An Estimation of Aggregate Production Function of Bangladesh: Policy Lessons

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Abstract- Following Solow-type neoclassical growth model, this paper has attempted to examine and analyse the relative impact of labor, investment, human capital and Terms of Trade (TOT) on aggregate level of output in Bangladesh. The estimated results indicate that in Bangladesh growth in the past has largely driven by the acceleration in capital accumulation and expansion of quantity and to some extent quality of labour, with a lesser role played by the human capital. The constant term not found to be significantly different from zero implying insignificant impact of growth of technology on growth in Bangladesh**.**

Key Words: Real Gross Domestic Product (GDP), Capital accumulation (I), Human Capital (H), Terms of Trade (TOT), Total Factor Productivity (TFP.)

JEL Classification: D24, E13, H51, H52

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I. Introduction

Traditional growth models relate growth with capital formation, growth of labour force and growth of a host of other inputs and technological change. The neo-classical paradigm considers technological change as an exogenous process, whereas endogenous growth literature makes this process endogenous, looking for possible driving forces. Economists, at least since the time of Solow (1957), explained output growth in terms of accumulation of factor inputs and of the growth of the total factor productivity. Later on, Mankiw (1995) modified one parameter by defining capital to include both human and physical capital. Additional determinants of growth beyond the basic factors of production have been looked for in different econometric works. Gradually, with the passes of time, economists like Miller and Upadhyay (2002) considered the emergence of growth theory as an important area of investigation and emphasized on the debate toward the effect of public policy on economic growth.

In the context of Bangladesh, empirical study shows that, the economy has performed well especiallyin recent years. Pragmatic policies, the effort of social mobilization and implementation of various reforms over the last three decades are some of the important grounds of moving the economy to a higher growth path. Through formulating comprehensive and insightful policy, it is possible to achieve sustainable economic growth over a long period of time. This also has meaningful impacts or consequences for human welfare. Therefore, for Bangladesh challenges lie not only in achieving higher growth rate but also in sustaining it. An important prerequisite to designing appropriate policies for improving the productivity is to understand the nature and sources of economic growth (*Mujeri, 2008*). It is therefore natural to ask about the "nature of current Bangladesh" that makes growth sustain for over a decade since 1990.

Although it is important to estimate the aggregate production function, for understanding the growth dynamics and identifying the prospective factors behind it, very few studies have investigated the empirical evidence on the subject in the context of Bangladesh. One reason for the paucity of empirical research in this area might be the lack of appropriate data.

This study intends to estimate the aggregate production function for Bangladesh with the ultimate objective of presenting some policies amenable for sustaining the present growth momentum as well as reaching to a higher growth trajectory. This task has been done by using a fairly standard & simple growth model to compare the relative importance of factors influencing the growth process of Bangladesh, and using reasonably standard time series data from1983 to 2011.This study basically follows the model used by Khan and Reinhart (1990). The estimates of the parameters provide a quantitative picture of the respective role of capital formation, growth of labour force, terms of trade (TOT) and

human capital, and some useful insight into the impact of technological change on growth of GDP. To our Knowledge, this information in the current context of changing global and regional scenario is unavailable and should prove useful in evaluating the existing policies and formulating future strategies.

The paper is organized in 7 sections. The next section discusses literature review followed by section III presenting a brief description of gradual evolution of growth trajectory in Bangladesh. In section IV we outline the basic model. The results of the estimates are contained in section V. Section VI summarizes the researchresults and their main policy implications. And the final section concludes the study.

II. Literature Review

There exists a substantial body of literature on the issue worldwide. And the literature in this area is too voluminous to summarize adequately here. Ever since *Solow's* seminal contribution to growth theory, many economists have estimated growth models for different countries. Besides, on the wake of worldwide shift towards the growth strategy concentrating on market forces and market led growth, some studies also focused upon the relative importance of public and private investment as drivers of growth. The work by Khan and Reinhart (1990), which was based on annual data for 1970-79 covering a sample of 24 LDCs, is worth mentioning in this regard. While Rati Ram (1996) extended this earlier research taking a much broader cross country sample of 53 LDCs and assessed the position for the 1980s as well as the 1970s. Cavallo and Daude (2011) analyzed the relationship between public and private investment in developing countries, where they used panel data of 116 developing countries with annual observations between 1980 and 2006.

Human capital has been being considered as one of the major sources of economic growth in modern economics such as Becker's (1965)work on human capital provided the analytical framework for understanding investments in education. Voons (2001) used growth model involving an aggregate production function and measured the social benefits from human capital improvements due to the investments in higher education in Hong Kong. While estimating a production function model of aggregate economic growth including two fundamental components of human capital- work experience and health (life expectancy), Bloom et al. (2004) found that good health has positive and significant effect on aggregate output. In 'The Contribution of Labor and Capital to Romania's and Moldova's Economic Growth', Zaman et al.(2007) applied Cobb-Douglas production functions in its classical form with a view to analyzing Romania's and Maldova's economic growth in relation to the intensity of using capital and labor as determinants of the production function and GDP level. They founda significant positive contribution of labor input to the economic growth but its magnitude was comparatively lower than that of the ratio of investments to fixed assets of the two countries.

For Bangladesh, Mujeri (2008) related the changes in the policy framework with growth of total factor productivity (TFP). For analyzing the sources of growth, he used the growth accounting framework to measure the relative contributions of labour and capital as well as that of TFP to growth in Bangladesh over different policy regime from 1971 to 2007. Alauddinet al, (1993) used nested and-non nested specification tests and assessment of economic variables, including elasticity and marginal products to evaluate the systematic differences between the average production function and three different specification of the stochastic frontier. By applying Cobb Douglas production function along with stochastic frontier, in their study, they estimated an industry level production technology for 47 sectors of the Bangladesh economy during 1976-77, and got 0.271 and 0.443 as coefficient of capital and labour respectively. Using the growth diagnostics framework developed by Rodrik, Hausmann and Valesco(2005), and benchmarking Bangladesh's performance with a set of comparable countries, Rahman and Yusuf (2009) found that Bangladesh economy lags behind the reference countries in terms of investment in physical and human capital. In Bangladesh, economic growth is hindered by several institutional and non-institutional factors. Factor sidentified by Rahman and Yusuf, are low levels of human capital, poor infrastructure, market failure in specific sectors, low level of trade, massive corruption, and complex regulations. They suggested for tackling investment bottlenecks, promoting trade and reducing regulatory burden on private sector on priority basis.

III. Growth Trajectory of Bangladesh

This section provides a brief overview of the growth performance of the Bangladesh economy and analyses the structure and sources of growth in order to understand the nature of economic growth achieved by the country and asses the relative contribution of different factors to incremental growth. The Bangladesh economy witnessed significant changes over the years since its independence in the year 1971. The country started out with a land scarce and labour abundant economy, having a low stock of accumulated capital and physical `infrastructure. The liberation war of 1971 destroyed about a fifth of Bangladesh's economy, and the post-war dislocation left the economy on a slow growth trajectory for almost about two decades (Rahman & Yusuf).

They also mention that the growth of GDP started to be supported by a rising rate of investment from 1980s and the economy has started to accelerate since the end of the 1980s. Not only has Bangladesh been growing faster since the end of the 1980s, growth itself has become less volatile.

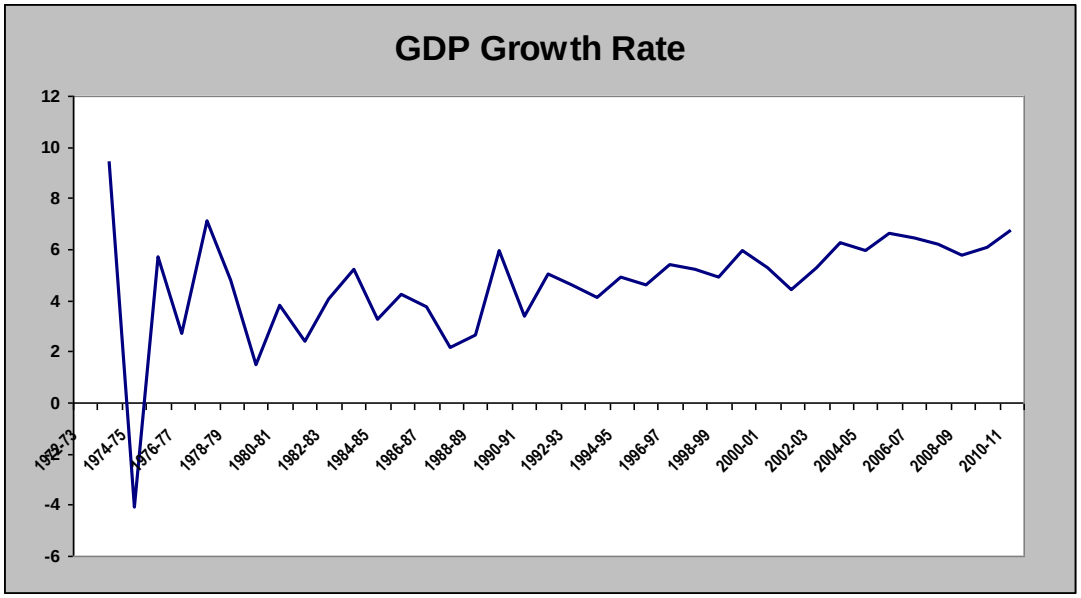

Figure 1 Real GDP growth rate of Bangladesh.

1991-96 was a period of transition. During this period, there had been considerable economic reforms through which more liberalized, deregulated and private sector friendly economy was created. This time favorable initial condition both in terms of improved economic fundamentals and human and social capital has also been formed. At the same time, the economy registered noticeable orientation with new role of private sector, a move towards the macroeconomic stability, efforts on development of human capital, emergence of NGOs as major service provider especially to the poor, recognition to the government–NGO partnership, and nourishing democracy (Mujeri,2008). Still achieving higher growth in Bangladesh is a challenge as the assertion of Hausmann et al. (2005:1) mentioned by Felipe et al. (2011:252), that "While development is a broad concept entailing the raising of human capabilities in general, we believe increasing economic growth rates is the central challenge that developing nations face".

In the last half of the 1990s a moderate acceleration in growth started and the growth performance showed increasing trend with less fluctuation till the present date. Rahman & Yusuf mentioned this achievement as the result of a turnaround in multifactor productivity (MFP) growth. For better explanation of this MFP turnaround, they have preferred the integration of macroeconomic stability, education, openness, growth of service sector and other demand driven activities, and the impact of the rapid adoption of information and communication technology.

IV. Specification of the Model

Theoretical Framework and Model Specification:

Following Khan and Reinhart (1990:20-22), this study uses Solow-type neoclassical growth model. The starting point is the aggregate production function which relates the maximum amount of output that can be produced given the quantities of factors of production and a variable usually referred to as total factor productivity:

$$Y = Af(K, L, Z) \quad \ldots\ldots 1$$

Where,

Y is the level of output (usually potential output)

K is the stock of physical capital

L is the labour force

Z is the vector including other factors affecting growth, and

A measures the factor productivity, which is generally assumed to grow at a (constant) exogenous rate;

In addition to capital, labour, and productivity growth, this general specification of aggregate production function has been used with various other determinants of growth. Some models used growth of export (Balassa, 1978, Ekanayake, 1999) on the ground that in a number of developing countries the growth of exports has led to the development of infrastructure, transport and communications, etc, which in turn help expand investment opportunity. Other Scholars such as Esfahani (1991) argued that through facilitation of imports of highly productive capital and intermediate goods, export mostly contributes to growth. Recent work on development theory emphasizes the role of health, education and research and development, and thus human capital has also been included in the specification of some models (Otani and Villanueva, 1989). Though, there have been a number of variants of equation proposed in the literature, the essential nature of the model remains the same. In this paper, we have used this production function in its classical form for analyzing Bangladesh's economic growth in relation to the intensity of using capital and labor as determinants of the production and to describe the relevant contributions of the various other factors of production, as well as that of productivity. Regarding other factors affecting growth we prefer to include human capital. Also, despite

apparent importance of export and import as the source of growth in the case of Bangladesh, for the sake of better fit of the model this study does not opt for including these factors. Rather, it takes terms of trade (TOT) as a proxy for trade orientation -. Incorporating our selected factors we can now rewrite the equation (1) for defining the aggregate production function of Bangladesh economy as follows:

Y= Af (K, L, H, T)……(2)

Where,

H represents human capital, and

T denotes the terms of trade (TOT). The variable T reflects the gains from international trade of the country and constitutes a kind of input in the production function.

Taking total differential and then expressing the equation in growth terms we get[2]:

$$\frac{dY}{Y}=\left[A.\frac{\partial Y}{\partial K}\right].\frac{dK}{Y}+\left[A.\frac{\partial Y}{\partial L}.\frac{L}{Y}\right].\frac{dL}{L}+\left[A.\frac{\partial Y}{\partial H}.\frac{H}{Y}\right].\frac{dH}{H}+\left[A.\frac{\partial Y}{\partial T}.\frac{T}{Y}\right].\frac{dT}{T}+\frac{dA}{A}\ldots\ldots\ldots(3)$$

Replacing change in capital stock with investment (I), and rewriting for estimation we get

$$\frac{dY}{Y_{-1}}=\alpha_0+\alpha_1.\frac{I}{Y_{-1}}+\alpha_2\frac{dL}{L_{-1}}+\alpha_3.\frac{dH}{H_{-1}}+\alpha_4.\frac{dT}{T_{-1}}$$

$$G^*=\alpha_0+\alpha_1.I^*+\alpha_2.L^*+\alpha_3.H^*+\alpha_4.T^*\ldots\ldots(4)$$

Dependent, as well as the explanatory variables except physical capital (K) are in growth form. Following Khan and Reinhart (1990), this specification has been adopted because of lack of data on capital stock. Co-efficient α_1 represents marginal productivity of capital, whereas, α_2, α_3 and α_4 represent elasticity of growth of GDP with respect to L, H and T respectively. α_0 is largely determined by the change in the existing technology and changes in other left out exogenous variables.

[2] ***Appendix 1***

V. Data Source, Data Description and Methodology

Sample period covered has been selected depending upon the availability of consistent data on relevant variables as well as fulfillment of all statistical requirements. Output growth is measured using GDP at constant 1995/96 prices. Like most developing countries, in Bangladesh it is extremely difficult to obtain accurate continuous time series data on the labour force. Therefore, for total employed labour force (15 years and above) data are taken from the labour force surveys of various years conducted by the Bangladesh Bureau of Statistics (BBS) (*collected from LABORSTA, 2010*). The yearly time series data on employed labour are then derived by using compound growth rate method from the discrete data of these labour force surveys. As education and health are the most important issues that accounts for the development of human capital, each year's government expenditure on these sectors have been used as proxy for time series data on human capital. Also, since the data on capital stock are not readily available, the present study has used data on investment, as it is synonymous to net addition to capital stock. Data on investment is collected from World Development Indicators (WDI, 2011) of World Bank. The investment series have been used at constant 1995/96 prices. To keep the data set consistent and being satisfied by the relevant econometrical methods, we restricted the series from 1983 to 2011. The variables G*, I*, L*, T*, H* have been used as growth of real Gross Domestic Product, investment GDP ratio, growth of labour force, terms of trade expressed in growth form and growth of human capital respectively.

VI. Econometric Analysis

Relevant econometrical tests have been conducted for checking the validity of the model. At first, data of the model have been tested for the presence of unit root. The order of integration of each variable is determined using Augmented Dickey Fuller (ADF) test. Results are presented in table-1.

Table -1: Augmented Dickey Fuller Results

Trend Assumption	Level/First Difference	Names of the Variables				
		G*= $\left(\frac{dY}{Y_{-1}}\right)$	**I* =** $\left(\frac{I}{Y_{-1}}\right)$	**L* =** $\left(\frac{dL}{L_{-1}}\right)$	**T*=** $\left(\frac{dT}{T_{-1}}\right)$	**H*=** $\left(\frac{dH}{H_{-1}}\right)$
Constant	Level	-2.305088	-1.743788	-1.712320	-6.383136***	-6.978963***
Constant & trend	Level	-12.72863***	-2.444935	-4.166716**	-5.557457***	-6.886792***
Constant	First difference	-5.986924***	-7.734616***	-3.587186**	-7.780009***	-8.189807***
Constant & trend	First difference	-5.867345***	-7.719376***	-3.239032*	-7.661603***	-8.059551***
Note: 1. 1%, 5% and 10% significance level are denoted by (***), (**) and (*) respectively						

Test results presented in Table -1 show that all variables except *Investment* are stationary in level. However, with first difference *Investment* becomes stationary, thus all variables are I(1). Since all the variables are noted to be I(1), there exist a possibility that they share a long run equilibrium which can be tested using co-integration test as stated by Engle and Granger (1987). Co-integration is said to exist between two or more non-stationary time series if they possess the same order of integration and a linear combination of these series is stationary. In order to test null hypothesis of co-integration among variables we perform least square estimation of our specified model. The results of co-integration test are given in Table -2.

Table -2: Residual Based Single Equation Tests For Co-integration

Variables	AEG Lag/ co-efficient	AEG t-statistic	Comment
G*, I*, L*, T*, H*	6	-5.537707	Significant at 1% level
ECM(-1)	-1.068988 (0.0000)	-5.459043	Significant at 1% level

We reject the null hypothesis of no co-integration at 1% level of significance. Error Correction term (ECM) shows the short term dynamic adjustments with the long run equilibrium relationship. The ECM is negative and significant, coefficient of which indicates full adjustment of the disequilibrium, one time period later. Since the error terms of the variables arestationary, we can make inference that the variables will move together and will never diverge in the long run.

Estimated long Run Model (OLS Regression)

Following table contains the results of the estimated long run model as specified in equation - 4:

G* = - 0.021+ 0.283 I*+ 0.255 L* + 0.023 H* - 0.004T*

Table-3

Dependent Variable: G* (growth of GDP)					
Sample: 1983 2011					
Included observations: 29					
Variable	Coefficients	Estimated coefficients	Std. Error	t-Statistic	Prob.
C	α_0	-0.021473	0.013711	-1.566094	0.1304
I*	α_1	0.282599	0.047316	5.972576	0.0000
L*	α_2	0.254786	0.096263	2.646772	0.0141
H*	α_3	0.022995	0.010860	2.117528	0.0448
T*	α_4	-0.004330	0.020613	-0.210079	0.8354
R-squared		0.683955	Mean dependent var		0.049055
Adjusted R-squared		0.628991	S.D. dependent var		0.011639
S.E. of regression		0.007090	Akaike info criterion		-6.899924
Sum squared resid		0.001156	Schwarz criterion		-6.662030
Log likelihood		101.5989	Hannan-Quinn criter.		-6.827197
F-statistic		12.44361	Durbin-Watson stat		2.116665
Prob(F-statistic)		0.000016			

All the explanatory variables except terms of trade (T*) are significant. The variable Investment (I*) is significant at 1% level, whereas Labour (L*) and human capital (H*) are significantly different from zero at 05% significant level. The constant term which assumed to represent the growth of technology is also insignificant.

So far our results tell us that an increase in the investment-income ratio of 1% will raise the growth rate of output by around 0.28 percentage points, also if there is an increase in the growth of labour force by 1% then the growth rate of output will increase by 0.25 percentage points. Coefficients of investment and labour do have important practical implications. Estimated results also support the significant role of human capital, though with the low elasticity (0.023 percentage point) of growth rate of output with respect to it. The result also indicates that terms of trade does not exert a significant effect on growth of output. While there is undoubtedly a relationship between growth of technology and output growth, our estimated results show that its effect is not significantly different from

zero i.e. it does not have any significant impact on growth of output. One reason for having lower responsiveness to the growth of human capital might be the selection of education and health sector govt. expenditure as proxy for H*. There is a lot more to human capital than education and health. But for simplicity and brevity, we focused simply on education and health. H* fails to capture the impact of other government and private sector's contribution. Some models used average years of schooling, as proxy for human capital. But because of lack of consistent and continuous data we were compelled to rely on this. What is important to notice is its positive sign indicating favorable impact of human capital on growth prospect of Bangladesh.

With regard to the growth of Bangladesh the estimates indicate that the major effect can be attributed to increase in the accumulated factors of production (labour & capital). Human capital plays relatively less important role. Output elasticity of labour is almost similar to that of capital. In other words, during the last three decades, the Bangladesh economy relied mainly on capital and labour in the production process. On the basis of these estimates we also observed that there is a seemingly theoretically inconsistent outcome regarding the impact of technological advancement on the growth process of Bangladesh. One conceivable explanation behind this apparently inconsistent outcome might be like that, technological growth did have some impact on growth process, which might have been nullified by the negative impact of intangible factors like absence of governance, lack of absorption capacity and incapability of government to reap the benefit of the technological change.

Short Run (Error Correction Model)

The Error Correction Model (ECM) is formed using the residual lagged one time period as the error correction term. Also the ECM model has been augmented to include the lagged variables (both of dependent GDP growth rate and of regressors investment, labour, human capital and terms of trade) to provide further insight into their relationship. The ECM models the short run dynamics of the model. Short-run error correction version of long-run production relation is shown in the following table:

Table-4

Dependent Variable: DG*

Method: Least Squares

Sample (adjusted): 1984 2011

Included observations: 28 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000765	0.001551	-0.492915	0.6372
DG*(-1)	0.192839	0.376296	0.512466	0.6241
DG*(-2)	0.323982	0.330949	0.978948	0.3602
DG*(-3)	0.198139	0.134265	1.475725	0.1835
DI*	0.659618	0.484431	1.361634	0.2155
DI*(-1)	-0.086853	0.494735	-0.175555	0.8656
DI*(-2)	-0.234007	0.770827	-0.303579	0.7703
DI*(-3)	0.002167	0.353519	0.006130	0.9953
DL*	0.273035	0.249072	1.096208	0.3093
DL*(-1)	0.447651	0.221145	2.024243	0.0826
DL*(-2)	-0.092289	0.277946	-0.332041	0.7496
DL*(-3)	-0.626084	0.267881	-2.337168	0.0521
DH*	0.020384	0.015783	1.291482	0.2375
DH*(-1)	0.004236	0.020174	0.209986	0.8397
DH*(-2)	-0.000402	0.007526	-0.053458	0.9589
DH*(-3)	0.002443	0.012036	0.202957	0.8449
DT*	0.013655	0.036674	0.372341	0.7207
DT*(-1)	0.035021	0.020312	1.724113	0.1283
DT*(-2)	0.033763	0.033387	1.011260	0.3456
DT*(-3)	0.005318	0.023927	0.222279	0.8304
ECM(-1)	-0.969999	0.413376	-2.346529	0.0513

R-squared	0.922121	Mean dependent var	0.000946
Adjusted R-squared	0.699610	S.D. dependent var	0.011715
S.E. of regression	0.006421	F-statistic	4.144158
Sum squared resid	0.000289	Durbin-Watson stat	1.710897

The error correction term tells us the speed with which model returns to equilibrium following an exogenous shock. The estimated ECM coefficient is -.969999, and it is statistically significant. This suggests 97% movement back towards equilibrium following a shock to the model, one time period later.

ECM output also shows that, in the short run, only growth of labour force with two period lag has significant positive impact on growth of GDP. Growth of labour force L* in the 2^{nd} lag has positive co-efficient of 0.447 which is statistically significant at 10% level. No other lagged variables display any significant influence on growth rate of GDP. One conceivable reason for this may be that, the number of observations is not adequate enough to absorb the lag impact appropriately.

Validity of the model:

Since the study based basically on single equation model and the specification does not include several variables that have been considered by other researchers, it is likely that, there might be bias in the estimates due to some of the omitted variables being correlated with the included regressors, or due to there is being a 'feedback' from the dependent variable to some of the regressors. For investigating such possibility we conduct Ramsey's Specification-error test (RESET) (Ramsey and Schmidt, 1976) and end up with test statistic which is not statistically significant and we failed to reject the null hypothesis of "no specification error". Therefore, it seems unlikely that there is a major problem with the specifications used in the study. Also the diagnostic tests including Breusch-Godfrey serial correlation LM test, Jecque-Berra-Normality test and White heteroskedasticity testrevealed that the model has all the desired econometric properties, namely it has a correct functional form and the models residuals are serially uncorrelated, normally distributed and homoskedastic for both the short run ECM model as well as for the long run model. R^2 & Adjusted R^2 are good enough and Durbin–Watson statistics are in line with high degree of model performance. Therefore the quality of the model is justified by statistical methods.

VII. Result Analysis with the practical implication and Policy Lessons

Result Analysis with the practical implication

Estimated results included in the table-2 refer to the significant contribution of capital and labour to economic growth. It is interesting to match the estimated results to the actual trend. During the last three decades sources of growth of Bangladesh were mainly investment and labour. Since the end of the 1980s, investment has risen steadily relative to GDP which would have been expected to raise Bangladesh's economic growth. For developing countries it is expected that labour has no notable impact on growth. As for

developing countries it is more likely that capital per unit of labour is scanty, therefore, marginal productivity is usually insignificant in the case of developing countries. Unlike this usual trend we have positive and significant impact of labour force on economic growth of Bangladesh. Not only that, growth of labour played as important role as was played by the growth of capital. Since the 1980s, while the population growth has been slowed, working age population has continued to reflect faster growth from earlier decades. Changes in the ratio of working age to total population have been contributing to economic growth since the 1980s. This may suggest that Bangladesh has been reaping the demographic dividend of the past population explosion in the recent decades. Moreover, labour market of Bangladesh has experienced a major qualitative and quantitative shift in the labour force with the influx of female labour in the labour force. In addition to that, Bangladesh's economic growth over the past decade has been driven by the growth in GDP per working age person, which can be viewed as a broad measure of labour productivity.

The post-1990 growth pick up is almost entirely driven by changes in labour productivity (Rahman & Yusuf, 2009). This might be an outcome of increased government expenditure on human resource development as well as inserted influence of private sector's initiatives on different aspect of human resource development. This result provides justification for increasing in the government expenditure on health, education, efficiency development, training, and skill development, creation of provision of technical and vocational education.

Estimated result also displays that although the magnitude is low, human capital do have positive and significant impact on growth. Some form of public expenditures- such as outlays on human capital might have been productivity enhancing and indirectly contribute to growth. But Bangladesh lags behind comparable countries in terms of educational attainment (Rahman & Yusuf). The link between education and educational outcome, and the thread connecting the educational outcome to economic growth is also complex and poorly understood.

The portion of output growth not explained by the growth of capital, labour and other inputs has been taken as the growth of TFP or growth of technology in the growth literature. Our estimation ends up with a constant term not significantly different from zero. Theoretically it might sound unrealistic that growth of technology does not have any significant impact on growth. One plausible explanation may be like that – the positive influence of growth of technology on growth process of Bangladesh might have been outweighed by negative impact of both economic and non-economic factors, such as, critical bottlenecks in the supply of essential inputs & services, human capital deficiencies, especially limited access to quality education and training, low absorptive capacity and weak base for adapting more innovative activities and more advanced technologies, low level of economic governance, and weak law and order situation. This could well be the reason for the apparent trend of TFP in Bangladesh.

Increased involvement in international trade has been a major factor in the post-1990 MFP turnaround. But in our result we got coefficient of T* which is not significantly different from Zero. The results indicate that the variable terms of trade is insignificant in explaining the variations in growth rate of GDP, which implies that treating Terms of trade as direct input is not statistically convincing.

Policy Lessons

Most of our findings are consistent with the conventional wisdom regarding the contribution of different factors to growth of GDP. Among the explanatory variables I* & L* seem to have most important effect. Therefore, priority should be given to enhancing the labour force and investment in order to achieve good performance of the economy. Accumulation of capital does play important role, as it ensures proper endowment of the work force. At the same time training, retraining of work force and productivity enhancing initiatives should be there for the effective utilization of the new technologies. Therefore, maintaining and enhancing the contribution of labour force to the growth of Bangladeshrests upon emphasizing on human capital. For Bangladesh Lucas's (1988) suggestion is important in that the socially optimal solution requires greater investments in human capital accumulation. It is likely that the country needs to make significant investment on education. But simply raising educational attainment without reforms in areas, like, creation of adequate opportunity of vocational and need based training; formulation of compatible curriculum etc. does not necessarily increase skill. This possibility has a profound implication for designing appropriate educational policy.

Despite theoretical and worldwide empirical significance of growth of technology and human capital on economic growth, negligible value of coefficient of human capital and insignificant constant term lead us to concentrate on some intangible aspects. In the absence of any persuasive evidence it is indeed difficult to draw any definitive inference about the impact of these intangible aspects. The formation of contemporary economic growth theory is aimed at separating and particularizing the influence of entire set of intangible assets of the economy, like, innovation, institutional effectiveness, education which is expressed through the contribution of the human capital. These aspects are beyond the purview of the quantitative measurement. But what can be inferred is that the qualitative education and effective institutional set up are needed that would be more congenial to economic growth in Bangladesh.

Whatever the case is, there is no disagreement about the fact that for realizing its potential of joining the ranks of the middle income country within the next decade, Bangladesh needs to identify TFP growth as the major engine of growth acceleration. Because the differences in output per worker across countries are, actually, due to differences in physical and human capital per worker and to differences in productivity. Examining across 127 countries Hall & Jones (1998) found that, difference in capital

accumulation, productivity and therefore in output per worker are fundamentally related to social infrastructures that are differences in institutions and government policies which determine the economic environment. They also found that government is the most efficient provider of this supportive environment.

In the context of Bangladesh, it is very likely that ensuring governance or institutional development would raise investment and GDP growth, eliminate rent, and achieve allocative and distributive efficiency. Much has been said, about the endemic corruption that pervades every sphere of life. Recent experience suggests that there is no quick fix to curbing corruption. Good governance requires institutional changes and cultural norms that can take many years, even generations to become established. It is likely to be far easier to simplify procedures, improve the regulatory regime, and develop customized system than to curb corruption. Tackling poor regulatory frameworks and developing systems would appear to be a sensible priority for the country's policy maker. Indeed, regulatory reforms may well facilitate a lasting reduction in corruption. In this regard crucial role must be played by the government.

VIII. Conclusion

In this study an attempt is made to examine and analyse the determinants of growth of GDP of Bangladesh using aggregate production function. Main objective is to identify some policy lessons supportive to achieving higher and sustainable growth of GDP. This study basically takes the model used by Khan and Reinhart (1990) and uses time series data from 1983 to 2011.Time series on identified variables (GDP, Investment, Labour, Human Capital & Terms of Trade) have been tested for stationary using Augmented Dickey-Fuller test of unit root, and co-integration test. Co-integration test in the study suggests the long-run association among the variables. The results indicate that the variable terms of trade is insignificant in explaining the variations in growth rate of GDP. Whereas, variables labour, capital and human capital provide highly significant explanations to the variations in economic growth. The constant term which assumed to represent the growth of technology is also found to be insignificant.

Estimated results suggest that, in Bangladesh growth in the past has largely driven by the acceleration in capital accumulation and expansion of quantity and to some extent quality of labour, with a lesser role played by the human capital and insignificant role by technological growth. But given the resource endowments and other compulsions, the major source of future acceleration of growth would have to come through TFP growth. This would require infusion of new technology; strategy that helps transfer a large portion of labour from informal services to a modern manufacturing sector and organized services; emphasize on R&D, appropriate reform in education policy, accelerating the flow of FDI,

development of human capital and technological skill. And it is the responsibility of the government to create the supportive environment within which individuals and firms make investments, accumulate skills, create and transfer ideas and produce goods and services.

As per as the growth or the possibility of reaching the higher growth trajectory is considered, future prospect of Bangladesh depends upon the capability of exploiting the natural advantage of demographic dividend along with enhanced investment, institutional development, effective coordination among relevant agencies and, above all removing the hindrance posed by the absence of governance. And the main lessons suggested by the present exercise is that, besides putting importance on the growth of conventional factors, like, capital, labour and technological change there should have been focus on these intangible factors as well.

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Appendix - 1

Model Specification:

Y= Af (K, L, H, T)

Where,

Y	is the level of output (usually potential output)
K	is the stock of physical capital
L	is the labour force
H	represents human capital, and
T	denotes the terms of trade (TOT).The variable T reflects the degree of openness of the country and constitutes a kind of input in the production function.
A	measures the factor productivity, which is generally assumed to grow at a (constant) exogenous rate;

Taking total differential and then expressing the equation in growth terms we get:

$$dY = A.\frac{\partial Y}{\partial K}.dK + A.\frac{\partial Y}{\partial L}.dL + A.\frac{\partial Y}{\partial H}.dH + A.\frac{\partial Y}{\partial T}.dT + dA$$

$$\frac{dY}{Y} = \left[A.\frac{\partial Y}{\partial K}\right].\frac{dK}{Y} + \left[A.\frac{\partial Y}{\partial L}.\frac{L}{Y}\right].\frac{dL}{L} + \left[A.\frac{\partial Y}{\partial H}.\frac{H}{Y}\right].\frac{dH}{H} + \left[A.\frac{\partial Y}{\partial T}.\frac{T}{Y}\right].\frac{dT}{T} + f(K,L,H,T)\frac{dA}{Af(K,L,H,T)}.$$

$$\frac{dY}{Y} = \left[A.\frac{\partial Y}{\partial K}\right].\frac{dK}{Y} + \left[A.\frac{\partial Y}{\partial L}.\frac{L}{Y}\right].\frac{dL}{L} + \left[A.\frac{\partial Y}{\partial H}.\frac{H}{Y}\right].\frac{dH}{H} + \left[A.\frac{\partial Y}{\partial T}.\frac{T}{Y}\right].\frac{dT}{T} + \frac{dA}{A}$$

Rewriting for estimation we get:

$$\frac{dY}{Y_{-1}} = \alpha_0 + \alpha_1.\frac{dK}{Y_{-1}} + \alpha_2\frac{dL}{L_{-1}} + \alpha_3.\frac{dH}{H_{-1}} + \alpha_4.\frac{dT}{T_{-1}}$$

Replacing change in capital stock with investment (I) we get:

$$\frac{dY}{Y_{-1}} = \alpha_0 + \alpha_1.\frac{I}{Y_{-1}} + \alpha_2\frac{dL}{L_{-1}} + \alpha_3.\frac{dH}{H_{-1}} + \alpha_4.\frac{dT}{T_{-1}} \qquad (4)$$

Where, $\frac{dY}{Y_{-1}}$ denotes the annual rate of growth of real GDP, and the interpretation of the coefficients are also straight forward as follows:

$\alpha_0 = \frac{dA}{A}$ assumed to capture the growth in productivity or the rate of growth in technological change;

$\alpha_1 = A.\frac{\partial Y}{\partial K}$ is the marginal productivity of physical capital;

$\alpha_2 = A.\frac{\partial Y}{\partial L}.\frac{L}{Y}$ is the elasticity of output with respect to growth of labour force

$\alpha_3 = A.\frac{\partial Y}{\partial H}.\frac{H}{Y}$ is the elasticity of output with respect to growth of human capital

$\alpha_4 = A.\frac{\partial Y}{\partial T}.\frac{T}{Y}$ is the elasticity of output with respect to terms of trade.