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Human or Physical Capital, Which Influences Sustainable Economic Growth Most? A Study on Bangladesh

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ABSTRACT

The economy of Bangladesh is experiencing sustained economic growth. Thus, the purpose of this study is to analyze how human capital and material, or physical capital interacts to influence the economic growth of Bangladesh. As a response to analyzing mechanisms of economic growth from 2000 to 2019, the present paper conducts quantitative research into the link between human capital, material capital, and economic growth in Bangladesh with the use of a Vector Autoregression Model (VAR). The study discovered that both human capital and physical capital can contribute to economic growth in different time dimensions, but their respective efficiency varies. As a result of the research, recommendations are made for policy development.

Keywords: Sustainable economic growth, Vector autoregression model, Human and Physical capital.

INTRODUCTION:

Bangladesh is considered a market economy in the process of developing. The Bangladeshi economy is one of the world's fastest growing. Bangladesh averaged 4.5% GDP growth in the decade following 2004. According to the World Bank, Bangladesh's economy grew 8.3% in the first quarter of 2019 making it the world's seventh fastest. The country has the 37th largest economy by nominal terms and is the 31st in purchasing power parity. Bangladesh is classified as a frontier market and a 'Next Eleven' emerging market economy (Absar *et al.,* 2021). Exports of ready-made garments, remittances from abroad, and domestic agricultural growth were the major factors driving its growth. In terms of exports, the country mainly exports textiles, shipbuilding, fish, and seafood and leather goods.

The pharmaceutical industry, the steel industry, and the food industry are other self-sufficient industries. With high foreign investment in Bangladesh's telecommunications sector, it has grown rapidly throughout the years. The government is promoting Digital Bangladesh as a way to develop Bangladesh's information technology sector. Bangladesh, which ranks seventh among Asia's gas producers, also holds substantial gas reserves. The Bay of Bengal is full of limestone, where a lot of exploration is taking place offshore (Ladd *et al.,* 2019; Pomi, 2019). Bangladesh's seaports enable Nepal and Bhutan to reach the sea via the sea. As well as Bangladesh, China's landlocked southwest, which includes Tibet, Sichuan, and Yunnan, is considered a possible entry point from Bangladesh (Alam *et al.,* 2021). Economic growth may be hampered by a lack of investment in infrastructure and human capital (Ahmed *et al.,* 2020).

The economic development of Bangladesh has achieved remarkable results, but human capital and physical capital investments have yet to be coordinated. Numerous studies have been done on economic growth domestically and abroad, most of which use mathematical models to study the factors that influence growth. Is economic growth more likely to occur when human capital investments are coordinated with physical capital investments? Human capital and material capital have also assumed a prominent role at this time. Extensive economic deve-

lopment is no longer an effective model in recent years. Therefore, it is important to know the key roles that physical infrastructure, human capital, and financial development play in the context of Bangladesh in enabling economic growth. In this study, VAR models are used to quantitatively analyze economic growth in Bangladesh in a mathematical and physical way, thereby filling up academic gaps in this area. Using the panel data from 2000-2019 to conduct theoretical and empirical research and then provide policy recommendations to promote economic growth.

Literature Review

The World Bank created a human capital index to quantify the economic impact of health and education. The relevance of human capital to economic growth has been emphasized by several relevant theories. By investing in education, health services, and other social services, the government is promoting the acquisition of human capital in developing countries. A skilled and educated work-force is a key component of economic growth, according to the human capital theory. It assumes that the formal education of the workforce determines their production capacity, that is, the higher the education, the higher the productivity. There are also several other growth theories, for example, endogenous theory, that emphasize the relative importance of endogenous and exogenous factors for economic growth. In addition to physical capital, countries around the world consider human capital as an independent factor of production, indispensable to achieve high levels of sustainable economic growth even during the pandemic (Absar *et al.,* 2021; Ayittey *et al.,* 2020; Dhar *et al.,* 2021). By investing in health and education, rich human capital is created, which is essential for economic development. Academic analysis can be performed at two levels based on the current research results. Economic growth is a function of two different factors, one of which is human capital and the other of which is physical capital (Amin, 2020; Islam and Alam, 2019). Many studies have examined human capital and economic growth interrelationships and made a complete analysis of them currently. According to many other researchers, health, training, education, and social services mean greater skills and capabilities of the work force, which improves economic growth. In several studies, the positive contribution of human capital formation to economic growth was demonstrated (Islam and Khan, 2019). Developing the concept of human capital and spurring a major research boom in this field, Schultz, (1961) was the first to analyze the relationship between human capital and economic development in an academic setting. Uzawa, (1965) examined regional differences in economic growth through human capital. According to Lucas (1988), human capital has both an external and internal spillover effect on growth. According to Mankiw *et al.* (1992), human capital has always played an essential role in economic growth, and the importance of economic differences between regions was also discussed. Musila and Belassi, (2004) found that either directly or indirectly, education has a tremendous effect on economic growth. By analyzing data from different provinces in China, Hongyi and Huang, (2009) demonstrate that education and health are positively related to economic growth. Recent researches have already discovered the relationship between human capital, performance and sustainable economic growth (Chowdhury and Dhar, 2012; Dhar *et al.,* 2014, 2017, 2018, 2019, 2020; Dhar, 2019; Dhar, 2020; Dhar and Mutalib, 2020; Masruki *et al.,* 2020; Aktar, 2021; Sarkar *et al.,* 2018).

Among recent research, Roopchund, (2017) discovered a direct relationship between human capital and economic growth, and further investment should be made in developing human capital to improve economic growth. According to the result, Sarkar *et al.* (2021) and Ho, (2018) found that except ageing issue human capital has a positive and significant impact on economic growth, both in the short and long term. The study concluded that policymakers should focus on policies that will foster sustainable economic growth by enhancing human capital. Second, physical capital plays a role in economic growth. The ratio of material capital versus human capital is higher than the global average, according to Heckman, (2005). Model econometric methods are used to establish the vector auto-regression model, the long-term equilibrium model, and the short-term equilibrium model in the research of Sun and Dong, (2007). According to the result, human capital, material capital, and economic growth are in long-term equilibrium. Gong *et al.* (2012) found that the advancement of capital stock was the dominant driving force for economic growth. A regression analysis by Garzarelli and Limam, (2019) showed that physical capital was a leading factor in economic growth in the central region, with a contribution rate

of 80%. In the absence of proper allocation, it will prevent material capital from functioning. The alternative is that it promotes economic growth and eradicates social inequality if it is allocated properly. In the results, Xu and Xie, (2018) indicated that physical capital continues to play a key role in economic growth and its contribution rate is as high as 4/5. Human capital quality, however, cannot be ignored when the stock of human capital is decreasing. Previous studies show a positive relation among exports, imports, capital formation and economic growth while the study of Shah *et al.* (2020) shows that in the long run capital formation and economic growth has no effect. In the existing literature, most scholars' research focuses on national issues, but there are relatively few studies focused on specific countries. Further, the current literature review focuses on the development of a single-equation theoretical framework for research, but the research results cannot explain the interaction between two variables, but only the influence of one sequence on another. Based on the above problems, physical capital and human capital data are used to develop an analysis framework for economic growth in Bangladesh. Using data ranging from 2000 to 2019, we have developed an autoregressive vector model (VAR) to analyze the relationship between human capital, physical capital, and economic growth in Bangladesh.

METHODOLOGY:

Source of Data

A number of factors influence human capital, including education and medical care, but education plays an important role. In order to measure human capital, university students are selected as an indicator. Physical capital refers to the actual total amount of fixed capital input, while GDP per capita represents real economic growth. Empirical research is founded on a VAR model using these three variables. In view of the availability and validity of the data, the data used in Bangladesh from 2000 to 2019 are from the official website of the National Bureau of Statistics and the Bangladesh Statistical Yearbook.

Theoretical model

Stationary test - Statistically, a spurious correlation or relationship is an association between two or more events, but one that is not causally related because of either coincidence or the presence of another unknown factor (Ali *et al.,* 2018). Using time series data models that are non-stationary can cause an erroneous test result because spurious relationships may appear (Mele and Magazzino, 2021). Augmented Dickey - Fuller (ADF) test measures the stability of our original variables to reduce the appearance of "spurious relationships". The test formula is as follows:

$$\Delta Y_t = a_1 + a_{2t} + (p-1)Y_{t-1} + \varepsilon_t$$

A unit root sequence has been determined to be unstable if H0: ρ = 1, Y represents the standard error, and ε_t is standard error. When calculating the F statistic in the sample data, if the F value is higher than the critical value, the empirical conclusion negates the null hypothesis, indicating that the original series Y is a stationary series, otherwise it means that the original series is a non-stationary series.

Granger causality test

Granger causality test can empirically test the direction of influence between variables (Chang *et al.,* 2014). The following formula shows the general Granger causality test formula. In the following formula, t represents time; k represents the maxi-mum lag of the variable, and represents the random disturbance term in the model. Based on this model, the Granger causality test model of Y, $\ln X_1$, $\ln X_2$, $\ln X_3$ and $\ln X_4$ is established (Pradhan *et al.,* 2018).

$$\ln Y_t = A_{10} + \sum_{i=1}^{k} A_{1i} \ln Y_{t-1} + \sum_{i=1}^{k} B_{1i} \ln X_{t-1} + \varepsilon_{1t}$$

$$\ln X_t = A_{20} + \sum_{i=1}^{k} A_{2i} \ln X_{t-1} + \sum_{i=1}^{k} B_{2i} \ln Y_{t-1} + \varepsilon_{1t}$$

VAR model

The VAR model embeds the variables to be studied and determines its lag value to analyze the dynamic relationship between the variables (Dungey & Pagan, 2000; Dinh, 2020). This model can reflect the impact of univariate changes on other variables in the system, so as to accurately describe the relationship between variables (Giordano *et al.,* 2007). The VAR model formula is as follows:

$$Y_t = \Phi_1 Y_{t-1} + \cdots \Phi_p Y_{t-p} + Dx_t + \varepsilon_t$$

Here, t=1, 2,..., T, Y_t are the k-dimensional endogenous column vector, x_t is the n-dimensional exogenous variable, p is the lag order, and $\Phi_1, \Phi_2, \Phi_3, \ldots\ldots, \Phi_p$ and D need to be estimated The coefficient matrix, εt is k as the disturbance term. Before establishing a VAR analysis, the best lag order should be specified using the AIC and SC rules, and stability analysis should be performed again to determine whether it is suitable to construct a VAR model. Suppose there is a VAR (2) model:

$$X_t = A_1X_{t-1} + A_2X_{t-2} + B_1Y_{t-1} + B_2Y_{t-2} + \varepsilon_{1t}$$

$$Y_t = C_1X_{t-1} + C_2X_{2-1} + D_{1Y}Y_{t-1} + D_2Y_{t-2} + \varepsilon_{1t} (t=1, 2\ldots T)$$

The impulse response analysis is mainly realized by the iterative method. When $\varepsilon_{10}=1$ and $\varepsilon_{20}=0$, X_0, X_1, $X_2\ldots$ and Y_0, Y_1, $Y_2\ldots$ and Y_0, Y_1, $Y_2,\ldots$ can be obtained through iteration. The above data are all X caused by X shock And the response sequence of Y. At the same time, when $\varepsilon_{10}=0$ and $\varepsilon_{20}=1$, the corresponding shock reflection function can be obtained.

RESULTS AND DISCUSSION:

Stationary test

To reduce the effect of random error over the empirical regression to some extent, you should first logarithmize the data, in order to avoid the interference of potential heteroscedasticity from the objective factors. Because non-stationary data modeling may result in spurious relationships that can lead to incorrect test conclusions, HC, PC, and GDP are recorded as LNHC, LNPC, and LNGDP. The Augmented Dickey - Fuller (ADF) test is used to measure the stability of the original variables in order to minimize the occurrence of spurious relationships. In the article, empirical research is conducted using Eviews 9.0 software. The test formula is as follows:

$$Yt = 1 + 2t + (-1)\ Yt - 1 + t$$

Here, ε_t is standard error, the original hypothesis H0: $\rho=1$, which means that the sequence Y has a unit root, and the conclusion obtained is that it is unstable. By calculating the F statistic in the sample data, if the F value is higher than the critical value, then the empirical conclusion indicates that the original sequence Y is a stationary process, otherwise, it indicates that the original sequence is a non-stationary process. The three sets of data were tested for stationary. **Table 1** shows the results of the tests:

Table 1: Stationary test.

Variable	Inspection (C, T, K)	ADF Statistics	Critical value		P value	Result
			1%	5%		
lnHC	(C, T,5)	-4.780495*	-4.309395	-3.921156	0.0102	Stationary
InPC	(C, T, 6)	5.462764**	-4.345414	-3.203362	0.0004	Stationary
lnGDP	(C, T, 3)	-0.997401	-3.145771	-2.038981	0.8876	Not Stationary
DlnGDP	(C, T, 0)	-3.896101**	-3.932267	-2.896229	0.0249	Stationary

Note: ** and * respectively mean to negate the original conjecture and reflect stability to the extent of 1% and 5%. Among them, C, T, K represents the intercept part, trend part and lag order part of the ADF test, respectively. The lag order is determined by the AIC, SC, and HQ criteria. As shown in **Table 1**, the LNGDP obtained after the logarithm analysis of the variables negates the original guess by 5%, indicating that the original sequence is not stable, but the stable sequence is obtained after the first-order difference processing. Additionally, LNHC and LNPC are stationary series. The original sequence data cannot be used in co-integration studies since they are not a single integration. VAR models are instead constructed using the Granger causality test.

Determine the optimal lag order

The FPE, AIC, SC, and HQ criteria indicate that the optimal lag order is 5, while the LR indicates that the optimal lag order is 4. Using the principle of determining the rule at most, this paper establishes the VAR (5) model. Granger's method is applied to the VAR (5) model to analyze the relationship between the sequences to investigate whether there is a causal connection between them.

Table 2: Optimal Lag Order.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	80.05128	NA	7.34E-09	-6.028361	-6.632147	-6.63204
1	182.4793	207.4177	1.01E-10	-12.18065	-12.33921	-13.55793
2	224.1720	34.16633	2.90E-11	-14.19696	-15.72363	-16.12214
3	238.0937	23.80382	1.84E-11	-17.63115	-16.01064	-17.71543
4	240.6002	22.42683*	4.27E-12	-18.01712	-16.10587	-18. 61843
5	247.2043	15.1703	2.51e-12*	-19.77660*	-17.73336*	-19.85022*

Granger causality test

Table 3 shows that the Granger causality test concludes that human capital and physical capital are both two-way Granger factors for economic growth, and human capital is also a two-way Granger factor for physical capital, which can be further tested for stability

Table 3: Granger causality test.

Null hypothesis	Observations	Chi-sq	P Value	Relationship
LNHC ≠ LNPC	20	28.02033	0.0045	No
LNHC ≠ DLNGDP	20	20.27531	0.0005	No
DLNGDP ≠ LNHC	20	16.97485	0.0067	No
LNPC ≠ LNGDP	20	15.58564	0.0041	No
LNPC ≠ LNHC	20	31.67854	0.0034	No
DLNGDP ≠ LNPC	20	19.67854	0.0043	No

Variance decomposition model

In order to establish the VAR model, LNHC, LNPC, and DLNGDP data were analyzed. After continuous testing, the optimal lag period, according to the minimum principle of AIC and SC, is the fifth order. The impulse response function can then be used to analyze the relationship between the three. The impulse response equation shows the effect of endogenous sequences on other endogenous sequences in VAR. For further study of the impact contribution degree of each sequence and the normalization degree of different sequence impacts, a variance decomposition equation must be constructed. To perform variance decomposition on DLNGDP, choose 30 periods as the lag period.

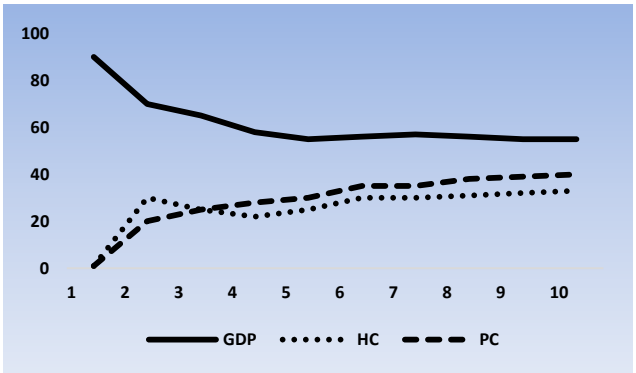

Fig 4: DLNGDP variance decomposition.

Per capita GDP fluctuations are explained by themselves in 57.5% of cases, human capital in 0-25% of cases, and physical capital in 0-30% of cases. The economic growth of Bangladesh can be explained to some extent by material and human capital, and this effect is strong throughout the region. Material capital contributes a relatively small amount as compared to human capital.

CONCLUSION AND RECOMMENDATIONS:

This paper uses the vector auto regression (VAR) model to analyze the effect of human capital and material capital on regional economic growth, and locks the scope to Bangladesh. Based on an analysis of Bangladesh data from 2000 to 2019, it is found that physical capital investment has a negative impact on economic growth in the short run, but in the long run, these two factors promote economic development and are the leading factors behind economic development in Bangladesh. It is imperative to organically combine the two to achieve the best possible economic growth in Bangladesh. Mathematical research shows that human capital investment has a relatively long return period compared to physical capital investment, but its return rate is often much higher. Finally, human capital has a very strong positive externality in comparison to physical capital investment. Investing in human capital is more beneficial in the long run. Bangladesh still lags behind other developed countries in terms of education level. Rural development must be accelerated, the training level of labor in underdeveloped countries must be improved, and the total amount of human capital must be improved across the board. Invest in education and higher education as part of a planned change in direction and proportion. It is absolutely necessary to invest in physical capital in the short term, such as new infrastructure and innovative technologies. Promote the integration of technology and industry development, as well as developing emerging industries vigorously. The policy trap we need to avoid is emphasizing one part of the input while under-estimating the other.

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CONFLICTS OF INTEREST:

The authors have no conflicts of interest in publishing this research study.

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