Bangladesh Development Studies
Vol. XLII, March 2019, No. 1

Total Factor Productivity in Bangladesh: An Analysis Using Data from 1981 to 2014

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This paper examines the total factor productivity (TFP) growth rate in Bangladesh during 1981-2014, carrying out the growth accounting exercise, and exploring the determinants of TFP growth in Bangladesh. We found that the capital share, obtained from the estimation of the neoclassical Cobb-Douglas production function, varies from half to two-thirds based on the different methods and assumptions used. The growth of factor accumulation still drives the growth of Bangladesh as the share of TFP has been found negative in most of the specifications. Government expenditure on education and instituions, particularly voice and accountability, turn out to be robust and significant in explaining positive TFP growth. On the contrary, increased regulatory control, broad money, inflation, and globalisation are found to impact TFP negatively. Therefore, this paper entails policy suggestions of investment in human capital, ensuring good governance and reforming public administration to enhance the TFP growth in Bangladesh

Keywords: TFP, Middle Income Trap, Cobb-Douglas Production Function, Growth Accounting Exercise, Steady State Growth
JEL Classification: B21, B22,C22, C52, E61, I28, O33,O47

I. INTRODUCTION

Bangladesh has been experiencing a steady increase in the growth rate of real GDP since independence, accelerating from an average of less than 4 per cent per year during 1972-1990 to 6.6 per cent in 2010-2018. Bangladesh is one of the sixteen countries that are waiting to gradauate from LDC status at the same time to secure a position in the middle-income bracket (WDI 2016 database). This

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The authors are grateful to Kazi Iqbal, Senior Research Fellow, Bangladesh Institute of Development Studies (BIDS) for his valuable comments to enrich the paper. The authors also express gratitude to the anonymous Referee and the Editor of the Journal (BDS) for their comments to sharpen the logic of the paper.

growth performance is overwhelming, considering the low initial base. It is a matter of great surprise that the country has successfully managed to continue a 6 per cent growth rate since 1996. The average growth rate of output for 1981-2014 is 4.89 per cent while its population has grown by around 2 per cent (Ministry of Finance, GoB) every year over the same period. The 7th Five Year Plan targeted to achieve 8 per cent annual GDP growth by 2015 and projected to further accelerate this growth to 10 per cent by 2021. The startling growth performance of Bangladesh naturally raises the interest of probing the major factors behind the growth over time. The conventional growth theories state that accumulation of capital, growth of labour force along with the quality of labour, and growth of total factor productivity are the major drivers that contribute to the growth.

Two dimensions of the labour force can contribute to the growth of an economy: increased participation rate of labour and increased productivity of labour. Labour force participation rate has increased by 1.2 times since 1990 (from 47 per cent in 1989-90 to 57 per cent in 2013[1]) followed by a persistent increasing trend over time in Bangladesh. Moreover, labour has also become more productive over time. According to Labour Productivity Index of ADB, the value of index doubled in 2014 from 1980.

The current research on growth accounting identfies capital accumulation as the most crucial determinant of growth in Bangladesh (World Bank 2012, 2007). It is quite consistent and aligned with the empirical evidences of the other developing countries. The share of investment to GDP follows a rising trend from 1986 to 2010. The contribution of private investment has always outweighed the contribution of public investment to GDP. The contribution of public investment to GDP has been more or less steady during the period 1981-2014 (between 5 per cent and 6 per cent). On the other hand, the share of private investment to GDP has increased over the same period. This accumulation of capital has facilitated the expansion and development of production capacities in agriculture, manufacturing, especially in the export-oriented garments sector, infrastructure, and human development.

This study on TFP is important in the light of middle-income trap (MIT). Bangladesh steps into the lower-middle-income economies (LMIEs) club in July 2015. As soon as Bangladesh meets the LMIEs criteria, the plausibility of falling into MIT becomes a crucial concern (Mccartney 2017). The past evidence of

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[1]Labour Force Survey 2013.

graduation phase of many developing countries demonstrates that getting stuck into lower-middle-income country status occurred due to the failure of sustaining their past growth momentum.[2] Empirical evidences also identify the absence of required structural adjustments, the existence of persistent economic vulnerabilities, and failure to develop social and human capital for being trapped into MIT. Since accumulation of physical and human capital is subject to diminishing return, countries relied on only factor accumulation for growth are more likely to get into the MIT. That is, enhancement of TFP is critical to escape the low level equilibrium trap.

Bangladesh experienced an average output growth rate of 4.89 per cent during 1981-2014 while its population has grown by around 1.99 percent every year over the same period. Hence, per-capita output over these years has increased by approximately 2.9 per cent. This growth performance implies that around more than 24 years will be required to double the current per capita income level. However, the average growth rate has increased in recent periods. Average growth rate for the period 2001-2010 stood at 5.66 per cent and for 2011-2014 was 5.98 per cent. On the other hand, population growth rate over the period 2001-2010 and 2011-2014 remains stagnant at 1.21 per cent (Table I). Hence, per capita GDP grows by 4.22 per cent over 2001-2010 and 4.77 per cent for 2011-2014, and with these per capita GDP growth rates, it needs 17 and 15 years respectively to double the current per capita income. However, years taken to double the current level GDP is reduced to around 12 years when per capita GDP growth rates of 5.48 per cent for 2010-2018 and 5.87 per cent for 2014-2018 are taken into account.

[2]It has been observed that many of the countries have fallen into lower MIT; a few into upper MIT. It took Turkey for 50 years to move from lower middle-income to upper middle-income with an average growth rate of 2.6 per cent. While it took 19 years for South Korea to move from lower middle-income to upper middle-income with an average growth rate of 7.2 per cent, it took less than 10 years for China Hong-Kong, Japan, Korea, and Singapore to transit from upper middle-income to high-income countries with as low as growth rate of 4.7 per cent. In contrast, it took for 40 years for Argentina to move from upper middle-income to high-income countries with an average growth rate of 1.2 per cent.

TABLE I

ECONOMIC GROWTH TRENDS IN BANGLADESH

Time Period	GDP growth rate	Population growth rate	Per capita GDP growth rate	Years needed to double the current level of per-capita GDP
1981-2014	4.89	1.99	2.90	24.15
2001-2010	5.66	1.44	4.22	16.60
2011-2014	5.98	1.21	4.77	14.68
2010-2015	6.20	1.15	5.05	13.86
2010-2018	6.61	1.12	5.48	12.77
2014-2018	6.98	1.10	5.87	11.92

Source: Author's calculation.

The per capita GNI of Bangladesh attains compound annual growth rates of 10.28 per cent (from US$800 to US$1,750) over the 2010-2018 period and 12.05 per cent (from US$1,110 to US$1,750) over the 2014-2018 period (source: World Bank Atlas method). The forecast of per capita GNI (PCGNI) required to join the high-income economies in the year 2041, using the extrapolation method based on the per capita GNI ($) threshold level data spanning over 1987-2018, yields a figure of US$19,736 per capita GNI.[3] Based on 32 years of per capita GNI data (1987-2018), extrapolation[4] method has been employed to predict a 23 year ahead data point. Now with 1,750 US dollar per capita GNI in hand in 2018, Bangladesh requires to achieve a compound growth rate of 11.1 per cent per year to join the high-income country club within 23 years. Compared to 12.3 per cent annual compound growth rate of per capita GNI that Bangladesh achieved over 2014-2018, the projected required growth rate of 11.1 per cent seems quite achievable. However, Bangladesh should experience a growth rate of 8.88 per cent in per capita GNI even if the high-income economies threshold level is fixed at the current 2018 level (i.e. US$12,376).

[3]A country is said to join high-income economies club if it has per capita GNI 12,376 US dollar in the year 2018, while this figure for Bangladesh for the same year is 1,750 US dollar.

[4]The advantage of using extrapolation method in economic forecasting is that it takes into account the fluctuations in data (economic business cycle in this specific case) occurred in the past years. Thus, it is predicted that the projected per capita GNI needed to join the high-income economies in 2041 stands out to be 19,736 US dollar, which is obtained through extrapolation based on last 32 years data considering the probable business cycle patterns.

TABLE II

REQUIRED GROWTH RATE TO BE A HIGH-INCOME ECONOMY COUNTRY BY 2041

Hypothetical per capita GNI (PCGNI) threshold income scenario to joinhigh- income economies in 2041	Corresponding per capita GNI growth rate needed per year for Bangladesh to be a high-income country in 2041	Compound growth rate of per capita GNI for Bangladesh (2014-2018)
Current value of PCGNI =12,376	8.88%	
Hypothetical value of PCGNI =15,000	9.79%	12.05%
Extrapolated value of PCGNI =19,736	11.11%	
Hypothetical value of PCGNI =20,000	11.17%	

Source: Authors' calculation.

If Bangladesh can sustain its per capita GNI growth rate of 12.05 per cent, which it achieved during the 2014-2018 period, the dream of being a high-income country can be easily implemented with this impressive rate. Per capita GDP growth of Bangladesh hits at 1,698.26 USD in 2018. The average annual compound growth rate of per capita GDP over 2010-18 stands out 10.19 per cent (from 781.15 USD in 2010 to 1,698.26 USD in 2018). If the time span is reduced, the same figure over 2014-18 stands at 11 per cent (1,118.85 USD in 2014 to 1,698.26 USD in 2018) and shows a prominent performance of per capita GDP growth. To double the current per capita GDP (1,698.26 USD in 2018) in 15 years and 10 years, the growth rate should be around 4.73 per cent and 7.18 per cent, respectively. Since the economy of Bangladesh has recently experienced a 7 per cent growth for the first time breaking down the circle of 6 per cent growth, it is expected that Bangladesh may double its per capita GDP in between next 10 to 15 years conditional on the sustenance of the current growth rate. Hence, the concern may be eased by addressing the question- how to sustain as well as increase the current rate of growth.

The rest of the paper is organised as follows. Section II provides an overview of the literature on growth models and TFP. Section III illustrates the methodologies adopted for estimation of TFP and growth accounting exercises. While section IV shows the result of determinants of TFP, section V discusses the results. Section VI contains policy suggestions, and section VII summarises the main conclusions.

II. TFP AND ITS DETERMINANTS: LITERATURE REVIEW

The number of literature on the estimation of TFP of Bangladesh and its determinants using standard econometric tools and time series data is limited. However, the volume of international literature on the issue is large that enables us to carry out the growth accounting exercise in different aspects.

Mujeri (2004) related the changes in policy framework with the growth of TFP in Bangladesh using the growth accounting framework to measure relative contributions of labour, capital, TFP growth in different policy regimes (1974-2006). This growth accounting framework concluded that capital accumulation played a significant role in most of the periods since 1970 with a slight dropping in the early 1990s. The growth of TFP follows a decreasing trend in different periods from 1974 to 1996, which then again reached the highest peak in 1997-2006. However, there had been a drastic fall in the growth of TFP from 0.27 per cent in 1983-1990 to 0.06 per cent in 1991-1996. The study also attempted to examine the determinants of TFP using plausible explanatory variables: impact of inflation, public consumption, real effective exchange rate (REER), and trade openness. The analyses showed that appreciation of REER had a significant negative impact on TFP, while increased trade openness yields higher productivity growth. Inflation and public consumption turned out to be statistically insignificant with a negative and positive effect on TFP growth, respectively. One of the limitations of this study can be explained by its methodological approach in estimating TFP, as well as determinants of TFP. In both regressions, time series methodology had not been applied.

Basu and Maertens (2007) analysed the causes of the growth of Indian economy during 1950-51 to 2006-07 period discussing the broad macro parameters and shed light on the debate on the growth composition and the relative importance of the factors involved in production processes along with their responses during different policy regimes. It concluded that the pre-1980 growth was driven by an accumulation of production factors, in which TFP has no role. However, the contribution of TFP to growth started surfacing up in the post-1980 growth. Hence, this study marked the decade of 1980s to be the take-off period of TFP for the Indian economy. Afterwards, an ascending positive pattern from the negative or zero state of TFP series was observed, which ultimately helped to sustain the economic growth. More importantly, this study concluded that TFP growth stemmed from the improved performances of the individual sectors instead of resource transfer from low productive sectors to higher productive sectors.

Jajri (2007) estimated production frontier, TFP growth, and determinants of TFP for Malaysian economy during 1971-2004. This study elicited technological change and technical efficiency change from the TFP series using the Malmquist productivity index. The study revealed a negative contribution of technical efficiency, which ultimately resulted in a lower level of TFP growth. It implied that the economy would experience a shift in production frontier in the presence of innovation. Trade openness and inter-sectoral resource mobilisation were attributed to be the prime sources of TFP growth for the Malaysian economy. The study emphasised on the efficient utilisation of human capital existing currently in the labour market, enabling workers skills for interacting with sophisticated technology and introducing the new technology in the economy as a means to increase the long-run growth rate through augmenting the role of TFP.

Rao and Hassan (2011) developed a framework to analyse the determinants of the long-term growth rate of Bangladesh based on the Solow (1956) growth model and its extension by Mankiw, Romer and Weil (1992) and followed by Senhadji's (2000) growth accounting procedure to estimate total factor productivity (TFP). Their growth accounting framework concluded that factor accumulation played a significant role in growth rate in Bangladesh, until 1990. TFP, with a minimal contribution, affected the growth positively after 1990. Its contribution accounted for about 1 per cent during the decade of the 1990s and then decreased to 0.5 per cent during the first eight years of 2000. An analysis of the determinants of TFP was carried out with the lagged value of explanatory variables for up to three years. The current government expenditures, inflation rate, trade liberalisation, investment, remittance, official development assistance (ODA), broad money (M2), and foreign direct investment have been used as the explanatory variables. All these variables came up with expected relation with TFP except remittance. Remittance seemed to affect TFP negatively, which could not be justified by any direct pieces of evidence.

Saha (2014) estimated TFP for the Indian economy during the period 1961-2008 utilising the conventional growth accounting approach. The study showed that the Indian economy encountered technological retrogress during the 1970s due to the average negative TFP growth in comparison to the low or zero average TFP growth during the 1960s. The study held the external shocks including war, drought, oil price-hike along with rigid rules mainly responsible for poor performances of TFP growth in these decades. However, the study concluded that internal economic reforms measures taken up during the 1980s paved the way for the amelioration of TFP growth for the next years. Thus, on average, the TFP growth registered to be 1.49 per cent for the Indian economy during the study period.

Akinlo and Adejumo (2016) explored the short-term and long-term determinants of TFP for the Nigerian economy during 1970-2009. The study revealed that human capital and trade openness impact TFP positively in the short-run and negatively in the long-run. On the contrary, foreign direct investment has a positive impact on TFP in the long-run but a negative impact in the short-run. In addition, inflation and unemployment rate deters TFP growth in the long-run and short-run, respectively. The study emphasises on adopting policies that ameliorate quality of education, stimulate intermediate imports and non-oil exports, and decrease the inflation and unemployment rate, which will increase TFP growth and, in turn, output growth.

Amjad and Awais (2016) explored the growth performance of Pakistan economy using the endogenous growth framework for the period 1980-2015 and obtained a deteriorating trend in TFP growth and labour productivity for the study period. This study identified inconsistency in achieving high growth rates and lower investment to be the prime cause of declining TFP growth. It also revealed that the economy cannot reap the benefit of education to promote necessary skills that facilitate economic growth through the roles of increasing TFP. This study, then, proposed adopting economic reforms such as introducing efficient skills in using factors of production as well as a technology-based curriculum to increase TFP growth. Also, deregulatory measures such as enabling environment for competition and private sector participation appeared to foster economic growth.

Bhattacharjee (2016) attempted to pin down the role of institutions coupled with human and physical capital stock, trade openness, and liberalisation on the economic growth of the four major economies of South Asia, using both time series and panel data analysis. Time series analysis showed that physical capital stock has a significant long-run positive impact on the growth across the countries. In contrast, the panel data analysis revealed that ensuring voice and accountability and regulation yield a significantly positive impact on the growth of the countries. In addition, government effectiveness and the rule of law imprint a significant negative impact on the per capita GDP of the countries. The study calls for ensuring and enabling the quality of institutions along with higher investment in human and physical capital for the study countries to sustain growth in future.

III. ESTIMATION OF TOTAL FACTOR PRODUCTIVITY IN BANGLADESH

The discussion on economics and dynamics of growth in existing theoretical and empirical literature has been based on the extensive use of two major theoretical growth models. The first is the Solow (1956) exogenous growth model, and the other is the canonical endogenous growth models of Uzawa (1968), Romer (1986,1990), Lucas (1988) and Barro (1990) and their variants. Rao and Cooray (2008) have emphasised the usefulness of the Solow model to explain both the long-run steady-state growth rate and the dynamics of growth between the steady states.

Solow (1956) model, also known as a Neoclassical model, assumes exogenous technological improvement, no international trade (since there is only one good-GDP), and perfect competition in all markets. Technology is assumed to be publicly available as a non-excludable, non-rival good. Labour and capital shares are constant in the long run. In the Solow model, countries with higher savings or investment rate can accommodate more capital per worker and thus generate more output per worker, which, in turn, will lead to the countries to higher-income economies. In contrast, high population growth will result in poorer fate to a nation. Changes in the investment rate and the population growth rate are unable to change the long-run growth rate, though it can bring changes in the long-run level of output per worker. Policy changes have level effects since it inserts a change in the level of per capita output permanently in response to a permanent policy change but proves its numbness to change the long-run growth rate.

Mankiw, Romer, and Weil (MRW 1992) attempted to test the validity of the Solow model. They introduced human capital in the Solow model to have a better fit of the model across countries. They also show how the Solow model resolves both the long-run steady-state growth and the transitional movement of growth between steady states. This variant of the Solow model conforms to the empirical literature on labour economics. They conclude that higher investment in physical capital, low population rate, a higher level of technology, and higher time spent on skills accumulation make countries richer.

The neoclassical growth models hold the view that either the savings rate (the Harrod–Domar model) or the rate of technical progress (the Solow model) exogenously determines the long-run growth rate. However, it cannot explain how the savings rate and the rate of technological progress are determined. To get rid of this shortfall, endogenous growth theory attempts to incorporate microeconomic foundations in a macroeconomic model. Investment in human capital, technological innovation, and knowledge are regarded as the key to economic growth as per the endogenous growth theory. According to it, long-run economic development of a country results from positive externalities, spillover effects of a knowledge-based economy and policy changes. This theory advocates adopting policies in favour of embracing openness, supporting competition and technological progress to foster growth (Fadare 2012). However, one of the major limitations lies in its collective failure to elucidate conditional convergence outlined in the empirical literature (Sachs and Warner 1997). It is beyond our scope to check endogenous growth theory by empirical evidence "too much of it involved making assumptions about how unmeasurable things affected other unmeasurable things." (Krugman 2013)

To begin with, the Solow model (1956) assumes a standard Cobb-Douglas production function that satisfies the constant returns to scale (CRS) assumption in both factors of production (capital and labour) with Harrod-neutral technological progress that allows improvements in technology to increase the efficiency of labour. Technical development of this form is thus labour-saving since the labour force in efficiency units increases faster than the number of workers available. The factors of production are allowed to grow up to the point where the marginal productivity of capital (MPK) pays off equivalent to the market rate of interest. Population growth is the source of labour growth, while the exogenous technological progress breeds into the growth of the stock of knowledge.

The mathematical representation of the Solow model with accompanying assumptions takes the form:

$$Y_t = K_t^{\alpha}(A_t * L_t)_t^{1-\alpha} \quad (1)$$

$$\Delta K_t = I_t - \boldsymbol{\delta} K_t \quad (2)$$

$$I_t = sY_t \quad (3)$$

$$\Delta l_t = n \quad (4)$$

$$\Delta l_t = g \quad (5)$$

where Y = output, K = capital, A = stock of knowledge, L = labour, $\boldsymbol{\delta}$= depreciation rate, s = propensity to save, n = growth rate of lathe labour force and g = growth rate of the stock of knowledge. The point at which the marginal productivity of capital (MPK) equals to the market rate of interest followed by net investment scores zero pins out the steady-state or equilibrium since Euler's theorem states that if each factor is paid its marginal product, then the sum of these factor payments equals output. Hence, the steady-state output per worker is settled at-

$$y^{*}=\left(\frac{s}{\delta+g+n}\right)^{\frac{\alpha}{1-\alpha}} A \tag{6}$$

Taking into account these parameters to be constant, the above equations reveal that the equilibrium growth rate of output per worker is roughly approximate to the parameter g, which is the TFP growth rate. The Solow model is called exogenous growth model since the steady-state growth rate of an economy equals TFP growth rate, and this very TFP is assumed to be exogenously determined in the Solow model.

The above steady-state per capita output equation directly stems from the assumption of diminishing marginal returns. It follows that if all of the parameters — savings rates (s), depreciation rate ($\boldsymbol{\delta}$), population growth rates(n), rates of technical progress(g)— of any two countries are equal in magnitude, these two countries must eventually achieve the same level of per capita income. The Solow model implies that compared to the capital abundant rich counterparts, the countries with lower initial per capita capital stock will reap the benefit of higher marginal productivity of per capita capital (or equivalently, per capita income). Hence,the resulting higher growth rates of these lower income countries will help attain higher level of GDP in the long run, and this will eventually lead all countries to converge at a steady-state per capita growth rate irrespective of the initial stage variations in growth rate across countries. In the long run, all countries will achieve the equilibrium (steady-state) growth rate, which will be equal to the growth rate of TFP. This central prediction of the Solow model is popularly known as Convergence hypothesis, and this has been examined in many academic papers to be confirmed for the validity of the Solow model.

Baumol (1986) tested convergence hypothesis by regressing the log difference in per capita income between 1870 and 1979 on the log of 1870 per capita income along with constant, covering the same 16 rich countries of Madison data. He concluded that despite wide differences in per capita income level at the initial year of 1870, almost all the initial gaps in per capita income had been removed by 1979. Baumol’s finding supported unconditional convergence hypothesis to be true for rich countries quite strongly. De Long (1988), however, criticised Baumol’s work for being plagued by selection bias and convergence did not exist. The absence of strong support in favour of the convergence hypothesis and assumption of exogenously determined TFP can largely be attributed to the cause of gaining wider acceptance of endogenous growth model.

Mankiw, Romer, and Weil (1992) tested the claims of Solow (1956) on the growth model in a panel data set up using the data from Penn World Table over 1960-1985. This study found a capital share estimate as high as 0.60, much higher than the stylised value (based on the U.S. data) of approximately one-third. In addition, the findings of the study provide evidence in favour of the Solow model in that in the long-run equilibrium, saving exerts a positive influence on real output per worker by country, while the correlation between labour force growth and real output per worker by country is found to be negative.

MRW (1992) brings extensions into the Solow model by incorporating human capital (H) into the production function. They develop a conditional convergence hypothesis leaving the traditional one by reasoning that it is not necessary to have the same capital-labour ratio for countries to converge to the same growth rate. The paradox of savings implies that countries with varying initial capital-labour ratio and propensity to saving but having a similar level of technological capabilities, and population growth should converge to the same growth rate. Specifically, the steady-state growth rate will vary across countries, and instead of converging to a unique SSGR as is stated in absolute convergence, different countries will converge to different SSGRs.

Though the MRW has shown the pervasive applicability of extended Solow model in various set up including panel data also, the problem of exogenously determined TFP remains a concern. Senhadji (2000) then comes up with the idea to find out the factors which determine exogenous TFP. In this regard, he makes the use of extended Solow model and uses the growth accounting framework to estimate the TFP as Solow residual. He has performed this exercise for a total of 88 developed and developing countries to avoid the selection bias and concluded the convergence hypothesis to be supported by his data set. This approach of Senhadji (2000) has received considerable attention and has been widely used for policy formulation.

3.1 Estimating the Production Function

To begin with the analysis of the Solow growth model for conducting the growth accounting exercise, this paper uses the Cobb-Douglas Production function with Harrod-neutral technological progress and constant returns to scale assumption. The growth accounting exercise (GAE) has been performed with the obtained share of factors of production from the estimated Cobb-Douglas production function to determine the contribution of factor accumulation to growth. The discrepancy between the realised growth rate and growth due to factor accumulation yields the TFP series. This paper then seeks to find out the determinants of TFP with its underlying causes and explain the relevance of these determinants in the context of Bangladesh.

Estimating the production function is considered to be the first step to determine the TFP. Following the popular work of Senhadji (2000), this paper attempts to estimate the extended Cobb-Douglas production function of the form:

$$Y_t = A_t K_t^{\alpha} (H_t * L_t)_t^{\beta} \tag{7}$$

where Y= output, A= stock of knowledge, H=index of human capital formulation through years of schooling, L= employment, and K=capital stock. The constant returns to scale (CRS) assumption allows transforming the above aggregate production function to intensive form-

$$y_t = A_t k_t^{\alpha} \tag{8}$$

where *y=(Y/H*L) and k= (K/ H*L)*. The variables in the intensive form production function are measured in per worker terms adjusted for skill improvement.

This paper attempts to estimate both the aggregate and intensive Cobb-Douglas production function with the help of four specific methods: the Ordinary Least Squares (OLS) methods; the Fully Modified Ordinary Least Squares (FMOLS) of Phillips and Hansen (1990); the Vector Error Correction (VEC) model and Auto-Regressive Distributed Lag (ARDL) model of Pesaran and Shin *et al.* (2001).

To estimate the Cobb-Douglas production function in a time series set-up, it is necessary to check for the unit root tests for the concerned variables. The major four types of unit root tests (i.e. ADF, PP, KPSS and DF-GLS (ERS)) have been performed in this regard on the variables with both level and first difference form. Besides, to be more accurate, variables are tested with both constant with the trend and without trend forms.

The results of the unit root tests (reported in Annex Table 2A.1a and Table 2A.1b) show that all of the four-unit root tests confirm that labour and output (GDP) are found to be I(1), that is, they contain a unit root. It implies that these two variables are non-stationary at levels but becomes stationary at first-difference. It is obvious that the capital variable is not found to be I(1) by ADF test but is found at the PP test (constant without trend). However, that capital variable is confirmed to be I(1) by the KPSS unit root test. Therefore, all of the three variables (capital, labour, output) needed for the estimation of production function are found to be non-stationary at levels, but stationary at first-difference; in other words, all of these three variables are I(1).

To estimate the Cobb-Douglas production function the first step is to estimate TFP. Four types of methods, namely OLS at first difference, Vector Error Correction (VEC) model, Fully Modified Ordinary Least Squares (FMOLS), and Auto Regressive Distributed Lag (ARDL) model, have been employed to check for the robustness of the estimated parameters. Since the variables are integrated of order one, which means these are not stationary at levels, so running the simple OLS will provide a misleading (spurious) result unless the stochastic trend is removed. Hence, OLS is run at the first difference of the variables, which are now stationary to obtain accurate results.

Phillips and Hansen (1990) propose an estimator which employs a semi-parametric correction to eliminate the problems caused by the long-run correlation between the cointegrating equation and stochastic regressors innovations. The resulting Fully Modified OLS (FMOLS) estimator is asymptotically unbiased and has a fully efficient mixture of normal asymptotics allowing for standard Wald tests based on asymptotic Chi-square statistical inference. The advantage of FMOLS over the OLS lies in the fact that it can deal with the serial correlation problem. When all of the variables are found to be the same order of integration, it is easier to estimate such an equation. It is a prerequisite for the Vector Error Correction Model to be all of the variables be the same order of integration. So, when the cointegration test is applied, it shows that all of these variables are cointegrated; that is, all of these variables share an equilibrium relationship in the long run. Hence, the Vector Error Correction model is the ultimate choice in case of cointegration among these variables. If these variables are not found to be cointegrated, Vector Auto-Regressive Model would be the option to use in that case. As a rationale to use the last method namely ARDL, the advantage of this over VEC model is that it permits to incorporate the different order of integrated variables (a mixture of I(1) and I(0) variables)) in a single equation.

When the OLS is run over the first-differenced stationary variables, it provides capital share (α) to be 0.68 along with labour share of around 0.30 (Table III). The FMOLS estimate gives a share of capital as high as 0.69. The ARDL estimate of α is found to be 0.654, while the VEC model yields the share of capital to be around 0.49. The coefficients of the share of capital along with labour share are found to be highly significant in all of the four cases. It implies that in the production processes, both labour and capital play a vital role. Table III shows the results for the aggregate Cobb-Douglas production function case. Hence, it is now of interest to observe whether the Cobb-Douglas production function exhibits the constant returns to scale assumption.

The production function: $Y_t = A_t K_t^{\alpha} (H_t * L_t)_t^{\beta}$

TABLE III

ESTIMATES OF THE COBB-DOUGLAS PRODUCTION FUNCTION (AGGREGATE FORM)

Method	Intercept	α	β
OLS at First difference	-0.06 (0.67) [0.51]	0.684 (7.49) [0.000]	0.299 (2.23) [0.03]
Vector Error Correction (VEC)	2.47	0.493 (7.43)	0.527 (4.56)
Fully Modified Least Squares (FMOLS)	1.65 (2.88) [0.07]	0.699 (14.21) [0.000]	0.121 (1.66) [0.10]
ARDL (Bounds Test)	0.06 (0.05) [0.96]	0.654 (8.20) [0.000]	0.255 (1.85) [0.07]

Note: Figures in parentheses and brackets show t-values and p-values, respectively.

The assumption of CRS breeds into the idea of intensive form production function estimates. If the production function is found to exhibit constant returns to scale property, the intensive production function can be estimated. The exercise of estimating the intensive form of Cobb-Douglas production function provides the scope of comparing wide ranges of capital share across different forms of production functions. To check for the CRS assumption, the null hypothesis of the capital and labour share adding up to one is tested against the alternative hypothesis of both the share being not equal to one.

H_0: α+β=1

H_1: α+β≠1

For brevity purpose, the result of the CRS assumption is presented below for the first-differenced OLS and FMOLS methods. It reveals that the CRS assumption varies across the methods used. The first difference OLS method supports the CRS assumption, while the FMOLS does not. The results of the Wald test Statistic with OLS at First difference under the null of CRS assumption is reported in Table IV.

TABLE IV

THE RESULTS OF THE WALD TEST STATISTIC WITH OLS AT THE FIRST DIFFERENCE FOR TESTING CRS ASSUMPTION

Test Statistic	Value	df	Probability
t-statistic	-0.0899	30	0.9289
F-statistic	0.008	(1,30)	0.9289
Chi-square	0.008	1	0.9283

Obviously, this result shows that the null of CRS cannot be rejected. It supports the CRS assumption.

The results of the Wald test Statistic with FMOLS at a level under the null of CRS assumption is reported in Table V.

TABLE V

THE RESULTS OF THE WALD TEST STATISTIC WITH FMOLS AT A LEVEL FOR TESTING CRS ASSUMPTION

Test Statistic	Value	df	Probability
t-statistic	-7.17	30	0.000
F-statistic	51.40	(1,30)	0.000
Chi-square	51.40	1	0.000

The above result shows that the null of CRS can be rejected safely. So, the CRS assumption does not hold.

Since there is no straight way to conclude whether the CRS assumption holds in the production processes, this study intends to incorporate both the CRS and non-CRS assumption to be in the safe side. Once accepted the CRS assumption, the results for the intensive form of the production function is presented in Table VI.

TABLE VI

ESTIMATES OF THE COBB-DOUGLAS INTENSIVE FORM PRODUCTION FUNCTION

Production function	$y_t = A_t k_t^{\alpha}$	
Method	**Intercept**	**α**
OLS at First difference	-0.007 (4.33) [0.000]	0.689 (10.96) [0.000]
Vector Error Correction (VEC)	-2.18	0.47 (14.50)
Fully Modified Least Squares (FMOLS)	-0.007 (3.22) [0.003]	0.699 (8.76) [0.000]
ARDL (Bounds Test)	-0.007 (2.80) [0.009]	0.709 (7.69) [0.000]

Note: Figures in parentheses and brackets show t-values and p-values respectively.

It is observed that even in the intensive production form, the share of capital resonates the magnitude and significance level of the aggregate production function. The share of capital ranges from around 0.47 to 0.71 across the different methods with all of the coefficients retaining the significant levels. To sum up, the share of capital varies between the range of 0.47 and 0.70. The empirical studies of many growth accounting exercises report the share of capital to be approximately one-third. Why does this study find the share of capital varying in the domain of half to around two-thirds for Bangladesh instead of the stylised value of one-third for the developed countries? At first glance, it might seem surprising to obtain such a high value of the capital share in the production processes of Bangladesh. This study is not the sole one to come up with a higher share of capital in the production processes of Bangladesh. There are at least three empirical evidences to present in favour of obtaining a high share of capital for Bangladesh. The studies carried out so far (Senhadji 2000, Mujeri 2004, Rao and Hassan 2009) also corroborate the notion of a higher share of capital contribution to the Bangladesh economy. Though these studies are different in terms of econometric methods, assumptions and time frame even, all of these reveal that capital share for Bangladesh always exceeded the benchmark of one-third usually set for the developed countries. Senhadji (2000) reported the contribution of capital in the output of Bangladesh to be around 0.41 during the period 1960-1994 using the FMOLS method. Additionally, Mujeri (2004) also obtained capital share around 0.65 for the period 1997-2006 using OLS method in the intensive form production function. Lastly, Rao and Hassan (2009) even also accounted for the capital share of output as high as 0.53 over the period 1970-2007 using the LSE-Hendry General to Specific (GETS) method. Hence, all of these study findings reveal that the share of capital is burgeoning as recent time periods are taken into account.

Another striking feature includes the lower share of labour for Bangladesh. IMF *World Economic Outlook* (April 2017, chapter 3) documents and analyses the downward trend of labour in the labour share of income since the early 1990s. The study reports that in a sample of 54 emerging market and developing economies (for which, on average, the decline in the labour share over the sample period is concentrated in the early 1990s), the labour share declined in 32 economies, which accounted for about 70 per cent of 2014 emerging market GDP while rising or remaining roughly constant in the rest. Global integration, and more specifically participation in global value chains, appears to be an important factor behind the decline in the labour share of income. The lower labour share in this study can also be explained with the same reasoning in this regard. Therefore, the findings of the increased share of capital in this study should not be a matter of concern considering the inclusion of recent periods instead of older ones compared to other studies.

The reason for obtaining such a higher value for the capital share involves the socio-economic spectrum of a country. *First*, the developed countries have an abundance of capital, and these countries basically run capital-intensive production. Due to capital abundance, the additional unit of capital has a meagre scope to contribute to the production. Hence, the share of capital in the developed countries is found to be one-third. On the contrary, the developing countries are starved of capital and abundant labour. So, the marginal productivity of capital in the production processes of the developing countries seems to be naturally high. This statement is particularly true for a developing country like Bangladesh, which has an abundance of labour supply and scarcity of capital. So, any additional unit of capital has the opportunity to contribute more to the production processes. Hence, the capital share is found to contribute to around half to two-thirds. *Second*, the developed countries have a good recording system which the developing countries lack in. The record of capital is not well maintained in the developing and third world countries as is maintained in the developed countries. So, reporting error can be, to some extent, attributed to the higher value of the capital share. *Third*, many components pertaining to technological development and technological import in the developing countries are taken into account as capital development. It may inflate the share of capital demeaning the contribution of technological progress. For example, when a computer is imported in a developing country like Bangladesh, it is merely considered as an import of capital goods, but the impact of technology that it brings and increases the efficiency of the labour is completely ignored in this case. It may also result in a higher share of capital which in turn undermines the impact of technological progress. For these reasons, the obtained capital share seems somewhat high. The higher productivity of capital, lack of better data management tool in recording capital accumulation, and the inflated share of capital demeaning the contribution of technological progress in developing countries compared to developed countries can be attributed for this higher capital share.

To sum up, this paper takes into account the estimates of the Cobb-Douglas production function in intensive form and in aggregate form with both CRS and non-CRS assumptions for robustness purposes. When these three cases (an intensive form of the production function and an aggregated form of the production function with CRS and non-CRS assumptions) estimated with the four types of econometric methods will produce a total of twelve point-estimate for the capital share which, in turn, yields twelve series of TFP measures. Differentiating the CRS specification of the Cobb-Douglas production function and rearranging terms yields:

$$d\ln Y = d\ln A + \alpha(d\ln K) + (1-\alpha)(d\ln L + d\ln H)$$

$$TFP = d\ln A = d\ln y - \alpha \ln k$$

$$\frac{\partial TFP}{\partial \alpha} = -\ln k < 0 \qquad (9)$$

Equation 9 states that the capital share and TFP are inversely proportional; more specifically, the higher the value of a share of capital, the lower will be the TFP contribution in the production processes. Since the share of capital is held constant in the growth accounting framework (GAE), the mechanism through which TFP is estimated, the higher value of capital share does not fundamentally influence the regression results of potential determinants of TFP. Hence, the determinants of the TFP will provide approximately the identical coefficients, irrespective of the higher or lower values of capital share.

3.2 Growth Accounting Exercise

The growth accounting exercise (GAE) is aimed at identifying the contributions from different factors of production in the economic growth rate of a country. This study executes the empirical growth accounting exercise by both aggregate production function with CRS and non-CRS assumptions and intensive form production function of the Cobb-Douglas form. With the help of growth accounting, it would be possible to discern the impact of capital and effective labour on the output, which later paves the way for determining the impact of TFP on output. The contribution growth of output made by the growth of factor inputs (capital and labour) is accounted for growth due to factor accumulation, and the part of growth which remains unaccounted is considered to be “technological progress” or TFP growth referred by Solow (1956). TFP growth helps net out the impact of the intangible aspects of human progress which enable both labour and capital to increase their productivity. TFP is calculated as a residual of growth which remains unexplained after distributing the growth rate into the respective factor of productions.

$$DlnA = DlnY - [\alpha(DlnK + (1-\alpha)(DlnL + DlnH)] \qquad (10)$$

$$DlnA = D\, lny - \alpha Dlnk \qquad (10.A)$$

TABLE VII

DECOMPOSITION OF GROWTH WITH CAPITAL ELASTICITIES OBTAINED FROM AGGREGATE PRODUCTION FUNCTION

				OLS with α=0.684 β=0.299 under non-existence of CRS assumption		OLS with α=0.684 Under the existence of CRS assumption	
	Mean ΔlnY	Mean ΔlnK	Mean Δln(L+HK)	Growth due to Factor Accumulation	Growth due to *Total Factor Productivity*	Growth due to Factor Accumulation	Growth due to *Total Factor Productivity*
1981-2014	0.0489	0.0612	0.0317	0.0547	-0.0059	0.0555	-0.0066
Contribution to Growth (%)				111.9724	-11.9724	113.5010	-13.5010
1981-1990	0.0365	0.0421	0.0385	0.0437	-0.0073	0.0446	-0.0081
Contribution to Growth (%)				119.9555	-19.9555	122.2891	-22.2891
1991-2000	0.0469	0.0600	0.0286	0.0530	-0.0061	0.0537	-0.0068
Contribution to Growth (%)				113.0918	-13.0918	114.5448	-14.5448
2001-2010	0.0566	0.0736	0.0305	0.0634	-0.0068	0.0642	-0.0076
Contribution to Growth (%)				112.0713	-12.0713	113.3875	-13.3875
2011-2015	0.0598	0.0731	0.0275	0.0621	-0.0022	0.0628	-0.0029
Contribution to Growth (%)				103.7279	-3.7279	104.8733	-4.8733

Table VII presents the results of the growth accounting exercise with respective TFP measures. It is observed that for the period 1981-2014, Bangladesh achieved 4.89 per cent growth rate propelled by an impressive capital growth rate of 6.12 per cent coupled with 3.17 per cent effective labour growth rate for the period 1981-2014. The labour productivity growth is in line with the world bank estimate of 3.4 per cent during the period 2003-2013. The table also reveals that factor accumulation can be largely attributed to the growth of Bangladesh. The factor accumulation growth rate over the same period stands out approximately 5.47 per cent and 5.55 per cent calculated with the OLS estimate of capital share under the non-CRS and CRS assumption of the aggregate Cobb-Douglas production function. Furthermore, it is noteworthy that, over this period, the factor accumulation growth rate remains higher than that of the growth rate of Bangladesh, which, in turn, sheds light on the scenario of the negative growth rate of TFP. Negative TFP means that the factors used in the production processes of the country get inefficient day by day and stand out to be a prevalent phenomenon in the developing countries. It suggests that Bangladesh has the scope for further increasing the growth rate of the economy only if it can bring negative productivity growth down to at least at zero level. Even if the factor productivity growth were at least zero, the growth rate would have been around 5.48 per cent (a non-CRS assumption with OLS estimate) to 5.55 per cent (CRS assumption with OLS estimate). The rest of the five tables of growth decomposition with different $\boldsymbol{\alpha}$ estimates and existence of CRS assumptions are also simulated and reported in the annex 2 (Tables 2A.2 to 2A.6).

If the total twelve scenarios of TFP (from Table 2A.1 to Table 2A.6 in annex 2) are now taken into consideration, it expresses that TFP is found to be negative in 11 out of 12 cases for Bangladesh over the period 1981-2014. The only white crow for which TFP is found to be positive over the same period is obtained when the FMOLS estimate of capital share under the non-CRS assumption is put into the growth accounting equation. It states that TFP attained a growth rate of 2.16 per cent over the period 1981-2014 in Bangladesh. To be more specific, out of the overall growth of 4.89 per cent over the period 1981-2014, TFP has the contribution to growth by 0.11 per cent. Though positive, the magnitude of TFP growth remains negligible. TFP growth over the whole period, in the range of negative growth cases, attained a less negative growth of -4.28 per cent with the capital share estimated by ARDL method under the non-CRS assumption. If TFP growth were at least zero instead of -4.28 per cent, Bangladesh could have attained a growth of 5.10 per cent for the whole period instead of 4.89 per cent. On the contrary, the highest negative TFP growth of -14.36 per cent is found with the capital estimated by ARDL method under the intensive form of Cobb-Douglas production function. If this could be reverted to at least zero, Bangladesh would then achieve overall growth of 5.59 per cent for the whole period.

Differences in TFP growth of Bangladesh exist across the literature. It stems chiefly from the differences in study periods, estimation techniques of the production function, etc. Studies that consider more recent periods tend to report positive, though negligible in magnitude, contribution of TFP to growth in Bangladesh. However, studies dealing with longer time frame, like this study, usually come up with the negative TFP growth rate. Hence, it indicates that this study is not the sole one to report negative TFP growth. Interestingly, studies with negative TFP growth also vary in terms of its magnitude. In resonance with this study, Sinha (2017) also states: "The average growth rate of TFP during 1991 – 2011 has barely managed to remain in the positive territory." The TFP series calculated from PWT8.1 data in this study also revealed the overall Negative TFP growth for Bangladesh economy during 1991-2011 periods. Based on the past scenario, this paper also casts doubt on experiencing any meaningful TFP growth in Bangladesh in the long-term. Moreover, the IRBD report (2016) by CPD also claims that TFP registers a negative growth for Bangladesh during the period 1991-

2014. The World Bank data was used in this study to estimate TFP from the Cobb-Douglas Aggregate Production function with constant returns to scale property (assuming a physical capital share of 0.40 on ad hoc basis). However, the major criticism for this study revolves around the fact that it does not calculate the share of capital. Instead, it just imposes the so-called benchmark value of the capital share, which results in an underestimation of the roles of factor accumulation and overestimation of the role of TFP in contribution to growth. Though negative, this, in turn, results in a less negative TFP growth for the stated period.

Now, if the periods in this study are analysed at sub-period levels, it is observed that Bangladesh is continuously improving in terms of growth. For example, Bangladesh attained a 3.65 per cent for the 1981-1990 period while for the 2000-2010 period, it has been able to uplift its growth rate by an additional 2.01 per cent to 5.66 per cent. Even for the sub-period of 2011-2014, the consistency of growth has been sustained with approximately 5.98 per cent rate. The similar pattern also holds true for the capital growth rate in the sub-periods. After 2000, capital grows by more than 7 per cent, and hence it can be regarded as the boosting element of growth in Bangladesh. However, the similar pattern is not observed for the growth rate of effective labour. Effective labour grew by around 3.85 per cent during 1981-1990, but in the following decade of 1991-2000, it shrank by around 1 per cent and attained 2.86 per cent growth. However, the effective labour growth rate increased to 3.05 per cent between 2001 and 2010, but even this growth rate fell short of the growth rate of the 1981-1990 period. It seems the effective labour growth rate remains drooping over the recent years.

The dissection of the TFP growth pattern reveals an interesting finding that it is becoming less negative from previous to recent decades. The magnitude of negativity in TFP falls from two-digit number in all 12 cases during 1981-1990 to a single digit in 5 of the cases over the decade of 2001-2010. It is a great improvement in terms of attaining a higher level of growth. For the period 2011-2014, it has been observed that out of 12 cases, TFP is found to be positive for the 5 cases, which gives a signal that the contribution of TFP on the growth of Bangladesh will occupy at least some impact in the ensuing years. The negligible contribution of TFP to growth becomes more conspicuous from the summary of TFP statistics obtained from all of the GAE tables. The concise table is presented below.

TABLE VIIIA

CONTRIBUTION TO GROWTH BY TFP (%)

Growth due to-	Mean ΔlnY	Mean ΔlnK	Mean Δln(L+HK)	Intensive Form Production Function OLS TFP	VEC TFP	FMOLS TFP	ARDL TFP
1981-2015	4.89	6.12	3.17	-13.67	-6.12	-14.01	-14.36
1981-1990	3.65	4.21	3.85	-22.17	-26.97	-21.96	-21.74
1991-2000	4.69	6.00	2.86	-14.75	-5.44	-15.18	-15.60
2000-2010	5.66	7.36	3.05	-13.65	-2.13	-14.17	-14.70
2011-2015	5.98	7.31	2.75	-5.14	6.85	-5.69	-6.24

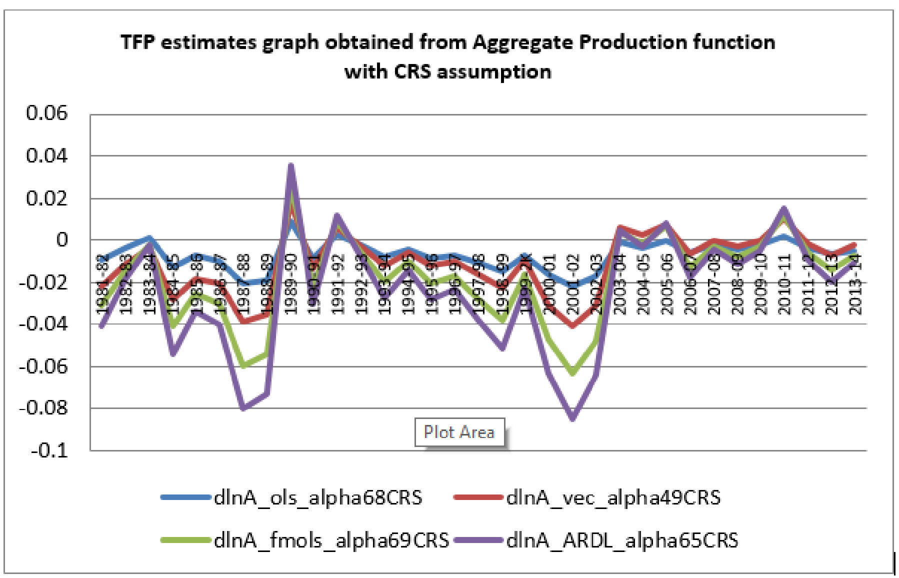
Note: Y=Output; K=Capital; L*HK= Effective Labour.

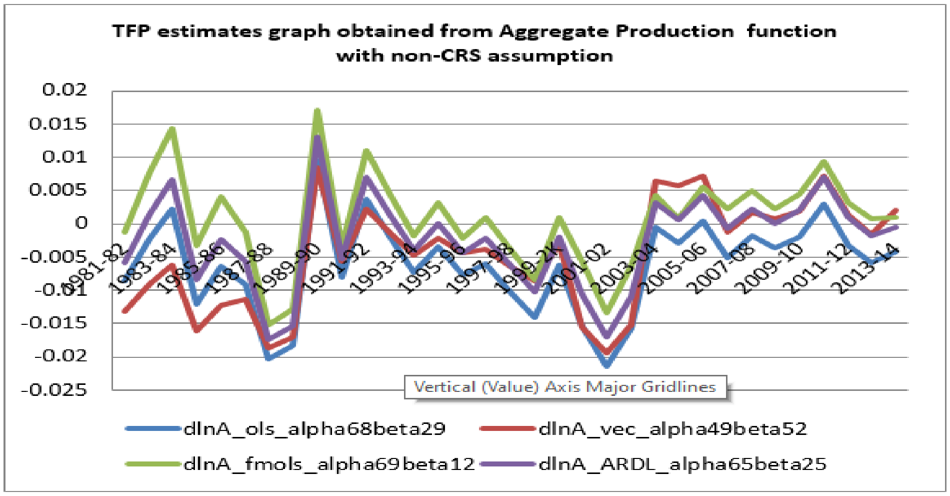
TABLE VIIIB

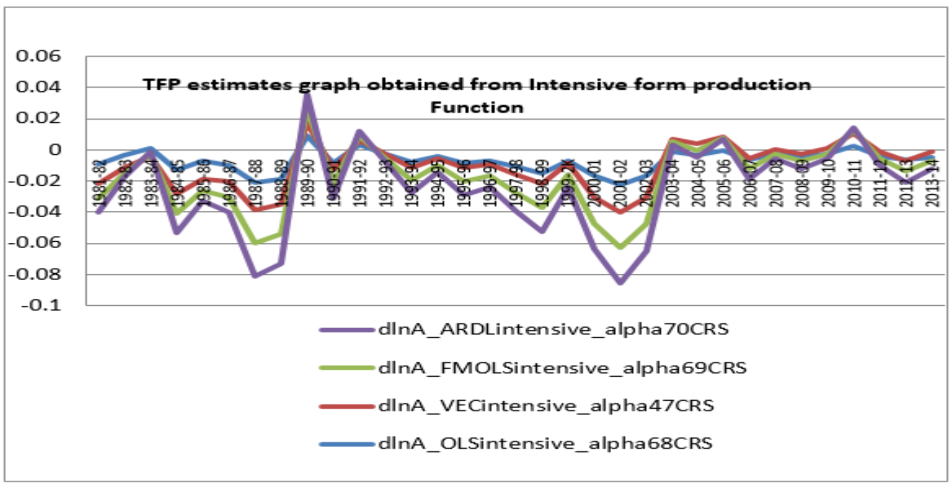
CONTRIBUTION TO GROWTH BY TFP (%)

Growth due to-	Aggregate Production Function							
	CRS assumption				Non-CRS assumption			
	OLS TFP	VEC TFP	FMOLS TFP	ARDL TFP	OLS TFP	VEC TFP	FMOLS TFP	ARDL TFP
1981-2015	-13.50	-6.91	-14.01	-12.46	-11.97	-8.71	2.16	-4.28
1981-1990	-22.28	-26.46	-21.96	-22.94	-19.95	-29.21	2.74	-10.45
1991-2000	-14.54	-6.42	-15.18	-13.26	-13.09	-8.13	0.20	-5.49
2000-2010	-13.38	-3.34	-14.17	-11.80	-12.07	-4.89	-0.24	-4.76
2011-2015	-4.87	5.59	-5.69	-3.22	-3.72	4.24	6.43	2.90

Figure 1: **TFP with Different Production Function and CRS Assumption**







Source: Authors' estimation.

The purpose of using so many alternatives is to ensure the robustness of the study findings. When it comes to a definite conclusion, this paper shows that though overall TFP growth in the study period is negative, it is becoming less negative from previous to recent decades. The contribution of TFP to growth has been marked as a hindrance to the growth of Bangladesh. So, positive TFP growth is a must to increase the long-run growth rate of Bangladesh. Then this paper focuses on the dynamics in the TFP series and attempts to analyse what factors affect TFP in Bangladesh.

IV. DETERMINANTS OF TFP

In the growth accounting framework (GAE), TFP is obtained as a leftover fraction of the output after factors of productions are attributed to the respective shares of output. This approach calls for constraining the long-run equilibrium conditions on the calculated non-steady-state dynamic model conforming to the data. TFP estimates are viewed as estimates of the steady-state growth rate (SSGR), while SSGR itself is considered an unobservable theoretical concept. The long-run equilibrium output per worker equation (equation 6 in this paper) in the Solow (1956) growth model paves the way for obtaining the long-run equilibrium growth rate or SSGR. Output-per worker is derived from dividing aggregate output by the number of effective labour, in a mathematical expression, $y = \frac{Y}{L*H}$. Using this concept in equation 6 of the SSGR output per worker yields the solution:

$$Y^* = \left(\frac{s}{\delta+g+n}\right)^{\frac{\alpha}{1-\alpha}} A * L * H \quad (11)$$

Taking the logarithm of the above equation gives:

$$\Delta \ln Y^* = SSGR = \Delta \ln A + \Delta \ln L + \Delta \ln H \quad (12)$$

The above equation is termed as long-run equilibrium or steady-state growth rate of output per worker. It is obtained assuming propensity to save (s), depreciation rate (δ), population growth rate (n), technological progress (g) and capital share of output (α) to be fixed in the long-run equilibrium or steady-state.

From TableVII and Annex Tables 2A.1 to 2A.6, it is observed that the mean value of the twelve TFP series (the highest positive mean TFP is 0.0011 in the case of aggregate production function with non-CRS assumption estimated by the FMOLS method, and the highest negative mean TFP is -0.007 in the case of intensive production function estimated by the ARDL method) for the entire sample period 1981-2014 is so small that it can be taken as zero. For the entire sample period, the mean value of labour is found around 0.044, and that of human capital is 0.012.

Table IX shows that under different scenarios of mean values of TFP, the steady-state growth rate for Bangladesh would vary from 4.92 per cent to 5.73 per cent for the period 1981-2014. The population growth rate in the same period is 1.99 per cent, implying that per capita income can grow at about 2.93 per cent to 3.74 per cent.

TABLE IX

STEADY-STATE GROWTH RATE FOR BANGLADESH UNDER DIFFERENT VALUES OF TFP (1981-2014)

	Assuming the too negligible amount	The highest negative value	The highest positive value	Mean TFP across 12 estimated series
Mean value of TFP (used as a proxy for ΔlnA) for the entire sample period	0.00	-0.007	0.0011	-0.00482
Corresponding SSGR value for the time period 1981-2014	0.0562	0.0492	0.0573	0.0513

The million-dollar question for Bangladesh in the impending periods is how can this spectacular growth rate be increased and sustained. With this end in view, it is necessary to look for variables that are identified for determining TFP and justify the relevance of those variables in the context of Bangladesh. Relying solely on the factor accumulation growth, it will be difficult to sustain the current growth, let alone increasing it in the near future. Hence, the way for augmenting the long-run growth rate is direly resonated as well as seems to be relevant in the present development context of Bangladesh. The literature and empirical analysis of the determinants of TFP consider it to be a function of a host of macro, institutional and even micro-level variables. The empirical research on the endogenous growth model has marked a lot of variables to be the determinants of TFP for the individual as well as cross-country analysis. Taking all of these facts into account, Durlauf *et al.* (2008) have concluded that literature on factors determining the growth always encompasses into economic institutions, culture, climate, legal-political systems, geographical isolation, and ethnic fractionalisation. Hence, the selection of variables to determine factors causing TFP growth remains a subjective task. Besides, many of the variables have no secondary let alone primary causal links to growth. In this regard, it is worth noting that failure to meet the policymakers' demands of suggesting policies for developing countries on how to increase growth rate result from this subjectivity in choosing variables (Prichette 2006). Hence, taking into account the realistic view in terms of suggesting policies, this study adopts Senhadji's (2000) approach in which he showed some variables of having capability of increasing the growth rate of TFP with response to various policy measures. The major conclusion of the study by Senhadji (2000) includes identification of factor accumulation to be the driver of growth for the 46 developing countries with negligible or no impact of TFP in cases and proof of conditional convergence. Senhadji (2000) uses a total of 10 variables from 6 broad categories for determining the source of cross-country differences in total factor productivity (TFP) levels in panel data set-up for 88 countries over 1960–94.

The variables which appeared statistically significant in his analysis are noted down with their respective signs in parenthesis: (1) life expectancy (positive), (2) public consumption (negative), (3) real exchange rate (negative),(4) ratio of reserves to imports (positive), (5) external debt to GDP ratio (negative), (6) capital account convertibility (positive) and (7) the ratio of war casualties to population (negative). However, the variables like (8) terms of trade shocks (positive), (9) inflation (negative) and (10) current account convertibility (positive) are appeared as insignificant, but its coefficient turned out to be negative (Rao and Hassan 2009).

This study exploits both the macroeconomic variables and institutional quality indicator variables with a view to analysing the determinants of TFP for Bangladesh. The contribution of this paper in the literature lies in the fact that this study attempts to incorporate the institutional quality indicator variables to determine TFP for the first time in Bangladesh context. This study selects a total of 12 relevant TFP determining variables in the context of Bangladesh, covering two broad categories (7 macro-level variables and 4 institutional quality indicator variables). The TFP determining 7 macro-level variables are noted along with the expected prior signs in parenthesis: Government expenditure on schooling as a percentage of GDP (positive), credit (positive), broad money as a percentage of GDP (positive), Government consumption net of schooling as a percentage of GDP (positive), inflation deflator (negative), remittance as a percentage of GDP (positive), and globalisation index (indeterminate). While the four institutional quality indicator variables included are voice and accountability (positive), rule of law (positive), regulatory control (negative), and control of corruption (positive). This study has incorporated the time dummy variable into the regression analysis to capture for any probable structural shift in the series. In this regard, the author employs the Zivot-Andrews (1992) test for detecting endogenously determined single structural break (Baum 2005), pervasively used in the standard time series analysis. Econometrically, a structural break in TFP of Bangladesh occurred in 2004 significant at 5% level (Results attached in Annex 3, Table: 3A.1.0). Hence, a time dummy variable is included to solve for structural break problem (Narayan 2005, Altinay and Karagol 2004)). The time dummy variable in this study assumes a value of 1 for years 2004 and onwards and 0 for otherwise.

Like the stationary test of the production function variables, the variables used as the determinants of the TFP require to be checked for the stationary properties. Keeping in harmony with the previous procedure, the same four types of unit roots tests have been performed to determine the nature of these variables (Table 3A.1 in Annex 3).

It is of no surprise that inflation and all of the TFP variables (a total of 12 variants) are found to be stationary at the level that is, these variables do not have any unit root (Table 3A.1 in annex 3). In contrast, the other variables named credit, broad money, government expenditure on schooling (as % of GDP), government consumption net of schooling (as % of GDP), remittance (as % of GDP), globalisation index, voice and accountability, rule of law, regulatory control, and control of corruption are not stationary at level, rather these variables are first difference stationary. After the first differencing, these variables achieve stationary. Hence, these variables can be termed as I (1) or integrated of order 1 variable. The stationary properties shown in the unit root tests are consistent with the macroeconomic variables' time-series properties.

The choice of econometric method for determinants of TFP poses a serious problem because of the heterogeneous nature of unit root property of the data. If all of the variables had the same order of integration, the Vector Auto-regressive model or the Vector Error Correction model (depending on the co-integration among the variables) would have been used to capture the long-run impact of the potential determinant variables on TFP. Though the Auto Regressive Distributed Lag (ARDL) model can be applied even with a mix of I(1) and I(0) variables, the dependent variable TFP being an I(0) variable does not permit to use it in the present context.

The unit root tests reveal the nature of I(1) and I(0) property of the potential TFP determining variables. Hence, by converting all of the variables into I(0), the estimates of the determinants of TFP is obtained by running the OLS method. Instead of running a single model for the determinants of TFP, this study runs for 3 different specifications of the models, each of which includes 10 independent variables out of a total of 12 selected variables. This exercise is aimed at ensuring the robustness of the significance of the impacts of the variables on TFP. The results are presented in Table X.

TABLE X

DIFFERENT SPECIFICATIONS OF THE TFP DETERMINANT MODELS

Dependent Variables: dlna_ols_alpha68crs, one of the TFP series out of twelve			
Exogenous Variables	Model specification 1	Model specification 2	Model specification 3
D. government expenditure on education	0.0284**	0.0262**	0.0294**
	(0.0103)	(0.0123)	(0.0113)
D. voice and accountability	0.0605***	0.0561***	0.0534***
	(0.0211)	(0.0183)	(0.0155)
D. regulatory control	-0.0480*	-0.0465*	-0.0488**
	(0.0271)	(0.0239)	(0.0215)
D. credit	-0.000946		
	(0.000702)		
D. broad money	-0.00130**	-0.00132*	-0.00150**
	(0.000589)	(0.000728)	(0.000666)
D. government consumption net of schoolings	-0.0111	-0.00703	-0.00810
	(0.00856)	(0.00723)	(0.00733)
Inflation deflator	-0.00102**	-0.000921**	-0.000915**
	(0.000464)	(0.000434)	(0.000437)
D. remittance	-0.00316*	-0.00293*	-0.00251
	(0.00168)	(0.00156)	(0.00160)
D. globalisation index	-0.00255**	-0.00233**	-0.00242**
	(0.00104)	(0.00111)	(0.00113)
Time Dummy	0.00478*	0.00414	0.00399*
	(0.00230)	(0.00274)	(0.00230)
D. control of corruption		0.00731	
		(0.0102)	
D. rule of law			0.0185
			(0.0119)
Constant	0.00542	0.00322	0.00357
	(0.00625)	(0.00560)	(0.00555)
Observations	32	32	32
Mean VIF	4.98	4.55	4.42
Ramsey RESET test statistic	0.86	1.11	4.12
	(0.48)	(0.37)	(0.02)
R-squared	0.566	0.555	0.562

Note: Robust standard errors are in parentheses. ***p<0.01, ** p<0.05, * p<0.1

In the model (Table X), keeping the dependent variable TFP series (obtained from the Aggregate production function with CRS assumption estimated by the OLS method) fixed, different specifications of the determinants of TFP equations have been estimated with the help of OLS method. It is conspicuous that irrespective of specifications, government expenditure on education, voice and accountability, regulatory control, broad money, inflation, and globalisation are found to be statistically significant at various levels. Hence, it can be safely concluded that these variables are the ultimate determinants of TFP in Bangladesh. However, the impact of remittance on TFP in Bangladesh context is not found robust and government expenditure net of schooling is found to be insignificant across the specifications. Credit, control of corruption and rule of law are found to have an insignificant impact on TFP in Bangladesh. The sign of the time dummy variable is always found to be positive and significant in most of the cases, implying that the TFP growth improves during 2004-2014 period in comparison to the more negative locust during 1981-2003 period.[5] The robust standard error is used for controlling the heteroskedasticity problem. In addition, the VIF test and the Ramsey RESET tests are performed to check for multicollinearity and omitted variable bias, respectively. The mean VIF values are found to be lower than 5, which means that the results are free from multicollinearity problem. Also, the insignificant F statistic for Ramsey reset test indicates that the models have no misspecification problem, i.e. no omitted, nonlinear variables to include in our model. It is observed that model 2 provides the R-squared value which lies in between the other two. This study from now on adopts the specifications of the independent variables of model 2 with which the 12 series of TFP variables will be regressed as the dependent variable. Choice of model specification 2 for further robustness check of the determinants of TFP is merely random, and the result of this specification is presented for brevity purpose. The same exercise of using 12 different series of TFP as a dependent variable has been carried out for model specifications 1 and 3 also. These results are presented in Annex 3 (Tables 3A.1.1-3A.1.6).

The TFP series obtained from aggregate production function estimates with non-CRS assumption estimated by four methods: OLS, VEC, FMOLS, and ARDL respectively are used as the dependent variable in Table XI. The results show that the significance of the variables along with the same sign remains roughly the same across the models. Government expenditure on schooling becomes insignificant only with the dependent variable of TFP as estimated by the VEC model. On the contrary, remittance is found to be significant only in the model in which TFP is estimated by the OLS method.

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[5]The authors have repeated the regression exercise omitting the time dummy variable. Similar signs and significance levels of other variables follow in these cases also. These results are available upon the request to authors.

TABLE XI

MODEL 2 SPECIFICATIONS APPLIED ON TFP SERIES OBTAINED FROM AGGREGATE PRODUCTION FUNCTION ESTIMATES WITH THE NON-CRS ASSUMPTION

Dependent Variables: TFP obtained from Aggregate production function estimates with the Non-CRS assumption by four methods: OLS, VEC, FMOLS, and ARDL respectively

	(1)	(2)	(3)	(4)
Variables	ols_Agg_noncrs	vec_Agg_noncrs	fmols_Agg_noncrs	ardl_Agg_noncrs
D. government expenditure on education	0.0263**	0.0262**	0.0276*	0.0269**
	(0.0124)	(0.0107)	(0.0140)	(0.0124)
D. voice and accountability	0.0551***	0.0555***	0.0458**	0.0506**
	(0.0184)	(0.0153)	(0.0194)	(0.0179)
D. regulatory control	-0.0459*	-0.0486**	-0.0402	-0.0436*
	(0.0239)	(0.0187)	(0.0249)	(0.0230)
D. broad money	-0.00128*	-0.00204***	-0.000843	-0.00121
	(0.000731)	(0.000655)	(0.000787)	(0.000725)
D. government consumption net of schoolings	-0.00705	-0.00701	-0.00724	-0.00714
	(0.00723)	(0.00821)	(0.00738)	(0.00728)
Inflation deflator	-0.000905**	-0.00122**	-0.000734*	-0.000881*
	(0.000432)	(0.000539)	(0.000416)	(0.000432)
D. remittance	-0.00289*	-0.00254*	-0.00256	-0.00266
	(0.00158)	(0.00131)	(0.00185)	(0.00159)
D. globalisation index	-0.00239**	-0.00129	-0.00309**	-0.00252**
	(0.00112)	(0.00121)	(0.00120)	(0.00115)
D. control of corruption	0.00728	-0.00262	0.00785	0.00562
	(0.0103)	(0.00927)	(0.0109)	(0.0103)
Time Dummy	0.00405	0.00937***	0.00282	0.00448
	(0.00276)	(0.00224)	(0.00302)	(0.00274)
Constant	0.00383	0.00679	0.00942	0.00720
	(0.00560)	(0.00560)	(0.00572)	(0.00558)
Observations	32	32	32	32
Mean VIF	4.55	4.55	4.55	4.55
Ramsey RESET test statistic	1.15	0.66	0.39	2.22
	(0.36)	(0.59)	(0.76)	(0.12)
R-squared	0.549	0.721	0.478	0.544

Note: Robust standard errors are in parentheses.*** p<0.01, ** p<0.05, * p<0.1.

In Table XII, the same set of independent variables is regressed over the TFP series obtained from aggregate production function with CRS assumption by the four methods. It is remarkable that the significance of all of the variables across the models remains the same with no sign of the variables toggling across the models.

TABLE XII

MODEL 2 SPECIFICATIONS APPLIED ON TFP SERIES OBTAINED FROM AGGREGATE PRODUCTION FUNCTION ESTIMATES WITH CRS ASSUMPTION

Dependent Variables: TFP obtained from Aggregate production function estimates with CRS assumption by four methods: OLS, VEC, FMOLS, and ARDL respectively				
	(5)	(6)	(7)	(8)
VARIABLES	ols_Agg_crs	vec_Agg_crs	fmols_Agg_crs	ardl_Agg_crs
D. government expenditure on education	0.0262**	0.0264**	0.0262**	0.0262**
	(0.0123)	(0.0106)	(0.0125)	(0.0119)
D. voice and accountability	0.0561***	0.0543***	0.0563***	0.0558***
	(0.0183)	(0.0152)	(0.0187)	(0.0177)
D. regulatory control	-0.0465*	-0.0479**	-0.0464*	-0.0467*
	(0.0239)	(0.0186)	(0.0243)	(0.0229)
D. broad money	-0.00132*	-0.00199***	-0.00127	-0.00142*
	(0.000728)	(0.000655)	(0.000739)	(0.000707)
D. government consumption net of schoolings	-0.00703	-0.00704	-0.00703	-0.00703
	(0.00723)	(0.00815)	(0.00721)	(0.00730)
Inflation deflator	-0.000921**	-0.00120**	-0.000899**	-0.000964**
	(0.000434)	(0.000533)	(0.000430)	(0.000444)
D. remittance	-0.00293*	-0.00250*	-0.00296*	-0.00286*
	(0.00156)	(0.00130)	(0.00160)	(0.00150)
D. globalisation index	-0.00233**	-0.00137	-0.00240**	-0.00218*
	(0.00111)	(0.00121)	(0.00111)	(0.00112)
D. control of corruption	0.00731	-0.00265	0.00809	0.00574
	(0.0102)	(0.00927)	(0.0103)	(0.0100)
Time Dummy	0.00414	0.00927***	0.00373	0.00494*
	(0.00274)	(0.00225)	(0.00279)	(0.00264)
Constant	0.00322	0.00752	0.00288	0.00389
	(0.00560)	(0.00559)	(0.00562)	(0.00556)
Observations	32	32	32	32
Mean VIF	4.55	4.55	4.55	4.55
Ramsey RESET test statistic	1.11	0.65	0.85	1.45
	(0.37)	(0.59)	(0.48)	(0.26)
R-squared	0.555	0.716	0.543	0.582

Note: Robust standard errors are in parentheses.*** p<0.01, ** p<0.05, * p<0.1

The same line of interpretation is resonated from Table XIII also, however, the dependent variables are now obtained from Intensive form production function estimates.

TABLE XIII

MODEL 2 SPECIFICATIONS APPLIED ON TFP SERIES OBTAINED FROM INTENSIVE FORM PRODUCTION FUNCTION

Dependent Variables: TFP obtained from Intensive form production function estimates by four methods: OLS, VEC, FMOLS, and ARDL respectively				
	(9)	(10)	(11)	(12)
VARIABLES	ols_Int_crs	vec_Int_crs	fmols_Int_crs	ardl_Int_crs
D. government expenditure on education	0.0262**	0.0264**	0.0262**	0.0261*
	(0.0123)	(0.0106)	(0.0125)	(0.0126)
D. voice and accountability	0.0562***	0.0541***	0.0563***	0.0564***
	(0.0184)	(0.0150)	(0.0187)	(0.0189)
D. regulatory control	-0.0465*	-0.0480**	-0.0464*	-0.0463*
	(0.0240)	(0.0181)	(0.0243)	(0.0247)
D. broad money	-0.00130*	-0.00207***	-0.00127	-0.00123
	(0.000732)	(0.000657)	(0.000739)	(0.000748)
D. government consumption net of schoolings	-0.00703	-0.00704	-0.00703	-0.00703
	(0.00722)	(0.00833)	(0.00721)	(0.00720)
Inflation deflator	-0.000913**	-0.00123**	-0.000899**	-0.000884*
	(0.000433)	(0.000550)	(0.000430)	(0.000427)
D. remittance	-0.00294*	-0.00245*	-0.00296*	-0.00298*
	(0.00157)	(0.00129)	(0.00160)	(0.00162)
D. globalisation index	-0.00235**	-0.00126	-0.00240**	-0.00245**
	(0.00111)	(0.00123)	(0.00111)	(0.00111)
D. control of corruption	0.00757	-0.00385	0.00809	0.00861
	(0.0103)	(0.00921)	(0.0103)	(0.0104)
Time Dummy	0.00400	0.00988***	0.00373	0.00346
	(0.00276)	(0.00221)	(0.00279)	(0.00282)
Constant	0.00310	0.00804	0.00288	0.00265
	(0.00560)	(0.00563)	(0.00562)	(0.00564)
Observations	32	32	32	32
Mean VIF	4.55	4.55	4.55	4.55
Ramsey RESET test statistic	1.03	0.76	0.85	0.68
	(0.40)	(0.53)	(0.48)	(0.58)
R-squared	0.551	0.730	0.543	0.535

Note: Robust standard errors are in parentheses.*** p<0.01, ** p<0.05, * p<0.1.

V. IMPLICATIONS OF RESULTS

The results from analyses on TFP determinants pave the way for policy suggestions. All the signs of macroeconomic variables: government expenditure on schooling (positive), credit (positive), government consumption net of schooling (negative), inflation deflator (negative), remittance (negative), and globalisation index (indeterminate) are aligned with *priori* expectations except for broad money (negative). The four institutional quality indicator variables- voice and accountability (positive), rule of law (positive), regulatory control (negative), and control of corruption (positive) -also match with the expected signs. The findings show that increased government expenditure on education and ensuring voice and accountability have a robust significant positive impact on TFP of Bangladesh. On the contrary, increased regulatory control, broad money, inflation, and globalisation have a robust negative effect on TFP in Bangladesh. However, the impact of remittance on TFP in Bangladesh context is not found to be robust, and government expenditure net of schooling remains insignificant across all the specifications. Besides, credit as a percentage of GDP, control of corruption and rule of law are found to have an insignificant impact on TFP in Bangladesh.

Government expenditure on schooling is found to have a significant positive impact on the TFP of Bangladesh, which is in accordance with the extensive literature on nexus between education and growth. Countries like Bangladesh need skilled human resources to increase the current growth rate. However, government consumption net of schooling has the expected negative sign (Mujeri 2004) but is found to be insignificant. Hence, the part of government spending excluding the schooling portion has no impact on increasing the growth of Bangladesh.

The negative relation between broad money and TFP of Bangladesh seems to be contrary to the conventional theories. However, this phenomenon is not unique to this study (Rao and Hassan 2009) and can be explained with the contemporary macroeconomic issues pertaining to the Bangladesh economy. Accumulation of "Idle Money" during the last five years of the study period resulted from unregulated and inefficient financial systems of Bangladesh. Either stagnant or slower pace of private investment growth may also stem out from the lack of confidence by entrepreneurs to invest in the domestic economy. The banking system of Bangladesh experienced a rising trend of unutilised deposits; the concentration of idle money surged up to around BDT 1.16 trillion in 2017. (Bangladesh Bank Report, August 2017). But the banking sector started suffering from liquidity crisis since January 2018, and this was quite predictable as capital goods experienced a high growth rate of 11.2 per cent to $20.119 billion in 2017 from $18.092 billion in 2016, indicating an upcoming bullish trend of the private sector. Also, the ratio of total non-performing loans (NPL) to total outstanding loan staggers at around 10.33 per cent in 2018-19. Selection of dishonest clients by the creditors, family-run banking management, nepotism in the management of banks, political interference, corruption by dishonest bankers coupled with weak monitoring capacity by the central bank can be largely attributed to the cause of growing NPL. According to the Capital, Asset, Management, Earnings, Liquidity and Sensitivity to the Market Risk (CAMELS) rating of different commercial banks of Bangladesh, only 6 out of currently operated 59 banks secured "A" rating based on the performance as of June 2018. The ratings of the banks are highly concentrated in category B, bearing the testimony of frustrating performance of the banking sector in the Bangladesh economy. Banks are in a liquidity crisis, and, at the same time, the confidence of the consumers on banks is eroding day by day. Lack of creating an investment congealing environment and lack of confidence on banks by the general people are expected to bring in adverse effects on the growth of TFP. Hence, the expansion of money supply has failed to have a positive impact on productivity growth.

The impact of globalisation on TFP of Bangladesh stands out significantly negative, which revokes the dispute if the Bangladesh economy was prepared to brace the crosswinds generated by globalisation wave. On the other hand, this finding contradicts with the perception of Bangladesh's overwhelming performance in post-recession shock after 2008. Considering the growing GDP rate and export earnings of Bangladesh at the post-recession period, the economy might seem substantially strong to cope up with the external shock resulted from globalisation. However, this is a short-run phenomenon and can be overruled by this finding of the negative impact of globalisation on the economic growth of Bangladesh. Hence, the finding suggests considering probable shock of globalisation for designing a prudent macroeconomic policy.

The findings of inverse relationship in remittance-growth nexus conform to the findings of Rao and Hasaan (2009). This can be explained by the unproductive uses of remittance that is accumulated as "Idle deposits" rather than consumption or investments. Inflation is found to have a significant negative impact on growth as expected. Inflation erodes long-run efficiency of investment and productivity of capital.

The positive effect of voice and accountability states that establishing as well as ensuring voice and accountability in the society will help increase the growth rate of Bangladesh (Bhattacharjee 2016). On the other hand, minimizing the regulatory control may create such a conducive environment that will increase the growth rate of Bangladesh.

VI. POLICY RECOMMENDATIONS

This paper comes up with two policy suggestions to improve TFP in Bangladesh. *First*, more investment in creating and nurturing human capital is found to increasing TFP in Bangladesh. Higher investment from the part of the government on schooling will produce human capital. Increased public expenditure on education and training is one of the building blocks to generate a pool of skilled labour force equipped with better education and expertise. When equipped with modern knowledge and technology, the same size of labor force can produce more output. This is essential to earn the status of a developed country.

Second, this paper also reveals that ensuring voice and accountability as well as minimizing regulatory control positively affects TFP in Bangladesh. That is institutions are import for TFP gorwht and hence the long term growh of Bangladesh. This evidence calls for enhacnging good governance including reforming public administration and other growth enhancing insitutions, mimimizing red tapism of bureaucracy, and ensuring free press and civil liberty.

Human capital and instiutions can help achieve higher economic growth through higher factor productivity.

VII. CONCLUSIONS AND LIMITATIONS

This paper carries out the production function estimation and finds that the share of capital ranges from half to two-thirds in the produced output of the Bangladesh economy. This high share of capital is puzzling for a devlepong country like Bangladesh which requires further research. However, there are empirical evidences (Senhadji 2000, Mujeri 2004, Rao and Hasan 2011) of such high share.

Growth accounting exercise also sheds light on the underlying factors of the growth. The negative contribution of TFP implies the persistent inefficiencies of factors in production processes. It suggests that Bangladesh has the scope for increasing the growth rate of the economy further only if it can bring negative productivity growth down to at least at zero level. If the factor productivity growth were zero, the growth rate would have been around 5.48 per cent (a non-CRS assumption with OLS estimate) to 5.55 per cent (CRS assumption with OLS estimate) for the whole period. This suggests that Bangladesh has the scope for increasing the growth rate of the economy further only by increasing TFP.

The second objective of the paper, exploring the determinants of TFP, has strong policy implications in designing strategies of the development of the economy. The puncline of this paper is that quality of insitituion is important in enhacing productivity.

We also found that government expenditure on education has a robust, positive impact on TFP of Bangladesh. However, increased regulatory control, broad money, inflation, and globalisation have negative effect on TFP, restraining the long term growh of the country. Hence, the paper has a strong result - human capital not only directly impacts growth, it enhances growrh through increasing productivity too.

The paper contains mainly two *limitations*. The share of capital obtained for the production function may seem to be high. However, there is no other better sources of capital share in output, to the best of our understanding. This paper cannot provide satisfactory explanations for the negative effect of broad money growth on TFP.

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Annex 1

Table 1A.1 :Data Source

Data	Source
GDP value	BBS at 1995-96 base prices in million taka
Capital stock*	BBS at 1995-96 base prices in million taka. The series is constructed by following the same procedure used in MIMAP study report published by BIDS (2002).
The Human Capital Index*	Barro-Lee database
The number of employed persons*	Penn Table 8.0 database
Government Expenditure on Schooling (as % of GDP)	World Development Indicators
Broad Money (as % of GDP)	
Credit (as % of GDP)	
Government Consumption net of schooling (as % of GDP)	
Inflation Deflator	
Remittance (as % of GDP)	
Globalisation Index data	KOF database
Data on Voice and Accountability, Rule of Law, Regulatory control, Control of Corruption	World Governance Indicator dataset. Extrapolation technique is used for making the series continuous.
Time dummy=1 for years 2004 and onwards; otherwise 0	

*Construction of the Capital stock estimation and Human Capital are described in Annex 2. The log of the variables, i.e. GDP, capital stock and labour have been used.

Annex 2

Capital Stock:

Estimation of the capital stock poses a crucial challenge to this study since there is no updated series for it. However, this study replicates and recalibrates the capital stock data (K1 series) from the MIMAP project (2002) report published by BIDS.[6] However, the MIMAP project provides the capital stock data for 1980-81 to 2000-01 period. In order to fill up the data points for the rest of the study years, this study exploits a variant of the PIM method, in line with the MIMAP project, to estimate the capital stock. Investment and GDP series at constant 1995-96 prices have been collected from BBS. Following the MIMAP study, the annual weighted depreciation rate of the economy is set at 4.27 per cent.

This study exploits the Harberger method (HM) to estimate the initial capital stock which is calculated by the following formula:

$$K_{t-1} = \frac{I_t}{g + \delta}$$

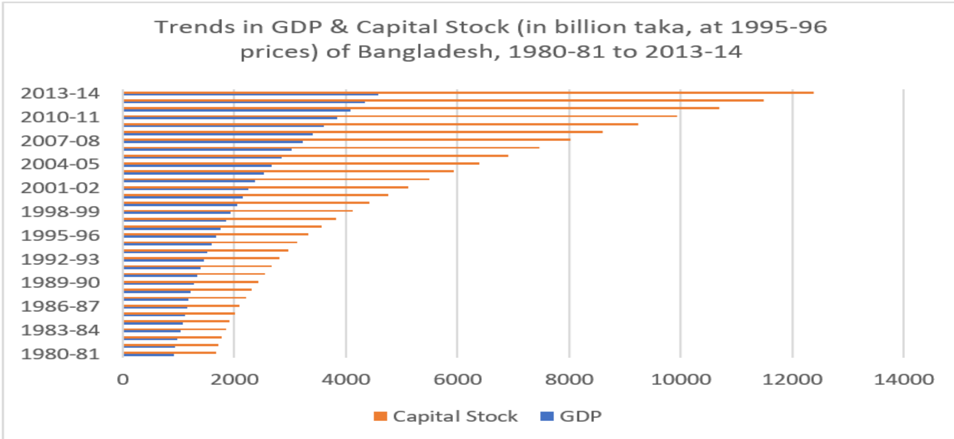
K_{t-1}=capital stock at time t-1; I_t=gross investment at time t; g= output growth rate; δ= rate of depreciation

To get rid of computational problems regarding fluctuations in the output growth and investment level, averages have been taken for the above formula in line with the MIMAP study. Since capital growth falls short of GDP growth consistently during the 1980s, a violation of the assumption of the HM, the following iterative procedures have been followed.

$$k_t = \sum_{i=0}^{t-1}(1-\delta)^t I_{t-i} + (1-\delta)^t k_0$$

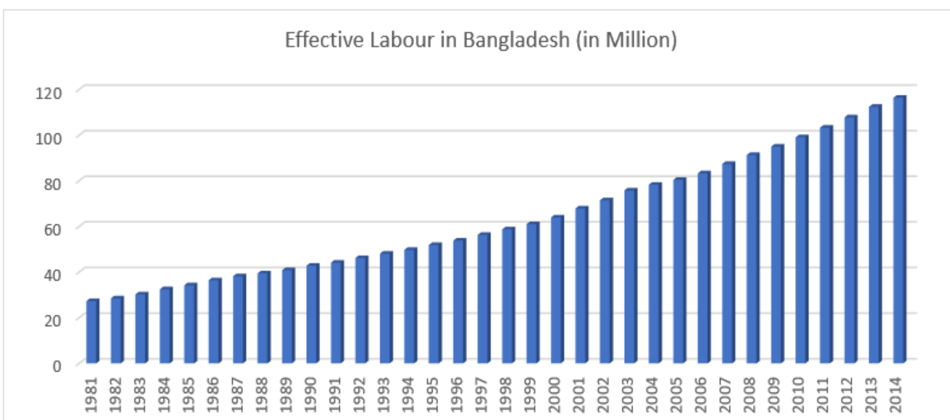
Therefore, following MIMAP study, this study estimates capital stock with an initial capital stock (k_0) of 1604245 taka (in million, base year 1995-96) measured from 5 years averages of investment and GDP since the discrepancy between the mean growth rate of capital and output is found to be minimum at this time period. The graph of GDP and capital stock series are depicted below in terms of billion taka rather than original million taka for the better exposition of the graph.

[6]The authors of this study are highly grateful to the authors of MIMAP study report for following their methodology. **References:** Rahman, Shamsur, and A.K.M. Atiqur Rahman. "The Estimation of Capital Stock for Bangladesh Economy." Bangladesh Institute of Development Studies, Feb. 2002. Micro Impacts of Macroeconomy and Adjustment Policies in Bangladesh.



Effective Labour and Human Capital Index

The number of employed persons and Index of human capital per person data have been extracted from Penn World Table 8.0 (known as PWT 8.0) database accessed on 18 July 2017. Multiplication of these two data series yields the desired human capital series. PWT 8.0 is the first attempt to measure human capital across countries which facilitates empirical researchers to conduct cross-country analysis involving human capital. The construction of the data series Index of human capital per person is based on years of schooling (Barro and Lee 2013) and returns to education (Psacharopoulos 1994).



The other variables are mentioned with their respective data sources. Relevant time series properties of the data series used in this study are described in annex (Table 2A.1a, 2A.1b and 3A.1).

Table 2A.1a: Unit Root Tests of the Cobb-Douglas Production Function Variables

Unit Root Tests				
	Augmented Dickey-Fuller (ADF)		Phillips Perron (PP) Test	
	Level		Level	
Variable	Constant Without Trend	Constant with Trend	Constant Without Trend	Constant with Trend
$Ln\,Y$	6.76	-0.80	6.85	-1.26
	(-2.95)	(-3.55)	(-2.96)	(-3.55)
$Ln\,K$	0.13	-1.58	5.06	-3.50*
	(-2.95)	(-3.55)	(-2.95)	(-3.54)
$Ln\,l$	-2.01	-2.64	-1.67	-2.63
	(-2.95)	(-3.55)	(-2.95)	(-3.55)
	First Difference		**First Difference**	
$\Delta Ln\,Y$	-0.97	-5.95***	-3.40**	-5.95***
	(-2.96)	(-3.55)	(-2.95)	(-3.55)
$\Delta Ln\,K$	-1.66	-1.19	-2.78*	-1.46
	(-2.95)	(-3.55)	(-2.95)	(-3.55)
$\Delta Ln\,l$	-3.42**	-3.73**	-3.43**	-3.77**
	(-2.95)	(-3.55)	(-2.96)	(-3.55)

Notes: ***, **, and * indicate significance at the 10%, 5% and 1% levels respectively. 5% Critical Values are reported in parentheses.

The brief justification for using four different types of unit root tests is as follows. The ADF test identifies the presence of higher-order autocorrelation by introducing lags of the first difference of the concerned variable as regressors in the test equation; the PP test addresses both the autocorrelation and heteroscedasticity in the disturbance process of the test equation. The KPSS test recognises that the absence of a unit root indicates only trend-stationarity but not guarantees stationarity. It addresses the fact that a non-stationary time series may not have a unit root, but it is trend- stationary. The mean of a variable can vary over a period in case of both unit root and trend-stationary processes. However, the distinction lies in the fact that in the presence of a shock, trend-stationary processes converge over time while unit root processes do not converge over time. Unlike the other unit root tests, the null hypothesis for the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test is that the data is of I(0) or stationary at level. The disadvantage for the KPSS test is that it tends to make Type I errors (that is to reject the null hypothesis too often). The probable solution to escape from high Type I errors involves combining the KPSS with an ADF test. If the result from both tests suggests that the time series is stationary, then one can be sure of the decision (Kocenda and Cerný 2014). Elliott, Rothenberg, and Stock (1996) show that the DF-GLS (ERS) test performs better in case of small sample size and power. Elliott *et al.* (1996:813) also pointed out that their “DF-GLS” test “has substantially improved power when an unknown mean or trend is present.”

Table 2A.1b: Unit Root Tests of the Cobb-Douglas Production Function Variables (continued)

Table: Unit Root Tests				
Variable	KPSS		DF-GLS (ERS)	
	Level		Level	
	Constant Without Trend	Constant With Trend	Constant Without Trend	Constant With Trend
$Ln\,Y$	0.69**	0.19**	-1.68*	-1.75
	(0.46)	(0.15)	(-1.95)	(-3.19)
$Ln\,K$	0.68**	0.21**	-3.14*	-2.01
	(0.46)	(0.14)	(-1.95)	(-3.19)
$Ln\,l$	0.69**	0.08	-0.13	-1.87
	(0.45)	(0.15)	(-1.95)	(-3.19)
	First Difference		**First Difference**	
$\Delta Ln\,Y$	0.73**	0.06	-0.24	-5.73*
	(0.46)	(0.14)	(-1.95)	(-3.19)
$\Delta Ln\,K$	0.61**	0.18**	-0.34	-1.26
	(0.46)	(0.15)	(-1.95)	(-3.19)
$\Delta Ln\,l$	0.24	0.08	-3.47*	-3.82*
	(0.46)	(0.14)	(-1.95)	(-3.19)

Notes: ***, **, and * indicate significance at the 10%, 5% and 1% levels respectively. 5% Critical Values are reported in parentheses.

Table 2A.2: Decomposition of Growth with Capital Elasticities Obtained from Aggregate Production Function

	Mean ΔlnY	Mean ΔlnK	Mean Δln (L+HK)	VEC with a=0.493 and b=0.527 under the non-existence of CRS assumption		VEC with a=0.493 under the existence of CRS assumption	
				Growth due to Factor Accumulation	Growth due to Total Factor Productivity	Growth due to Factor Accumulation	Growth due to Total Factor Productivity
1981-2014	0.0489	0.0612	0.0317	0.0531	-0.0043	0.0523	-0.0034
Contribution to Growth (%)				108.7131	-8.7131	106.9149	-6.9149
1981-1990	0.0365	0.0421	0.0385	0.0471	-0.0107	0.0461	-0.0097
Contribution to Growth (%)				129.2138	-29.2138	126.4686	-26.4686
1991-2000	0.0469	0.0600	0.0286	0.0507	-0.0038	0.0499	-0.0030
Contribution to Growth (%)				108.1326	-8.1326	106.4234	-6.4234
2001-2010	0.0566	0.0736	0.0305	0.0593	-0.0028	0.0585	-0.0019
Contribution to Growth (%)				104.8909	-4.8909	103.3426	-3.3426
2011-2015	0.0598	0.0731	0.0275	0.0573	0.0025	0.0565	0.0033
Contribution to Growth (%)				95.7528	4.2472	94.4051	5.5949

Table 2A.3: Decomposition of Growth with Capital Elasticities Obtained from Aggregate Production Function

	Mean ΔlnY	Mean ΔlnK	Mean Δln (L+HK)	FMOLS with a=0.699 and b=0.121 under the non-existence of CRS assumption		FMOLS with a=0.699 under the existence of CRS assumption	
				Growth due to Factor Accumulation	Growth due to Total Factor Productivity	Growth due to Factor Accumulation	Growth due to Total Factor Productivity
1981-2014	0.0489	0.0612	0.0317	0.0478	0.0011	0.0557	-0.0069
Contribution to Growth (%)				97.8335	2.1665	114.0182	-14.0182
1981-1990	0.0365	0.0421	0.0385	0.0355	0.0010	0.0445	-0.0080
Contribution to Growth (%)				97.2543	2.7457	121.9606	-21.9606
1991-2000	0.0469	0.0600	0.0286	0.0468	0.0001	0.0540	-0.0071
Contribution to Growth (%)				99.7995	0.2005	115.1824	-15.1824
2001-2010	0.0566	0.0736	0.0305	0.0567	-0.0001	0.0646	-0.0080
Contribution to Growth (%)				100.2414	-0.2414	114.1763	-14.1763
2011-2015	0.0598	0.0731	0.0275	0.0560	0.0039	0.0633	-0.0034
Contribution to Growth (%)				93.5661	6.4339	105.6955	-5.6955

Table 2A.4: Decomposition of Growth with Capital Elasticities Obtained from Aggregate Production Function

	Mean ΔlnY	Mean ΔlnK	Mean Δln (L+HK)	ARDL with a=0.654 and b=0.255 under the non-existence of CRS assumption		ARDL with a=0.654 under the existence of CRS assumption	
				Growth due to Factor Accumulation	Growth due to Total Factor Productivity	Growth due to Factor Accumulation	Growth due to Total Factor Productivity
1981-2014	0.0489	0.0612	0.0317	0.0510	-0.0021	0.0550	-0.0061
Contribution to Growth (%)				104.2842	-4.2842	112.4664	-12.4664
1981-1990	0.0365	0.0421	0.0385	0.0403	-0.0038	0.0448	-0.0084
Contribution to Growth (%)				110.4552	-10.4552	122.9455	-22.9455
1991-2000	0.0469	0.0600	0.0286	0.0494	-0.0026	0.0531	-0.0062
Contribution to Growth (%)				105.4920	-5.4920	113.2690	-13.2690
2001-2010	0.0566	0.0736	0.0305	0.0593	-0.0027	0.0633	-0.0067
Contribution to Growth (%)				104.7648	-4.7648	111.8097	-11.8097
2011-2015	0.0598	0.0731	0.0275	0.0581	0.0017	0.0618	-0.0019
Contribution to Growth (%)				97.0971	2.9029	103.2291	-3.2291

Table 2A.5: Decomposition of Growth with Capital Elasticities Obtained from Intensive Production Function

	Mean ΔlnY	Mean ΔlnK	Mean Δln (L+HK)	OLS Intensive with a=0.689 under the existence of CRS assumption		VEC with a=0.47 under the existence of CRS assumption	
				Growth due to Factor Accumulation	Growth due to Total Factor Productivity	Growth due to Factor Accumulation	Growth due to Total Factor Productivity
1981-2014	0.0489	0.0612	0.0317	0.0556	-0.0067	0.0519	-0.0030
Contribution to Growth (%)				113.6734	-13.6734	106.1217	-6.1217
1981-1990	0.0365	0.0421	0.0385	0.0446	-0.0081	0.0463	-0.0098
Contribution to Growth (%)				122.1797	-22.1797	126.9721	-26.9721
1991-2000	0.0469	0.0600	0.0286	0.0538	-0.0069	0.0494	-0.0026
Contribution to Growth (%)				114.7572	-14.7572	105.4453	-5.4453
2001-2010	0.0566	0.0736	0.0305	0.0643	-0.0077	0.0578	-0.0012
Contribution to Growth (%)				113.6503	-13.6503	102.1329	-2.1329
2011-2015	0.0598	0.0731	0.0275	0.0629	-0.0031	0.0557	0.0041
Contribution to Growth (%)				105.1476	-5.1476	93.1447	6.8553

Table 2A.6: Decomposition of Growth with Capital Elasticities Obtained from Intensive Production Function

	Mean ΔlnY	Mean ΔlnK	Mean Δln(L+HK)	**FMOLS Intensive with a=0.699 under the existence of CRS assumption**		**ARDL with a=0.709 under the existence of CRS assumption**	
				Growth due to Factor Accumulation	Growth due to Total Factor Productivity	Growth due to Factor Accumulation	Growth due to Total Factor Productivity
1981-2014	0.0489	0.0612	0.0317	0.0557	-0.0069	0.0559	-0.0070
Contribution to Growth (%)				114.0182	-14.0182	114.3631	-14.3631
1981-1990	0.0365	0.0421	0.0385	0.0445	-0.0080	0.0444	-0.0079
Contribution to Growth (%)				121.9608	-21.9608	121.7420	-21.7420
1991-2000	0.0469	0.0600	0.0286	0.0540	-0.0071	0.0542	-0.0073
Contribution to Growth (%)				115.1824	-15.1824	115.6076	-15.6076
2001-2010	0.0566	0.0736	0.0305	0.0646	-0.0080	0.0649	-0.0083
Contribution to Growth (%)				114.1763	-14.1763	114.7021	-14.7021
2011-2015	0.0598	0.0731	0.0275	0.0633	-0.0034	0.0636	-0.0037
Contribution to Growth (%)				105.6956	-5.6956	106.2436	-6.2436

Annex 3

Table 3A.1: Unit Root Test Results for Potential TFP Determinants Variables

Variables Name	ADF (Intercept only)	ADF (Trend and Intercept)	PP (Intercept only)	PP (Trend and Intercept)	KPSS (Intercept only)	KPSS (Trend and Intercept)	DFGLS-ERS (Intercept only)	DFGLS-ERS (Trend and Intercept)
Credit	0.36	-1.37	0.83	-1.33	0.74**	0.18**	-1.38	-1.47
	(-2.96)	(-3.56)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
ΔCredit	-5.30*	-3.35***	-5.31*	-8.80*	0.19	0.41**	-5.19*	-5.44*
	(-2.95)	(-3.59)	(-2.95)	(-3.55)	(0.46)	(0.15)	(-1.95)	(-3.19)
M2	0.44	-2.10	-0.31	-1.54	0.64**	0.17**	-0.72	-1.40
	(-2.96)	(-3.56)	(-2.96)	(-3.55)	(0.46)	(0.15)	(-1.95)	(-3.19)
ΔM2	-4.26*	-4.38*	-4.21*	-4.27**	0.15	0.07	-3.99*	-4.30*
	(-2.96)	(-3.56)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Govt. expenditure on education (as % of GDP)	-.96	-1.33	-4.31*	-0.46	0.66**	0.20**	-0.96	-1.33
	(-1.96)	(-3.19)	(2.95)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
ΔGovt. expenditure on education (as % of GDP)	-4.82*	-5.30*	-5.21*	-12.91*	0.45***	0.48*	-5.30*	-4.82*
	(-3.19)	(-1.95)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Govt. consumption net of schooling (as % of GDP)	-2.51	-5.29*	-2.67	-3.85**	0.27	0.10	-1.89***	-2.61
	(-2.96)	(-3.60)	(-2.96)	(-3.55)	(0.46)	(0.15)	(-1.95)	(-3.19)
ΔGovt. consumption net of schooling (as % of GDP)	-4.34*	-4.37*	-5.49*	-5.91*	0.28	0.17**	-5.07*	-5.45*
	(-2.96)	(-3.57)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.96)	(-3.19)
Inflation_deflator	-4.14*	-4.20*	-4.17*	-4.24*	0.23***	0.14**	-3.98*	-4.32*
	(-2.96)	(-3.56)	(-2.96)	(-3.55)	(0.46)	(0.15)	(-1.96)	(-3.19)
ΔInflation_deflator	-8.76*	-8.62*	-16.38*	-18.01*	0.50*	0.50*	-8.72*	-8.89*
	(-2.96)	(-3.56)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Remittance	-1.08	-2.13	-0.31	-1.81	0.55**	0.17**	-1.25	-2.02
	(-2.96)	(-3.57)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Δ Remittance	-1.86***	-1.49***	-4.78*	-4.80*	0.19	0.13***	-1.81***	-1.87
	(-2.97)	(-3.57)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Globalisation index	-0.52	-2.40	-0.51	-2.41	0.65*	0.12***	-3.17**	-2.23
	(-2.96)	(-3.56)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.96)	(-3.19)
Δ Globalisation index	-5.63*	-5.49*	-5.63*	-5.48*	0.16	0.16**	-4.73*	-5.52*
	(-2.96)	(-3.56)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Voice and Accountability	-0.89	-4.21**	-1.04	-1.92	0.56	0.08	-0.38	-3.24**
	(-2.56)	(-3.59)	(-2.96)	(-3.56)	(o.46)	(0.15)	(-1.96)	(-3.19)
Δ Voice and Accountability	-4.08*	-3.05***	-3.98*	-3.90**	0.08	0.07	-4.21*	-4.19*
	(-2.98)	(-3.62)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Rule of law	-1.57	-2.77	-1.57	-2.81	0.68*	0.10	-0.73	-2.75
	(-2.96)	(-3.55)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Δ Rule of law	-5.88*	-5.80*	-5.88*	-5.80*	0.05	0.04	-5.86*	-5.93*
	(-2.96)	(-3.56)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Regulatory control	-0.81	-1.06	-2.70***	-1.31	0.60**	0.18**	-0.81	-1.06
	(-1.95)	(-3.19)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Δ Regulatory control	-4.96*	-6.03*	-5.08*	-5.84*	0.42***	0.07	-4.96*	-6.02*
	(-1.95)	(-3.19)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Control of corruption	-2.65***	-2.22	-2.34	-1.79	0.56**	0.16**	-0.53	-1.26
	(-2.95)	(-3.56)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)
Δ Control of corruption	-3.75*	-3.99*	-3.77*	-4.05*	0.28	0.10	-3.73*	-4.13*
	(-2.96)	(-3.56)	(-2.96)	(-3.56)	(0.46)	(0.15)	(-1.95)	(-3.19)

(Contd. Table 3A.1)

Variables Name	ADF (Intercept only)	ADF (Trend and Intercept)	PP (Intercept only)	PP (Trend and Intercept)	KPSS (Intercept only)	KPSS (Trend and Intercept)	DFGLS-ERS (Intercept only)	DFGLS-ERS (Trend and Intercept)
Different versions of TFP variables								
Dlna_ardl_alpha65beta25	-3.20* (-1.95)	-4.61* (-3.19)	-4.45* (-2.96)	-4.47* (-3.56)	0.16 (0.46)	0.08 (0.15)	-3.20* (-1.95)	-4.61* (-3.19)
Dlna_ardl_alpha65CRS	-4.08* (-2.96)	-4.16* (-3.56)	-4.10* (-2.96)	-4.16* (-3.56)	0.17 (0.46)	0.08 (0.15)	-4.08* (-1.95)	-4.30* (-3.19)
Dlna_ardlintensive_alpha70CRS	-4.26* (-2.95)	-4.22* (-3.56)	-4.27* (-2.96)	-4.22* (-3.56)	0.11 (0.46)	0.09 (0.15)	-4.31* (-1.95)	-4.36* (-3.19)
Dlna_fmols_alpha69beta12	-3.47* (-2.96)	-3.43* (-3.56)	-4.82* (-2.96)	-4.74* (-3.56)	0.10 (0.46)	0.10 (0.15)	-3.52* (-1.95)	-3.56* (-3.19)
Dlna_fmols_alpha69CRS	-4.24 (-2.96)	-4.21 (-3.56)	-4.25 (-2.96)	-4.21 (-3.56)	0.12 (0.46)	0.09 (0.15)	-4.28 (-1.95)	-4.35* (-3.19)
Dlna_fmolsintensive_alpha69CRS	-4.28* (-1.95)	-4.35* (-3.19)	-4.25* (-2.96)	-4.21* (-3.56)	0.12 (0.46)	0.09 (0.15)	-4.28* (-1.95)	-4.35* (-3.19)
Dlna_ols_alpha68beta29	-4.26* (-2.96)	-4.25* (-3.56)	-4.27* (-2.96)	-4.25* (-3.56) *	0.13 (0.46)	0.09 (0.15)	-4.29* (-1.95)	-4.39* (-3.19)
Dlna_ols_alpha68CRS	-4.19* (-2.96)	-4.19* (-3.56)	-4.21* (-2.96)	-4.19 (-3.56)	0.13 (0.46)	0.09 (0.15)	-4.22* (-1.95)	-4.33* (-3.19)
Dlna_olsintensive_alpha68CRS	-4.21* (-2.96)	-4.20* (-3.56)	-4.22* (-2.96)	-4.20* (-3.56)	0.13 (0.46)	0.09 (0.15)	-4.24* (-1.95)	-4.34* (-3.19)
Dlna_vec_alpha49beta52	-3.17* (-2.96)	-3.81* (-3.56)	-3.17* (-2.96)	-3.82* (-3.56)	0.46 (0.46)	0.07 (0.15)	-2.94* (-1.95)	-3.93* (-3.19)
Dlna_vec_alpha49CRS	-3.23* (-2.96)	-3.87* (-3.56)	-3.23* (-2.96)	-3.89* (-3.56)	0.46 (0.46)	0.07 (0.15)	-2.99* (-1.95)	-3.99* (-3.19)
Dlna_fmolsintensive_alpha47CRS	-3.11* (-2.96)	-3.82* (-3.56)	-3.11* (-2.96)	-3..81* (-2.96)	0.49 (0.46)	0.08 (0.15)	-2.85* (-1.95)	-3.95* (-3.19)

Note:*, **, and ***indicate significance level at 1%, 5%, 10% respectively.

Table 3A.1.0 : Zivot-Andrews (1992) Test for Detection of a Single Endogenous Structural Break

Dependent Variable: ols_agg_noncrs	Intercept	Trend	Both Intercept & Trend
T-Statistic	-5.315**	-4.625**	-5.156**
Break Period	2004	2003	2004

Notes: ***, **, and * indicate significance at 10%, 5% and 1% respectively. Critical values at Intercept: 1%: -5.34 5%: -4.80 10%: -4.58; Critical values at Trend: 1%: -4.93 5%: -4.42 10%: -4.11; Critical values at both Intercept and Trend: 1%: -5.57 5%: -5.08 10%: -4.82

*Only one result for Zivot-Andrew test is shown just for brevity purpose. The other (11) results are available upon request to the authors. All of these results confirm a structural break in 2004 in TFP series of Bangladesh.

Table 3A.1.1: Model 1 Specifications Applied on TFP Series Obtained from Aggregate Production Function Estimates with the Non-CRS Assumption

	Aggregate Production Function Estimates with Non-CRS Assumption			
Variables	(1)	(2)	(3)	(4)
	ols_Agg_noncrs	vec_Agg_noncrs	fmols_Agg_noncrs	ardl_Agg_noncrs
D. government expenditure on education	0.0285**	0.0256**	0.0300**	0.0287**
	(0.0104)	(0.00932)	(0.0122)	(0.0105)
D. voice and accountability	0.0594**	0.0633***	0.0496**	0.0553**
	(0.0212)	(0.0160)	(0.0225)	(0.0205)
D. regulatory control	-0.0474*	-0.0563**	-0.0410	-0.0459*
	(0.0272)	(0.0210)	(0.0285)	(0.0262)
D. credit	-0.000941	-0.00104	-0.000889	-0.000935
	(0.000706)	(0.000659)	(0.000792)	(0.000705)
D. broad money	-0.00126**	-0.00177***	-0.000853	-0.00116*
	(0.000590)	(0.000497)	(0.000625)	(0.000572)
D. government consumption net of schoolings	-0.0111	-0.0107	-0.0111	-0.0110
	(0.00858)	(0.00885)	(0.00888)	(0.00857)
Inflation deflator	-0.00101**	-0.00133**	-0.000832*	-0.000982**
	(0.000463)	(0.000526)	(0.000464)	(0.000459)
D. remittance	-0.00312*	-0.00311**	-0.00275	-0.00293*
	(0.00169)	(0.00129)	(0.00192)	(0.00166)
D. globalisation index	-0.00261**	-0.00145	-0.00330***	-0.00273**
	(0.00104)	(0.00113)	(0.00114)	(0.00107)
Time Dummy	0.00469*	0.00958***	0.00347	0.00504**
	(0.00232)	(0.00206)	(0.00261)	(0.00235)
Constant	0.00603	0.00864	0.0115*	0.00929
	(0.00626)	(0.00589)	(0.00646)	(0.00620)
Observations	32	32	32	32
Mean VIF	4.98	4.97	4.98	4.98
Ramsey RESET test statistic	0.94	0.51	0.86	1.78
	(0.44)	(0.68)	(0.48)	(0.18)
R-squared	0.559	0.739	0.484	0.558

Table 3A.1.2: Model 1 Specifications Applied on TFP Series Obtained from Aggregate Production Function Estimates with CRS Assumption

	Aggregate Production Function Estimates with CRS Assumption			
Variables	(5)	(6)	(7)	(8)
	ols_Agg_crs	vec_Agg_crs	fmols_Agg_crs	ardl_Agg_crs
D. government expenditure on education	0.0284**	0.0257**	0.0286**	0.0280**
	(0.0103)	(0.00923)	(0.0106)	(0.00992)
D. voice and accountability	0.0605***	0.0621***	0.0603**	0.0607***
	(0.0211)	(0.0159)	(0.0216)	(0.0202)
D. regulatory control	-0.0480*	-0.0556**	-0.0474	-0.0492*
	(0.0271)	(0.0210)	(0.0278)	(0.0260)
D. credit	-0.000946	-0.00103	-0.000939	-0.000960
	(0.000702)	(0.000655)	(0.000715)	(0.000679)
D. broad money	-0.00130**	-0.00172***	-0.00127**	-0.00137**
	(0.000589)	(0.000495)	(0.000602)	(0.000565)

(Contd. Table 3A.1.2)

Aggregate Production Function Estimates with CRS Assumption				
Variables	(5)	(6)	(7)	(8)
	ols_Agg_crs	vec_Agg_crs	fmols_Agg_crs	ardl_Agg_crs
D. government consumption net of schoolings	-0.0111	-0.0107	-0.0111	-0.0110
	(0.00856)	(0.00881)	(0.00860)	(0.00851)
Inflation deflator	-0.00102**	-0.00131**	-0.00100**	-0.00107**
	(0.000464)	(0.000521)	(0.000464)	(0.000465)
D. remittance	-0.00316*	-0.00306**	-0.00317*	-0.00314*
	(0.00168)	(0.00128)	(0.00172)	(0.00159)
D. globalization index	-0.00255**	-0.00153	-0.00263**	-0.00239**
	(0.00104)	(0.00113)	(0.00104)	(0.00104)
Time Dummy	0.00478*	0.00948***	0.00441*	0.00552**
	(0.00230)	(0.00207)	(0.00234)	(0.00224)
Constant	0.00542	0.00936	0.00511	0.00604
	(0.00625)	(0.00589)	(0.00631)	(0.00615)
Observations	32	32	32	32
Mean VIF	4.98	4.98	4.98	4.98
Ramsey RESET test statistic	0.86	0.53	0.77	0.96
	(0.48)	(0.66)	(0.52)	(0.43)
R-squared	0.566	0.735	0.551	0.597

Note: Robust standard errors are in parentheses.*** p<0.01, ** p<0.05, * p<0.1.

Table 3A.1.3: Model 1 Specifications Applied on TFP Series Obtained from Intensive Form Production Function Estimates

Intensive Form Production Function Estimates				
	(9)	(10)	(11)	(12)
Variables	ols_Int_crs	vec_Int_crs	fmols_Int_crs	ardl_Int_crs
D. government expenditure on education	0.0285**	0.0254**	0.0286**	0.0288**
	(0.0104)	(0.00937)	(0.0106)	(0.0107)
D. voice and accountability	0.0604***	0.0623***	0.0603**	0.0602**
	(0.0213)	(0.0155)	(0.0216)	(0.0219)
D. regulatory control	-0.0478*	-0.0565**	-0.0474	-0.0470
	(0.0273)	(0.0205)	(0.0278)	(0.0282)
D. credit	-0.000944	-0.00104	-0.000939	-0.000934
	(0.000706)	(0.000665)	(0.000715)	(0.000724)
D. broad money	-0.00129**	-0.00177***	-0.00127**	-0.00125*
	(0.000593)	(0.000495)	(0.000602)	(0.000611)
D. government consumption net of schoolings	-0.0111	-0.0107	-0.0111	-0.0111
	(0.00858)	(0.00893)	(0.00860)	(0.00863)
Inflation deflator	-0.00102**	-0.00134**	-0.00100**	-0.000987**
	(0.000464)	(0.000535)	(0.000464)	(0.000465)
D. remittance	-0.00316*	-0.00305**	-0.00317*	-0.00317*
	(0.00169)	(0.00126)	(0.00172)	(0.00175)
D. globalisation index	-0.00257**	-0.00141	-0.00263**	-0.00268**
	(0.00104)	(0.00115)	(0.00104)	(0.00104)
Time Dummy	0.00466*	0.0100***	0.00441*	0.00416*
	(0.00231)	(0.00206)	(0.00234)	(0.00236)
Constant	0.00531	0.00983	0.00511	0.00490
	(0.00627)	(0.00589)	(0.00631)	(0.00635)
Observations	32	32	32	32
Mean VIF	4.98	4.98	4.98	4.98
Ramsey RESET test statistic	0.83	0.51	0.77	0.70
	(0.49)	(0.68)	(0.52)	(0.56)
R-squared	0.561	0.747	0.551	0.541

Note: Robust standard errors are in parentheses.*** p<0.01, ** p<0.05, * p<0.1.

Table 3A.1.4: Model 3 Specifications Applied on TFP Series Obtained from Aggregate Production Function Estimates with the Non-CRS Assumption

	Aggregate Production Function Estimates With Non-CRS Assumption			
Variables	(1)	(2)	(3)	(4)
	ols_Agg_noncrs	vec_Agg_noncrs	fmols_Agg_noncrs	ardl_Agg_noncrs
D. government expenditure on education	0.0295**	0.0265**	0.0308**	0.0296**
	(0.0114)	(0.00967)	(0.0132)	(0.0114)
D. voice and accountability	0.0524***	0.0556***	0.0430**	0.0484***
	(0.0156)	(0.0125)	(0.0173)	(0.0153)
D. regulatory control	-0.0481**	-0.0562***	-0.0411	-0.0462**
	(0.0216)	(0.0149)	(0.0240)	(0.0209)
D. rule of law	0.0182	0.0176**	0.0156	0.0168
	(0.0120)	(0.00695)	(0.0137)	(0.0116)
D. broad money	-0.00146**	-0.00198***	-0.00104	-0.00135*
	(0.000668)	(0.000562)	(0.000709)	(0.000652)
D. government consumption net of schoolings	-0.00811	-0.00735	-0.00826	-0.00803
	(0.00732)	(0.00816)	(0.00744)	(0.00730)
Inflation deflator	-0.000900*	-0.00121**	-0.000731*	-0.000876*
	(0.000435)	(0.000535)	(0.000423)	(0.000433)
D. remittance	-0.00247	-0.00242*	-0.00216	-0.00230
	(0.00161)	(0.00124)	(0.00187)	(0.00160)
D. globalisation index	-0.00248**	-0.00131	-0.00318**	-0.00260**
	(0.00114)	(0.00122)	(0.00124)	(0.00117)
Time Dummy	0.00391	0.00879***	0.00278	0.00431*
	(0.00232)	(0.00208)	(0.00257)	(0.00233)
Constant	0.00419	0.00662	0.00981*	0.00747
	(0.00556)	(0.00550)	(0.00569)	(0.00551)
Observations	32	32	32	32
Mean VIF	4.42	4.42	4.42	4.42
Ramsey RESET test statistic	3.90 (0.03)	0.52 (0.67)	0.83 (0.49)	3.49 (0.04)
R-squared	0.555	0.732	0.479	0.552

Note: Robust standard errors are in parentheses.*** p<0.01, ** p<0.05, * p<0.1.

Table 3A.1.5: Model 3 Specifications Applied on TFP Series Obtained from Aggregate Production Function Estimates with CRS Assumption

Aggregate Production Function Estimates with CRS Assumption				
Variables	(5)	(6)	(7)	(8)
	ols_Agg_crs	vec_Agg_crs	fmols_Agg_crs	ardl_Agg_crs
D. government expenditure on education	0.0294**	0.0267**	0.0296**	0.0290**
	(0.0113)	(0.00961)	(0.0115)	(0.0108)
D. voice and accountability	0.0534***	0.0544***	0.0533***	0.0536***
	(0.0155)	(0.0124)	(0.0159)	(0.0148)
D. regulatory control	-0.0488**	-0.0554***	-0.0483**	-0.0498**
	(0.0215)	(0.0149)	(0.0222)	(0.0202)
D. rule of law	0.0185	0.0172**	0.0186	0.0183
	(0.0119)	(0.00703)	(0.0124)	(0.0110)
D. broad money	-0.00150**	-0.00193***	-0.00147**	-0.00157**
	(0.000666)	(0.000562)	(0.000679)	(0.000641)
D. government consumption net of schoolings	-0.00810	-0.00736	-0.00816	-0.00798
	(0.00733)	(0.00810)	(0.00734)	(0.00734)
Inflation deflator	-0.000915**	-0.00119**	-0.000894*	-0.000958**
	(0.000437)	(0.000529)	(0.000435)	(0.000445)
D. remittance	-0.00251	-0.00238*	-0.00252	-0.00249
	(0.00160)	(0.00122)	(0.00164)	(0.00151)
D. globalisation index	-0.00242**	-0.00138	-0.00250**	-0.00225*
	(0.00113)	(0.00122)	(0.00113)	(0.00113)
Time Dummy	0.00399*	0.00870***	0.00362	0.00473**
	(0.00230)	(0.00208)	(0.00233)	(0.00224)
Constant	0.00357	0.00734	0.00327	0.00416
	(0.00555)	(0.00548)	(0.00559)	(0.00549)
Observations	32	32	32	32
Mean VIF	4.42	4.42	4.42	4.42
Ramsey RESET test statistic	4.12	0.55	3.60	4.46
	(0.02)	(0.65)	(0.04)	(0.02)
R-squared	0.562	0.727	0.548	0.592

Note: Robust standard errors are in parentheses.*** p<0.01, ** p<0.05, * p<0.1.

Table 3A.1.6: Model 3 Specifications applied on TFP Series Obtained from Intensive Form Production Function

Intensive Form Production Function Estimates				
Variables	(9)	(10)	(11)	(12)
	ols_Int_crs	vec_Int_crs	fmols_Int_crs	ardl_Int_crs
D. government expenditure on education	0.0295**	0.0263**	0.0296**	0.0298**
	(0.0113)	(0.00966)	(0.0115)	(0.0117)
D. voice and accountability	0.0534***	0.0546***	0.0533***	0.0532***
	(0.0156)	(0.0123)	(0.0159)	(0.0161)
D. regulatory control	-0.0486**	-0.0562***	-0.0483**	-0.0479**
	(0.0217)	(0.0145)	(0.0222)	(0.0226)
D. rule of law	0.0185	0.0171**	0.0186	0.0187
	(0.0121)	(0.00672)	(0.0124)	(0.0127)
D. broad money	-0.00149**	-0.00199***	-0.00147**	-0.00144**
	(0.000670)	(0.000560)	(0.000679)	(0.000688)
D. government consumption net of schoolings	-0.00812	-0.00727	-0.00816	-0.00819
	(0.00733)	(0.00829)	(0.00734)	(0.00735)
Inflation deflator	-0.000908**	-0.00122**	-0.000894*	-0.000879*
	(0.000436)	(0.000546)	(0.000435)	(0.000433)
D. remittance	-0.00251	-0.00237*	-0.00252	-0.00252
	(0.00161)	(0.00121)	(0.00164)	(0.00167)
D. globalisation index	-0.00244**	-0.00126	-0.00250**	-0.00255**
	(0.00113)	(0.00125)	(0.00113)	(0.00113)
Time Dummy	0.00387	0.00926***	0.00362	0.00338
	(0.00231)	(0.00208)	(0.00233)	(0.00235)
Constant	0.00347	0.00780	0.00327	0.00308
	(0.00556)	(0.00552)	(0.00559)	(0.00562)
Observations	32	32	32	32
Mean VIF	4.42	4.42	4.42	4.42
Ramsey RESET test statistic	3.96	0.58	3.60	3.19
	(0.02)	(0.64)	(0.03)	(0.05)
R-squared	0.557	0.739	0.548	0.538

Note: Robust standard errors are in parentheses.*** p<0.01, ** p<0.05, * p<0.1.