exists if the relevant series were cointegrated.

Then the causality test was applied to examine the causal relationship among the variables (e.g., Granger, 1969, 1980; Gujarati and Porter, 2009; Verbeek, 2017; Wooldridge, 2013). Broadly, the possible results for health expenditure and economic growth for Bangladesh can be classified into the following three categories: (i) bidirectional causality between health expenditure and economic growth; (ii) unidirectional causality (either from health expenditure to economic growth or vice versa); or (iii) neutrality or no causality among these two variables.

Empirical results and their interpretations

This section is divided into various parts. Firstly, the stationarity tests of the variables were conducted. The Johansen test of cointegration followed this. Thirdly, the Granger causality analysis was employed for both the short and long run. After that, some diagnostic tests were carried out in the following section. Finally, the robustness of the results was checked. EViews 10 was used for empirical estimation.

Tests of stationarity

A stationary time series is one whose statistical properties such as mean, variance, and autocovariance remain the same over time. If a time series is nonstationary, it will have little practical value when forecasting. In the ADF test, a variable is stationary when the absolute t-statistic is greater than the test critical values. In Table 1, the results of the ADF test for stationarity are provided. It shows that the health expenditure variable at the level is nonstationary. Similarly, the other two variables of interest are also observed to be nonstationary. However, all these three variables become stationary after taking the first difference.

Table 1. Augmented Dickey-Fuller test

Variable		Probability	Test critical values		
			1% level	5% level	10% level
Health	–1.711837	0.4070	-3.920350	–3.065585	-2.673459
ΔHealth	–3.365383**	0.0288	-3.920350	–3.065585	-2.673459
Growth	0.750365	0.9892	-3.920350	–3.065585	-2.673459
ΔGrowth	–4.678542***	0.0035	-4.057910	–3.119910	-2.701103
Capital	1.785817	0.9991	-3.959148	–3.081002	-2.681330
ΔCapital	–3.041050*	0.0537	-3.959148	–3.081002	-2.681330

*** significant at 1% level, ** significant at 5% level, * significant at 10% level

Test of cointegration

Two or more variables will be cointegrated if they have a long-term or equilibrium relationship between them. For variables to be cointegrated, there should be at least one cointegrating equation. Therefore, if the null hypothesis of no cointegrating equation is rejected, the variables will be cointegrated. When the absolute statistical value is greater than the critical value, the null hypothesis of no cointegrating equation will be rejected, implying a long-term or equilibrium relationship. In Table 2, the result of the Johansen cointegration test is reported. The test is applied to see if there is any cointegrated relationship. The augmented equation with capital shows that the series is cointegrated, implying a long-run relationship between health and GDP.

Table 2. Cointegration test

Hypotheses		Statistic	Critical value	Probability
Null	Alternative		5% level	
Trace test				
None		37.97942	29.79707	0.0046
At most 1		10.23038	15.49471	0.2634
Maximum eigenvalue test				
$r = 0$	$r = 1$	27.74904	21.13162	0.0051
$r <= 1$	$r = 2$	9.426398	14.26460	0.2524

Trace test and Max-Eigen statistics indicate one cointegrating equation(s) at the 0.05 level.

Both the trace test and the maximum eigenvalue test show that there is at least one cointegrating equation, implying the existence of a long-run relationship.

Granger causality

After initial tests of stationarity and cointegration, the Granger causality test is applied to check any causal relationship between health expenditure and economic growth. Although the capital variable appears on the right side of both the GDP and the health equations, the capital equation is omitted here as this study does not examine capital causality.

$$\Delta^2 GDP_t = \alpha_1 + \beta_1 ECT_{t-1} + \sum_{i=1}^{n} \gamma_{yi} \Delta^2 H_{t-1} + \sum_{i=1}^{n} \gamma_{yi} \Delta^2 GDP_{t-1} + \sum_{i=1}^{n} \gamma_{yi} \Delta^2 K_{t-1} + \varepsilon_{yt} \quad (5)$$

$$\Delta^2 H_t = \alpha_1 + \beta_1 ECT_{t-1} + \sum_{i=1}^{n} \gamma_{yi} \Delta^2 GDP_{t-1} + \sum_{i=1}^{n} \gamma_{yi} \Delta^2 H_{t-1} + \sum_{i=1}^{n} \gamma_{yi} \Delta^2 K_{t-1} + \varepsilon_{yt} \quad (6)$$

Here, GDP_t = gross domestic product, ECT=error correction term, H= health, K= capital, ε= error or disturbance term of the equation. Long-run causality is present if the error correction term (ECT) is significant in the vector error correction model (VECM) estimation. The probability value indicates the level of significance of the ECT term. The results of the Granger causality test for the health expenditure and economic growth in Bangladesh are provided below.

Table 3. VECM and long-run causality

Dependent variable	ECT	t-Statistic	Probability
ΔGDP	–0.336470**	-2.09984	0.0435
ΔHealth	0.937778**	2.18227	0.0363

** significant at 5% level

The ECT terms in both the VECM test equations are significant in Table 3, implying long-run bidirectional causality between health and economic growth. Negative ECT implies long-run convergence to equilibrium. Therefore, the value of -0.336470 implies that around 33% or one-third of convergence will occur in a year. Although positive ECT implies long-run divergence from equilibrium, reporting them in causality analysis is not uncommon (e.g., Wadud, 2009; Mukhtar and Rasheed, 2010).

VECM can also examine short-run causality from the significance of the relevant explanatory variable. The results relating to this are provided in Table 4. Again, the probability value indicates the level of significance of the explanatory variables.

Table 4. VECM and short-run causality

Dependent variable	Explanatory variable		t-Statistic	Probability
	ΔGDP_{t-1}	$\Delta Health_{t-1}$		
ΔGDP	---	0.381554***	3.31264	0.0022
ΔHealth	–0.066033	---	–0.10009	0.9209

*** significant at 1% level

From Table 4, where results of VECM in terms of short-run causality are reported, it can be seen that the health variable in the growth equation is significant while the growth variable in the health equation is not. Therefore, it can be concluded that there is unidirectional short-run causality from health to economic growth.

Diagnostic tests

Diagnostic checking of the estimated models was carried out to check for autocorrelation, normality, and heteroscedasticity. The earlier estimates will not be reliable if there are autocorrelation and heteroscedasticity problems. Moreover, it is also important that the error terms are normally distributed. The findings are reported in Table 5.

Table 5. Diagnostic tests

Diagnostic tests	Statistic	p-value
Serial Correlation LM Tests	8.66	0.47
Jarque-Bera (Joint)	1.40	0.97
Heteroskedasticity Tests	36.80	0.88

From the diagnostic test results (Table 5), it can be seen that there are no autocorrelation and heteroscedasticity problems. Moreover, the model also passes the Jarque-Bera normality test, indicating the error is normally distributed in this model. Although only joint normality is reported, all variables are individually normally distributed; it may also be mentioned. These are not separately reported for brevity.

Robustness check

For robustness, the block exogeneity Wald test is applied, which also shows a short-run causal relationship. Another advantage of this test is that it can show whether the concerned variable has any causal relationship with the additional variable included in a multivariate analysis. In this case, this test will indicate if health and capital cause economic growth and if economic growth and capital have any causal relationship to health.

Table 6. Block exogeneity Wald test

Dependent variable	Explanatory variables	Chi-square	Probability
Health	D(ln_GDP)	0.010018	0.9203
	D(ln_Capital)	0.708515	0.3999
	Both variables together	1.265630	0.5311
GDP	D(ln_Health)	10.97357	0.0009***
	D(ln_Capital)	0.513955	0.4734
	Both variables together	11.04814	0.0040***

*** significant at 1% level

The block exogeneity Wald test findings for robustness confirm the earlier short-run unidirectional causal relationship from health to economic growth. Another critical point that this estimate provides is that the collective impact of health and capital is significant, implying that investing in both human and physical capital together also positively affects the economy in the short run.

Discussion

The results of this study are provided in Tables 1 to 6. The ADF test results of stationarity showed that all the study variables were nonstationary but became stationary after the first difference. The Johansen cointegration test showed a long-run relationship between health and GDP.

Relating to the main objectives of this paper mentioned in the introduction section, the findings of this paper are twofold. Firstly, bidirectional causality is found in the long run, implying both the variables of health expenditure and economic growth affect each other in the long run. Therefore, both of them should be emphasized to achieve higher economic growth and provide better health facilities. This finding is in line with earlier works. For example, Sumi et al. (2015) observed a similar relationship in their study on Bangladesh. Similar findings were also obtained by Elmi and Sadeghi (2012) in their study on developing countries, by Tang (2010) on Malaysia, by Amiri and Ventelou (2012) on OECD countries.

The other important finding of this study is the causal relationships between the long run and the short run. Unidirectional causality from health expenditure to economic growth is evidenced, implying that more health expenditure is required to achieve higher economic growth in the short run. Similar findings were also observed by Aluko and Oluseyi (2015) for Zimbabwe, Tekabe (2012) for a panel study of five low-income countries in Sub-Saharan Africa, and Devlin and Hansen (2001) in their study on 20 OECD countries.

However, the above findings differ from other studies where unidirectional causality from GDP to health expenditure was observed. For example, Mehrara and Musai (2011) found this type of relationship in their study on Iran between 1979 and 2008. In another work on a group of Latin American and Caribbean countries, and for OECD countries, Rodríguez and Valdés (2019) saw similar relationships for 1995–2014. Previous studies observed an interesting aspect of different relationships for different income groups (Erdil and Yetkiner, 2009; Rana et al., 2020). However, these studies were based on different countries and could not be covered in this country-specific study.

Diagnostic tests were also carried along with robustness checks. The results showed that the model was free from the problems of heteroscedasticity, autocorrelation, and non-normality. In addition, the Wald test confirmed that the result of short-run unidirectional causality running from health expenditure to economic growth is robust.

Conclusions and policy implications

The paper aimed at investigating the causal relationship between health expenditure and economic growth. This is particularly crucial during these times of the COVID-19 pandemic when the health sector again has come into prominence. However, the question remains crucial for policymakers to decide how best to allocate resources for the health sector. One option could be to go for the growth-led strategies to achieve higher economic growth first and then improve the health sector. Another option could be to go for a health-led growth strategy where the health sector will be invested first, and through improved human capital will increase economic growth.

This study observes three essential findings with the specific objectives stated at the beginning and the results obtained in this study applying multivariate causality analysis, including the capital. Firstly, there is bidirectional long-run causality between health expenditure and economic growth. Secondly, the causal relationship changes in the short run to a unidirectional one running from health expenditure to economic growth, implying that higher health expenditure can improve economic growth in the short run. Finally, spending on health along with on capital has a joint causal impact on economic growth. This paper concludes that while higher economic growth can improve the health sector, similarly improving the health sector can also enable the economy to achieve higher economic growth in the long run through multifaceted direct and indirect impacts (Bloom and Canning, 2003; WHO, 1999). However, for the short run, which is particularly crucial for the current COVID-19 pandemic, priority should be given to investing in the health sector along with capital investment. This paper can be helpful to researchers and policymakers in formulating plans for improvement in the health sector both in the short and long run. It also highlights the importance of different policies for different time horizons.

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