How can we double per capita incomes in Bangladesh in 15 years?

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How Can We Double Per Capita Incomes in Bangladesh in 15 Years?*

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Abstract

This paper develops a framework to analyse the determinants of the long term growth rate of Bangladesh. It is based on the Solow (1956) growth model and its extension by Mankiw, Romer and Weil (1992) and follows Senhadji's (2000) growth accounting procedure to estimate total factor productivity (*TFP*). Our growth accounting exercise shows that growth rate in Bangladesh, until the 1990s was primarily due to factor accumulation. Since then, however, *TFP* has made a small positive contribution. An analysis of the determinants of *TFP* shows that remittances by emigrant workers has no significant long run growth effect. Using our results on the determinants of *TFP* we examine policy options to double per capita income of Bangladesh in about 15 years.

Keywords: Solow Growth Model, Total Factor Productivity, Growth Accounting, South Asia, Bangladesh.

JEL Classifications: O10, O15

* We are grateful for comments by Professor John Lodewijks and a referee of the conference on *Ideas and Innovations for the Development of Bangladesh: The Next Decade,* to be held at Harvard University campus, in October, 2009. The conference referee has pointed out some errors in the data in an earlier version of this paper. These were inadvertent errors and when corrected gave slightly different results. After completing the earlier version of this paper, we have seen an interesting paper by Barajas, Chami, Fullenkamp, Gapen and Montiel (2009) on the growth effects of remittances where they found that these are insignificant. Our results for Bangladesh are also similar.

1. Introduction

Bangladesh has received relatively less attention in the growth and development literature. A poor Asian country with a per capita income of US$428 in 2007, its average rate of growth of output (GDP) from 1970 to 2007 was 3.5% with large fluctuations until the early 1990s. Its population has increased at 2.3% per year and therefore its per capita income grew only at 1.2% implying that it will take 58 years to double the per capita income. However, the average growth rate of GDP has increased during 2000 to 2007 to 5.6% and the rate of growth of population decreased to 1.9% implying that per capita income grew at 3.8% and can be doubled in 18 years if this growth rate can be sustained. To double per capita incomes in about 15 years, the target rate of growth of GDP should be about 6.5% if the rate of growth of population can be kept below 2%. This is possible to achieve if the 2000-2007 average values of the determinants of total factor productivity (*TFP*) can be maintained. Only small improvements to these averages are necessary. We shall also examine if per capita incomes can be doubled in 10 years. However, this needs 9% annual growth in GDP and some significant changes to the determinants of *TFP*. The question is whether it is possible to achieve and maintain these higher rates of growth in GDP because in Bangladesh the underlying autonomous trend *TFP* is negative at -0.3% per year. Furthermore, the 5.6% average growth since 2000, as we show later, has been mainly due to factor accumulation and it is difficult to sustain this higher growth rate for a number of years without a substantial increase to *TFP*. While *TFP* is generally low in many developing countries, it seems to be even lower in Bangladesh. The objective of this paper is to addresses some issues concerning the low *TFP* and how it can be increased by analysing its main determinants. During this process we also pay attention to the growth effect of remittances by the emigrant workers. In some recent studies this topic has received significant attention because many development economists seem to believe that remittances are an important source of growth.[1] Remittances have been relatively high for Bangladesh. As a proportion of GDP during 2000 to 2007 workers' remittances (*WRRAT*) were 6.5% and growing at the rate of 12% per year.

To address the aforesaid issues we shall use Solow (1956, 1957) for theoretical guidelines and our empirical methodology is based on extensions to the Solow model made by Mankiw,

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[1] Several earlier papers on this topic, e.g., Ratha (2003), were optimistic that remittances will have positive long term growth effects. However, Barajas et. al., (2009) have noted that these are merely suggestions rather than showing that remittances have actually done so. Commenting on such optimistic views Barajas et. al., concluded that "…no nation can credibly claim that remittances have funded or catalyzed significant economic development." Barajas et. al., has also a good survey of other macroeconomic effects of remittances. This version of our paper has benefited from Barajas et. al., and contains some changes to our earlier draft.

Romer and Weil (1992, MRW henceforth), Senhadji (2000) and Rao and Cooray (2008). The structure of this paper is as follows. Section 2 briefly outlines the use of aforesaid theoretical and empirical papers for the present paper. It is essential to estimate a production function to pursue our objectives. Therefore, Section 3 discusses and provides estimates of the production function based on alternative time series methods. A growth accounting exercise (*GAE*) is conducted in Section 4 to obtain estimates of *TFP*. Section 5 analyses the key determinants of *TFP* and attention is given to the growth effects of remittances. Policy implications of our paper based on simulation results are discussed in Section 6 and Section 7 concludes.

2. Solow Model and Extensions

The literature on the economics and econometrics of growth is vast. It has used two types of theoretical growth models viz., the Solow (1956) exogenous growth model and many variants of the canonical endogenous growth models of Uzawa (1965), Romer (1986,1990), Lucas (1988) and Barro (1990).[2] However, many empirical papers have used somewhat *ad hoc* specifications based on the endogenous growth models with a variety of cross country techniques. Commenting on the policy relevance of these empirical works for the developing countries, Pritchett (2006) has observed that in spite of the vast progress in this literature, there is a tension between the academic interests in the determinants of the long term growth and the need for short to medium term growth policies by the policy makers in the developing countries. Rao and Cooray (2008) have argued that this tension is partly due to a failure to distinguish between policies for growth in the short to medium terms from policies for long run growth. They have pointed out that MRW have shown how the Solow (1956) growth model can be used to explain both the long run steady state growth rate and the dynamics of growth between the steady states.[3] Rao and Cooray

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[2] Ignoring refinements and extensions, these canonical endogenous models use different factors to explain the observed persistent growth in per capita incomes in the advanced countries. In Uwaza (1968) and Romer (1986) persistent growth is due to investment with externalities. In Romer (1990) this is due to accumulation of knowledge through research and development. In Lucas (1988) it is human capital and in Barro (1990) government expenditure on infrastructure causes growth. In comparison, in the exogenous model of Solow (1956) persistent growth is due to the exogenous (unexplained) growth of knowledge i.e., growth in total factor productivity (*TFP*).

[3] This transitional dynamics can also be explained with the much neglected closed form solution of Sato (1962) for the Solow model; see Rao (2006).

have also noted that Senhadji (2000) has demonstrated how Solow's (1957) growth accounting framework can be used to analyse the determinants of *TFP*, which is the solution for the long run equilibrium growth rate for the Solow model.

The implication of these observations is that the usefulness of the Solow (1956) growth model and his 1957 growth accounting framework seem to have been underestimated for analysing the growth and development policies of the developing countries. This is important because the prevalent view is that the Solow (1956) growth model does not have any significant policy implications for growth, even for the developed countries, and somewhat irrelevant for the problems of the developing countries. Hicks (1965), for instance, observed that "Growth Theory (as we shall understand it) has no particular bearing on underdevelopment economics, nor has the underdevelopment interest played any essential part in its development."[4] Therefore, the vast empirical growth literature has neglected the Solow model and used, by and large, some *ad hoc* specifications loosely justified as based on a variety of endogenous growth models. Commenting on the unsatisfactory nature of specifications in these empirical works, Easterly, Levine and Roodman (2004) have noted that "This literature has the usual limitations of choosing a specification without clear guidance from theory, which often means there are more plausible specifications than there are data points in the sample." Rogers (2003) also took a similar view about the *ad hoc* nature of specifications in many cross-country studies but justified these *ad hoc* specifications because though this is less than ideal, the complexity of economic growth and the lack of an encompassing model make it a necessity. Consequently, as found by Durlauf, Johnson, and Temple (2005), the number of potential growth improving variables used in various empirical works is as many as 145.

Since Rao and Cooray (2008) have demonstrated how Solow (1956), and its extended version by MRW (1992), can be used to analyse the short to medium term growth rates with country specific time series data, in this paper we shall demonstrate how the growth accounting framework of Senhadji (2000) can be used to analyse the determinants of the long term growth rate of Bangladesh. Prior to this it is necessary to understand, albeit briefly, the main conclusions of the Solow (1956) growth model and its extensions.

The standard Cobb-Douglas production function with constant returns and Harrod neutral technical progress can be used to explain the main implications of the Solow (1956) model. Further, the following assumptions are necessary. The two inputs capital and labour are assumed, respectively, to grow due to positive net investment until the marginal productivity of capital

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[4] Quoted by Pritchett (2006).

(*MPK*) equals the market rate of interest; and labour supply grows due to population growth. The stock of knowledge also grows due to the exogenous progress of technology. The model, with these assumptions, can be represented as follows.

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha} \quad (1)$$
$$\Delta K_t = I_t - dK_{t-1} \quad (2)$$
$$I_t = sY_t \quad (3)$$
$$\Delta \ln L_t = n \quad (4)$$
$$\Delta \ln A_t = g \quad (5)$$

where *Y* = output, *K* = capital, *A* = stock of knowledge and *L* = labour, *d* = depreciation rate, *s* = proportion of output saved and invested, *n* = growth of labour force and *g* = growth of the stock of knowledge. The steady state or equilibrium is defined as a state where *MPK* equals the rate of interest and positive net investment stops at this point. The solution for the steady state output per worker (y^*) is:[5]

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

Given that the parameters are constant, the steady state growth rate of output (*SSGR*) per worker is $\Delta \ln A$ i.e., the rate at which *TFP* grows. An important implication of the Solow model is that the equilibrium rate of growth of an economy equals *TFP* and a change in the investment rate would have only transitory growth effects but permanent level effects. Since the Solow model assumed that *TFP* is exogenous, it is also known as the exogenous growth model. Another important implication of the Solow model is that although different countries may grow at different growth rates, eventually all countries will converge to an equilibrium growth rate. However, countries with lower initial incomes will grow at a faster rate because *MPK* in these countries will be higher. Therefore, the gap between actual and the steady state levels of income will be higher, which makes the transitory growth rate higher. As these countries attract more capital inflows, this gap will eventually decrease and all countries will reach equilibrium (steady state) and grow at the rate of *TFP*. This prediction of the Solow model, known as convergence hypothesis, was the subject matter of many empirical papers in the 1960s of which the pioneering work is Baumol (1986). The convergence hypothesis has been used as an indirect test for the validity of the Solow (1956) growth model. While this hypothesis was shown to be valid

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[5] $\tilde{y} = \frac{y}{A} = \frac{Y}{L \times A}$ is referred to as the state variable of output in the textbooks.

by Baumol for a group of advanced economies, later empirical studies with larger samples of developed and developing countries found that there is no general support for the convergence hypothesis. This finding and the assumption that *TFP* is exogenous in the Solow model seem to be the main reasons for the popularity of endogenous growth models in the empirical growth literature.

MRW (1992) is the first attempt to extend the Solow (1956) model and show that it can explain observed facts as well as the endogenous growth models. They have augmented the production function in equation (1) with human capital (*HK*) and showed that the extended Solow model can adequately explain the growth rates of a large sample of developed and developing countries. However, they have modified the convergence hypothesis by arguing that *SSGRs* differ between countries and therefore different countries will converge to different *SSGR*s. This is known as the conditional convergence hypothesis. The main message given by MRW is that the extended Solow (1956) growth model is applicable to a large number of countries with diverse structures.

However, *TFP* still remained exogenous even in the extended model of MRW. Therefore, Senhadji (2000), based on the extended Solow model and the growth accounting framework of Solow (1957), is of considerable interest for using the Solow model for policy. Senhadji has used Solow (1957) to conduct a growth accounting exercise for a sample of 88 developed and developing countries. He has estimated *TFP*s as the Solow residuals for all these 88 countries and examined what factors determine *TFP* by regressing on some key determinants. He also found that the conditional convergence hypothesis is valid for his sample and added additional support to MRW's findings. We shall explain later Senhadji's approach in some detail.

3. The Production function

The previous section has noted that an extended Cobb-Douglas production function is useful for the Solow model to explain growth. Using the estimated factor shares from this production function a growth accounting exercise (*GAE*) can be conducted to decompose growth into contribution due to factor accumulation. *TFP* is estimated as the residual i.e., difference between the actual growth rate and growth due to factor accumulation. Using these estimates of *TFP,* which are also estimates of the long run growth rate for a country, it is possible to examine some key factors that determine *TFP.*

For this purpose we follow Senhadji (2000) to conduct a *GAE* to estimate *TFP* for Bangladesh and to analyse its key determinants. While Senhadji has used only one time series method based on the fully modified ordinary least squares (*FMOLS*) of Phillips and Hansen (1990) because he has estimated production functions for a large number of countries, we shall use four time series methods viz., *FMOLS,* the Johansen maximum likelihood (*JML*), the bounds test of Pesaran and Shin (1990) and the LSE-Hendry general to specific (*GETS*) method. Senhadji has also used a simpler specification for the human capital augmented production function of MRW.[6] His Cobb-Douglas specification, with constant returns, is as follows.

$$Y_t = A_t K_t^{\alpha} (H_t \times L_t)^{(1-\alpha)} \tag{7}$$

where Y = output, A = stock of knowledge, K = stock of capital, H = an index of human capital formation through education and L = employment. The assumption of constant returns to scale gives the following simplified form, known as the intensive form of the production function.

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

where $y = (Y / H \times L)$ and $k = (K / H \times L)$. In equation (8) the variables are measured in per worker terms adjusted for skill improvement. To estimate (7) and (8) it is first necessary to check the time series properties of the variables Y, K, LH, y and k. We have conducted the *ADF*, *KPSS* and *DF-GLS* tests to test if these variables are $I(1)$ in levels and $I(0)$ in their first differences. *ADF* and *KPSS* have less power against the null although the null of unit roots in *ADF* is reversed in *KPSS*. In contrast the Elliot, Rothenberg and Stock (1996, 1992, hereafter ERS) *DF-GLS* test belongs to a class known as the efficient unit root tests.[7] These efficient tests have more power against the unit root null and less size distortions in comparison to the *ADF* test. The test results based on *ADF*, *KPSS* and *DFGLS* are in Table 1.

As can be seen, these tests did not give unequivocal results. While in the more efficient *DF-GLS* test all the levels of the variables are found to be non-stationary, *ADF* test rejected the null of non-stationarity for $\ln(L \times H)$ and $\ln y$. In the *KPSS* test, where the null is stationarity, the null could not be rejected for $\ln(H \times K)$. *DF-GLS* could not reject the null of non-stationarity for $\Delta \ln Y$, $\Delta \ln K$, and $\Delta \ln k$ although $\Delta \ln Y$ is found to be stationary by the less efficient *ADF* test.

[6] MRW have used a Cobb-Douglas function with three input factors of the following type:

$$Y_t = A_t K_t^{\alpha} H_t^{\beta} L_t^{(1-\alpha-\beta)}$$

However, they have used secondary school enrolment ratios as a proxy for human capital and this was much criticised. Senhadji's specification reduces the above to one parameter for estimation instead of two.

[7] Others in this class are the ERS point optimal test and the Ng and Perron (2001) tests.

All the 3 tests found $\Delta \ln K$ and $\Delta \ln k$ are non-stationary. The ERS point optimal test and *DF-GLS* have the same asymptotic power under some conditions. Therefore, we have applied the point optimal test to determine if $\Delta \ln Y$, $\Delta \ln K$ and $\Delta \ln k$ are stationary. The computed test statics for these 3 variables, respectively, are -13.904, -94.084 and -28.523. These exceed the 5% critical value of -2.970 and the null of unit root can be rejected.[8]

Table 1
Unit Root Tests

Variable	*ADF*	*KPSS*	*DF-GLS*	Variable	*ADF*	*KPSS*	*DF-GLS*
$\ln Y$	0.206 (-3.553)	0.220* (0.146)	-1.221 (-3.190)	$\Delta \ln Y$	-9.310* (-2.948)	0.614* (0.463)	0.963 (-1.952)
$\ln K$	-2.007 (-3.544)	0.195* (0.146)	-1.399 (-3.190)	$\Delta \ln K$	-1.850 (-2.951)	0.654* (0.463)	-1.511 (-1.951)
$\ln LH$	-5.210* (-3.568)	0.093 (0.146)	-2.183 (-3.190)	$\Delta \ln LH$	-2.886** (-2.968)	0.156 (0.463)	-3.148* (-1.953)
$\ln y$	-5.185* (-3.536)	0.217* 0.146	-2.088 -3.190	$\Delta \ln y$	-4.971* (-2.946)	0.585* (0.463)	-3.117* (-1.951)
$\ln k$	-3.132 (-3.568)	0.193* (0.146)	-1.165 (-3.190)	$\Delta \ln k$	-1.682 (-2.945)	0.635* (0.463)	-0.956 (-1.951)

Notes: 5% CVs are in the parentheses below the computed test statistics.
* significant at 5% and ** significant at the 10% levels.

For valid estimates and inferences with *FMOLS* and *JML,* it is necessary that all the variables should be *I(1)* in levels. However, the Bounds test and *GETS* do not need pre-testing of the variables and given the ambiguities in the roots tests, comparisons of the estimates of the

[8] The SBC criteria, generally used for selecting the lag length, has selected a zero lag for $\Delta \ln k$. This may leave some serial correlation in the residuals of the equation with GLS detrended variables for the *ADF* equation. Therefore, we have used the modified SBC to select the lag length and this option selected 2 lags for this variable. It is also not uncommon to add 2 additional lags to the unmodified lag selection criteria to minimise serial correlation and for MA structures in the residuals; see Harris and Sollis (2003). It is not uncommon to get such conflicting test results in small samples which lead some to say that it is possible to get any result with more than 150 options available to test for unit roots in softwares like the EViews.

[10] This is one reason why the bounds test, also known as the *ARDL* approach to cointegration, is very popular in the applied work. However, it is less well known that *GETS* can also be used without the need for pretesting; see Rao, Singh and Kumar (2009).

cointegrating equations with these four techniques are of interest.[10] Estimates of the cointegrating equations for equations (7) and (8), with these four methods are in Tables 2.

Table 2 Estimates of the Cointegrating Equations					
Production Function	$Y_t = A_t K_t^{\alpha}(H_t \times L_t)^{\beta}$			$y_t = A_t k_t^{\alpha}$	
	1	2	3	4	5
Method	*Intercept*	α	β	*Intercept*	α
FMOLS	3.203 (7.80)	0.377 (8.68)	0.791 (9.41)	4.947 (19.23)	0.490 (20.65)
JML	5.130 (3.48)	0.467 (15.15)	0.533 (16.00)	5.836 (18.17)	0.404 (13.33)
ARDL (Bounds Test)	2.242 (2.57)	0.402 (4.50)	0.808 (4.66)	5.177 (15.97)	0.468 (15.30)
GETS	3.550 (5.143)	0.443 (12.30)	0.665 (7.15)	4.597 (11.50)	0.529 (12.80)
Notes: t-ratios are in the parentheses and all are significant at 5% level.					

In this table estimates of the share of profits (α) varied from 0.377 with *FOML* (row 2) to 0.529, with *GETS* in the last row. The stylised value of α, used in many growth accounting exercises, especially for the developed countries, is one third. But α for the developing countries could be higher than the stylised value.[11] In the estimates of the unconstrained equation in columns (1) to (3) the null that there are constant returns ($\alpha + \beta = 1$) is not ejected by the Wald test.

Good estimates of α are necessary because it affects the estimate of *TFP*. Differentiating the specification in (7) and rearranging terms gives:

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[11] By definition the share of profits is:

$$\alpha = \frac{\dfrac{\partial \ln(Y)}{\partial \ln(K)} \times K}{Y} \approx \frac{\Delta Y}{\Delta K}\left(\frac{K}{Y}\right)$$

The numerator is the remuneration for capital which is the marginal product of capital (*MPK*) multiplied by capital stock and (*K/Y*) is the capital-output ratio (*KYRAT*). It is to be expected that *MPK* will be higher in the developing countries because of their lower capital stocks and α should be higher. This effect will be partly offset by lower *KYRAT*s in the developing countries. But in proportionate terms the differences in *MPKs* are likely to be higher than *KYRATs*.

$$d\ln Y = d\ln A + \alpha(d\ln K) + (1-\alpha)(d\ln L + d\ln H)$$
$$\therefore d\ln A = TFP = d\ln y - \alpha \ln k$$
$$and\ \ \frac{\partial TFP}{\partial \alpha} = -\ln k < 0 \qquad (9)$$

where the lower case letters are as defined earlier.[12] The result in (9) implies that using overestimated values of α, in a *GAE,* gives underestimated *TFP* values. Eve though this is unlikely to significantly affect the regression results when *TFP* is regressed on its potential determinants because α is held constant in the *GAE*, their statistical properties may differ somewhat. We shall use both measures of *TFP* where appropriate.

4. Growth Accounting

As noted in the introduction, to double per capita incomes in Bangladesh, it is necessary to achieve a GDP growth rate of about 6.5%. However, if growth in GDP is mainly due to factor accumulation instead of *TFP*, it will be difficult to sustain this higher growth rate. For this reason *GAE* is important because it can be used to decompose the rate of growth of output ($\Delta \ln Y$) into how much is due to the rates of growth of capital ($\Delta \ln K$), labour (ΔL) and human capital ($\Delta \ln H$). The total of these 3 contributions is the rate of growth due to factor accumulation. The residual is an estimate of *TFP*. This can be explained as follows with the production function (7). Taking its total differential gives:

$$D\ln Y = D\ln A + \alpha(D\ln K) + (1-\alpha)(D\ln L + D\ln H)$$
$$\therefore D\ln A = D\ln Y - \left[\alpha(D\ln K) + (1-\alpha)(D\ln L + D\ln H)\right] \qquad (10)$$
$$= \mathrm{D}\ln y - \alpha D\ln k \qquad (10a)$$

From the above it can be seen that *TFP* can be estimated as a residual using either of the two equations, but it is more convenient to tabulate results from (10a). We shall use two alternative estimates of α. The lowest estimate of 0.377 is close to the stylised value of one third. The average of all the estimated values in Table 2 is 0.448. We shall use both values i.e., 0.377 and 0.448 to estimate *TFP*. These values of *TFP* are plotted, respectively, as *TFP1* and *TFP2* in Figure 1. As can be seen they are very close up to 1985 and since then *TFP*2 is slightly lower.

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[12] Senhadji's derivation of the result in (4) doe not seem to be correct because he fails to simplify this derivation.

Figure 1

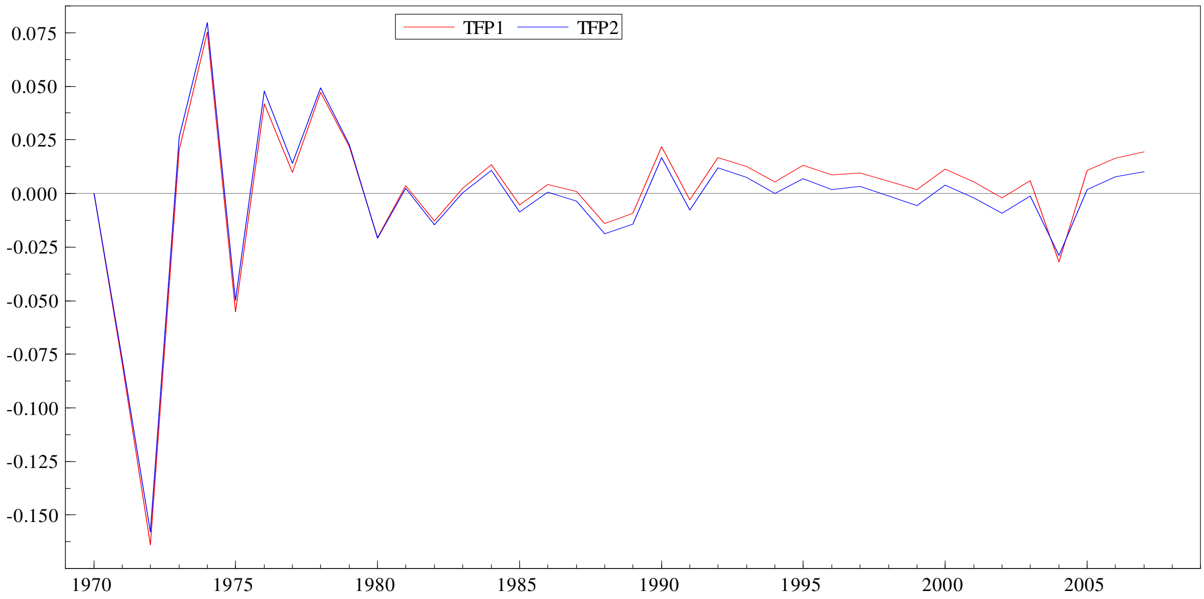

Table 3 provides the results of growth accounting exercises carried out in this paper. It shows how much factor accumulations have contributed to growth in Bangladesh and how much has been contributed by TFP. The summary statistics reported there are the two estimates of *TFP* with growth decomposition for the entire sample period and sub-periods. For example, the first row shows that during the whole sample period 1971 – 2007, the mean growth rate was 3.5%. Of this growth rate 99.29% was contributed by factor accumulation and only a meagre 0.71% was contributed by TFP1. In case of TFP2, its contribution was rather negative 3.04%. *TFP* has been fluctuating widely up to 1990 with an average of negative *TFP* till 1989 and its means became positive only since 1990. Its contribution was about 1% during the decade of the 1990s and then decreased to 0.5% during the 8 years of 2000. Although in Bangladesh *TFP*'s contribution to growth is small and virtually negligible, this is also true in many other developing countries. Senhadji has estimated that *TFP*'s proportionate contribution to growth in the South Asian countries is 12% during 1960-2000. To reach this regional average, Bangladesh should sustain its *TFP* of the 1990s and improve this to achieve a sustainable growth in GDP of 6.5% to double per capita incomes in a decade and half. For this purpose it is necessary to analyse the key determinants of *TFP*.

Table 3
Decomposition of Growth

	Mean $\Delta \ln Y$	Mean $\Delta \ln K$	Mean $\Delta \ln(L + HK)$	Growth due to factor accumulation-1#	Growth due to factor accumulation-2@	Growth due to *TFP*1#	Growth due to *TFP*2@
1971-2007	0.035	0.047	0.028	0.035	0.036	0.0003	-0.001
Contribution to Growth (%)				99.29%	103.04%	0.71%	-3.04%
1971-1979	0.008	0.0004	0.027	0.017	0.015	-0.009	-0.007
Contribution to Growth (%)				212.85%	189.15%	-112.85%	-89.15%
1980-1989	0.032	0.047	0.028	0.035	0.037	-0.004	-0.005
Contribution to Growth (%)				111.83%	116.13%	-11.83%	-16.13%
1990-1999	0.047	0.062	0.023	0.038	0.040	0.009	0.007
Contribution to Growth (%)				80.19%	86.09%	19.81%	13.91%
2000-2007	0.056	0.079	0.035	0.052	0.055	0.004	0.001
Contribution to Growth (%)				92.09%	97.63%	7.91%	2.37%

Notes: # assumes that $\alpha = 0.377$ and @ assumes $\alpha = 0.448$.

5. Determinants of *TFP*

It is difficult to interpret annual estimates of *TFP*, obtained as residuals from *GAE*s, as estimates of true long run or the steady state growth rate (*SSGR*). *SSGR* is an unobservable theoretical concept and similar to the natural rate of unemployment. It should be derived by imposing the steady state conditions on an estimated non-steady state dynamic model that fits the data. In the Solow growth model, as discussed in Section 2, *SSGR* is derived from equation (6) for the steady state level of per worker income (y^*). Since

$$y \equiv \frac{Y}{L \times H}$$

and equation (6) gives:

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

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

The above derivation implies that the parameters s, d, n, g and α remain constant in the steady state. Using the average value of *TFP1* for the entire sample period of 1971-2007 from Table 3 as a proxy for $\Delta \ln A$, which is near zero, and the actual average growth rates of labour of 2.5% and human capital of 0.3%, the *SSGR* of output of Bangladesh is slightly above 2.8%. The rate of growth of population is 2.2% implying that per capita incomes can grow only at about 0.6%. If the average values for these variables from 2000 to 2007 are used and can be sustained, the implied long run growth rates of output and per capita income, respectively, are 3.5% and 1.7%. If the average values for the entire sample period are used, it will take more than 100 years to double per capita incomes. To double per capita incomes in 15 years, per capita incomes should grow at 4.6% implying that the target rate of growth of GDP should be about 6.5%. This has been noted in the introduction. How can this be achieved? For this purpose first it is necessary to understand the key variables determining *TFP*. It is hard to sustain a high growth rate with factor accumulation alone and therefore policies to increase the current low rate of growth of *TFP* are necessary. Although *TFP* is not a true measure of *SSGR,* an analysis of this proxy variable gives some insights into how to improve the long run growth rate. Many empirical studies, based on the endogenous growth models and cross country regressions, have identified an over-abundance of determinants of *TFP*.[13] Therefore, any list of a few crucial determinants is unlikely to be complete.

Durlauf, Kourtellos, and Tan (2008) have summarised the main findings of several cross country studies and grouped them into 6 broad categories. According to them the fundamental determinants of growth are (1) economic institutions (2) legal and political systems (3) climate (4) geographical isolation (5) ethnic fractionalization and (6) culture.[14] These findings are unlikely to satisfy the needs of the policy makers of developing countries because they need policies to quickly increase the growth rate of per capita incomes (see Pritchett (2006), Rao and Cooray (2008)). Some variables identified by Durlauf, Kourtellos and Tan can be changed only in the very long run and others like ethnic fictionalisation and culture are difficult to change even in the long run.

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[13] Actually these studies regress the average growth rate for the whole sample of 30 or more years in the cross section studies and average growth rates of 5 years in the panel data studies. The assumption is that these average growth rates are good proxies for the unobservable long run growth rate or the *SSGR*. In the Solow model *SSGR* is given by *TFP*. It is for this reason we interpret endogenous growth empirical work as explanations of *TFP*.

[14] These are broadly consistent with the view of Frankel (2003) that the three big determinants that seem to have emerged from the cross country studies on growth are based on climate, openness, and institutions.

It is pragmatic, therefore, to follow Senhadji's approach where he has identified some determinants that can respond to policy measures in the short to medium terms to increase *TFP*. However, he has used cross country methods for estimating the relationship between *TFP* and its determinants and modifications are necessary to suit our country specific time series data. The *TFP* determinants used by Senhadji are: (1) initial level of income, (2) life expectancy, (3) external shocks (proxied with the terms of trade shocks), (4) macro economic conditions (proxied with inflation rate, public consumption, real exchange rate, ratio of reserves to imports and level of external debt), (5) trade regime (proxied with current account and capital account convertibility) and (6) political stability (proxied with the ratio of war casualties to the population). His major findings are as follows. Firstly, growth in the developing countries is mostly due to factor accumulation and the contribution of *TFP* has been small;[15] secondly, there is support for conditional convergence, thus validating the applicability of the MRW augmented Solow model for a large number of countries with diverse economic structures; and thirdly, the significant explanatory variables of *TFP*, with the expected signs in brackets, are: (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). The insignificant variables are: (8) terms of trade shocks (positive), (9) inflation (negative) and (10) current account convertibility (positive) but its coefficient turned out to be negative. Some of these findings are useful for our analysis of *TFP* of Bangladesh.

Some neglected variables by Senhadji are likely to have small long run growth effects. These are (1) ratio of foreign direct investment to GDP (*FDIRAT*) and (2) financial development which we proxy with the ratio of M2 to GDP (*M2RAT*), (3) ratio of workers' remittances to GDP (*WRRAT*) if some of this is invested in human and physical capital and (4) ratio of aid to GDP (*AIDRAT*). We have also selected some of the variables used by Senhadji with modifications. These are (5) the ratio of current government expenditure to GDP (*GRAT*), (6) inflation rate (*PRAT*) and (7) trade liberalization, proxied with the ratio of imports plus exports to GDP (*TRAT*) or the ratios of export to GDP (*EXRAT*) and imports to GDP (*IMRAT*) because exports and imports may not have the same sized effects, and (8) the ratio of credit to private sector to GDP (*CRAT*). In our empirical work *EXRAT* and *IMRAT* performed better than *TRAT*. We have ignored the investment ratio because in the Solow model this variable has only permanent level

[15] In the East Asian countries, with an average value of $\alpha = 0.48$, factor accumulation contributed 77.5% to growth. In the South Asian countries, where the average $\alpha = 0.56$, *TFP*'s contribution was half at only 12%. The rate of growth of *TFP* was negative in the Sub-Saharan Africa, Middle East and North Africa and Latin America.

effects and no long run growth effects. Needless to say this is not an exhaustive list of the potential determinants of *TFP*. However, since there are only 37 observations on *TFP* we have to be selective in our choice of these determinants and the lag structure for these variables. In order to understand their significance, one could regress *TFP* on the current and 3 periods or more lagged values of the aforesaid 7 or 8 determinants. However, this is not possible because there would be at least 38 parameters, including the intercept and trend, to estimate with 37 observations. Therefore, we have selected 2 lags for each explanatory variable and ignored *CRAT* and used only *M2RAT* to capture developments in the financial sector. It is possible to reduce the parameters by removing the insignificant variables to increase the degrees of freedom. But this procedure suffers from the path dependency problem because the results would be sensitive to the order in which the insignificant variables are removed; see Hendry and Krolzig (2005). Therefore, we have used Hendry and Krolzig's *PcGETS* in which the aforesaid path dependency problem is minimised to select a parsimonious optimal lag structure for alternative specifications. There is a limitation with the estimates with *PcGETS* because essentially it uses OLS for estimation and the estimates may be biased if some explanatory variables are endogenous. Therefore, we shall use the *PcGETS* estimates only as an indicator of the more important explanatory variables and reestimate the preferred equations with the two stage least squares instrumental variables method.[16] The general specification for the estimated equation is:

$$TFP_t = \alpha_0 + gT + \sum_{i=0}^{2} \alpha_{1i} FDIRAT_{t-i} + \sum_{i=0}^{2} \alpha_{2i} M2RAT_{t-i} + \ldots\ldots + \sum_{i=0}^{2} \alpha_{8i} IMRAT_{t-i} \qquad (8)$$

where the 9 explanatory variables are time $T(\pm)$, *FDIRAT*(+), *M2RAT*(+), *WRRAT*(±), *AIDRAT*(+), *GRAT*(-), *PRAT* (-), *EXRAT* (+) and *IMRAT* (-1). The prior expectations of the signs of the coefficients are in the brackets with the variables but their signs may change. For example if remittances are used for consumption, it may have a negative sign and aid is misused it will have negative sign. Details of the definitions of the variables and sources of data are in the appendix.

Empirical results with *PcGETS* for *TFP*1 are tabulated in Tables 4 and estimates for *TFP*2, which are similar to those for *TFP*1, are given in Table 4A in the appendix. Column (1) of Table 4 gives estimates for *TFP*1 with *TRAT* and without remittances by workers (*WRRAT*). The long run coefficients of this equation are in column (2). In column 3 the same equation is estimated by

[16] *PcGETS* has option to estimate with instrumental variables but it is not possible to use this option to select parsimonious dynamic equations. We have used *TSP* for the instrumental variables estimates and found that *TSP* and *PcGETS* gave very similar instrumental variables estimates.

Table 4

Variables	Equations							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	TFP1	*Long run coefficients*	*TFP1*	*Long run coefficients*	*TFP1*	*Long run coefficients*	*TFP1*	*Long run coefficients*
Intercept	0.090 (3.23)**	0.089 (3.23) **	0.071 (3.45) **	0.071 (3.45) **	0.047 (3.64) **	0.047 (3.64)**	0.085 (4.22)**	0.085 (4.22)**
Trend	-0.003 (-6.72)**	-0.003 (-6.80) **	-0.004 (-4.34) **	-0.004 (-4.11) **	-0.001 (-1.60)	-0.001 (-1.60)	-0.004 (-4.67) **	-0.004 (-4.75) **
$GRAT_t$		-0.788 (-2.62) **						
$GRAT_{t-2}$	-0.788 (-2.617)**							
$AIDRAT_{t-2}$							0.000 (-4.37) **	0.000 --
$PRAT_t$	-0.110 (-5.45) **	-0.201 (-6.78) **	-0.078 (-3.12) **	-0.084 (-2.50) **	-0.028 (-1.15)	-0.098 (-2.72) **	-0.081 (-3.41) **	-0.100 (-2.96) **
$PRAT_{t-1}$			0.074 (4.54) **				0.059 (3.58) **	
$PRAT_{t-2}$	-0.091 (-4.31) **		-0.080 (-4.79) **		-0.070 (-3.12) **		-0.079 (-5.03) **	
$M2RAT_t$		0.076 (2.62) **						
$M2RAT_{t-2}$								
$TRAT_t$		0.122 (1.70)*				-0.050 (-4.30) **		
$TRAT_{t-2}$	0.122 (1.705)*				-0.050 (-4.30) **			
$EXRAT_t$			1.135 (4.26) **	0.820 (3.28) **			0.007 (2.84) **	0.009 (3.68) **
$EXRAT_{t-1}$			0.621 (2.17) **				0.008 (2.87) **	
$EXRAT_{t-2}$			-0.935 (-3.97) **				-0.006 (-2.26) **	
$IMRAT_t$			-0.641 (-3.53) **	-0.330 (-2.06) **			-0.005 (-2.86) **	-0.005 (-2.81) **
$IMRAT_{t-2}$			0.308 (3.87) **					
$\bar{R}^2$	0.851		0.851		0.644		0.864	
SEE	0.014		0.014		0.021		0.013	
χ^2_{nn}	4.651 [0.10]		0.548 [0.76]		7.075 [0.02]		0.629 [0.73]	
$\chi^2_{sc(1-4)}$	0.560 [0.69]		2.184 [0.10]		0.831 [0.52]		2.921 [0.04]	

Notes: t-ratios are below the coefficients in the parentheses. * and ** stand for 10% and 5% significance.
The χ^2 tests are for the non-normality and serial correlation (1st to 4th order) in the residuals. p-values are in the square brackets and none are significant at the 5% level except the serial correlation in column (7).

replacing *TRAT* with *EXRAT* and *IMRAT* and its long run coefficients are in column (4). In columns (5) and (7) the equations in columns (1) and (3) are estimated with *WRRAT* as an additional explanatory variable. Columns (6) and (8) contain their long run coefficients. Estimates of the equations in column (1) with *TRAT* and in column (3), where *EXRAT* and

IMRAT replaced *TRAT,* are very close and it is hard to decide which one is better. When these two equations are estimated with *WRRAT* as an additional explanatory variable, *PcGETS* has deleted *WRRAT* as insignificant in the final equations. Addition of *WRRAT* as an explanatory has only marginally changed estimates of the parameters in columns (5) and (7) and the test for the normality of the residuals became significant at the 5% level in both equations. For this reason it can be said that the equations in columns (1) and (3), without *WRRAT* as an explanatory variable, are preferable.

These two preferred equations have very close summary statistics but selected different sets of significant explanatory variables. All the estimates in Table 4 imply that the underlying autonomous *TFP* in Bangladesh is negative and slightly less than half a percentage point. Inflation rate (*PRAT*) is selected by both the preferred equations and its effect on *TFP* as expected is negative but different in the two estimates. While the equation of column (1) has selected *GRAT* and *M2RAT* as significant determinants of *TFP* with the expected signs for their coefficients, neither was selected by the equation of column (3). But this equation makes clear that the absolute magnitudes of the coefficients of export ratio (*EXRAT*) and imports ratio (*IMRAT*) are not the same as is assumed by the *TRAT* variable in column (1). In neither equation *PcGETS* has indicated that there are outliers although an inspection of the plots of the actual predicted values of *TFP* indicated that there are a few outliers but the effect on *TFP* of the devastating floods in 2004 is more striking. Since the two equations in Table 4 have identified different variables as determinants of *TFP*1, we have combined them and reestimated with the two stage instrumental variables method. This has the advantage of overcoming the endogeneity problem and the estimates are reported in Table 5. Estimates for *TFP*2 are in Table 5A in the appendix.

In Table 5 the equation in column (1) is estimated with OLS and has all the variables with their lags of the first two equations of Table 4. Although the summary statistics of this equation are good, 4 coefficients (*GRAT(-2), M2RAT(-2), IMRAT* and *EXRAT)* are insignificant even at the 10% level. We have reestimated this equation by adding a dummy variable *DUM04* for the effects of heavy floods in 2004 and its estimates are in column (2). As can be seen from its summary statistics, addition of *DUM04* has improved the fit and only the coefficient of *EXRAT*

Table 5						
Variables	Equations					
	(1) OLS TFP1	*(2) OLS TFP1*	*(3) OLS TFP1*	*(4) IV TFP1*	*(5) IV TFP1*	*(6) IV TFP1*
Intercept	0.111 (4.10)**	0.128 (5.57)**	0.125 (7.71)**	0.124 (6.61)**	0.122 (6.24)**	0.123 (5.89)**
Trend	-0.004 (-3.13)**	-0.004 (-4.21)**	-0.003 (-5.09)**	-0.003 (-6.99)**	-0.003 (-6.47)**	-0.003 (-6.38)**
$GRAT_{t-2}$	-0.620 (-1.29)**	-0.691 (-1.74)**	-1.303 (-5.05)**	-1.293 (-4.25)**	-1.199 (-3.12)**	-1.286 (-3.06)**
$PRAT_t$	-0.088 (-3.50)**	-0.100 (-4.70)**	-0.090 (-5.71)**	-0.088 (-8.88)**	-0.090 (-7.61)**	-0.088 (-6.27)**
$PRAT_{t-1}$	0.038 (1.77)*	0.031 (1.75)*				
$PRAT_{t-2}$	-0.096 (-5.05)**	-0.100 (-6.32)**	-0.109 (-7.22)**	-0.109 (-6.48)**	-0.106 (2.84)**	-0.109 (-5.55)**
$M2RAT_{t-2}$	0.047 (1.11)	0.092 (2.44)**	0.093 (2.91)**	0.093 (3.86)**	0.110 (2.84)**	0.095 (1.62)
$IMRAT_t$	-0.291 (-1.26)	-0.333 (-1.72)*				
$EXRAT_t$	0.444 (1.39)	0.348 (1.31)				
$EXRAT_{t-1}$	0.675 (2.42)**	0.590 (2.54)**	0.446 (2.37)**	0.450 (3.36)**	0.433 (3.14)**	0.450 (3.34)**
$EXRAT_{t-2}$	-0.563 (-2.14)**	-0.416 (-1.87)*	-0.367 (-1.89)*	-0.375 (-3.05)**	-0.359 (-2.93)**	-0.376 (-3.12)**
DUM04		-0.042 (-3.43)**	-0.042 (-3.50)	-0.042 (-14.46)**	-0.043 (-13.09)**	-0.043 (-8.07)**
$WRRAT_t$					-0.241 (-0.563)	
$REMRAT_t$						-0.007 (-0.03)
$\bar{R}^2$	0.649	0.758	0.748	0.748	0.755	0.739
SEE	0.013	0.012	0.011	0.011	0.011	0.011
DW	2.540	2.399	2.384	2.399	2.501	2.405
$F_{(zero\ slopes)}$	7.280 [0.00]	11.364 [0.00]	13.621 [0.00]	1368.921 [0.00]	1250.652 [0.00]	1173.143 [0.00]
$F_{(Over\ Ident)}$	--	--	--	1.163 [0.36]	1.332 [0.28]	1.281 [0.30]

Notes: t-ratios are below the coefficients in the parentheses. * and ** stand for 10% and 5% significance. The F tests, with p-ratios in the square brackets, are for the null that the coefficients are zero and the null that the selected instruments are over-identified. These equations are estimated with TSP and those in Table 4 with *PcGETS*. They give somewhat different summary statistics.

has remained insignificant. This equation is reestimated by deleting the insignificant *EXRAT* but this made the coefficient of *IMRAT* insignificant. The reestimate in column (3) is without *EXRAT* and *IMRAT* and it can be seen that there are no changes to the estimated parameters and the summary statics. Therefore, it is our preferred *OLS* estimates of the determinants of *TFP*. This equation implies that the underlying autonomous *TFP* is -0.3%. Both government expenditure and inflation decrease *TFP* and financial development and exports increase *TFP*. It is noteworthy that the government expenditure (*GRAT*) has the largest absolute effect on *TFP*.

The above equation is reestimated with the instrumental variables method and the results are in column (4). The instrumental variables are one and two period lagged endogenous variables in addition to the intercept, trend and *DUM04*. The F-test is not significant at the 5% level validating our choice of instrumental variables. As can be seen there are no major changes in this estimate. Its summary statistics and coefficient estimates are similar to the *OLS* estimates in column (3) because the only contemporaneous variable is *PRAT*. It also implies that the underlying autonomous *TFP* is negative at about -0.3%. The 2004 floods have had a one off negative shock to *TFP* of slightly more than 4%. *GRAT* and inflation have negative effects while *M2RAT* and *EXRAT* have positive effects on *TFP*.

We have added to the equation in column (4) additional determinants of *TFP* but none of their coefficients are found to be significant. In columns (5) and (6) estimates with 2 measure of remittances viz., *WRRAT* and *REMRAT* are shown. *WRRAT* is remittances by immigrant workers who are classified as residents in a foreign country and *REMRAT* includes remittances by workers who are not classified as residents in a foreign country. *REMRAT* thus includes remittances by workers who are on short term contracts and diplomatic staff etc. It can be seen that neither of their coefficients are significant and they did not significantly affect the estimates of the other coefficients. Other variables added to the equation in column (4) are *FDIRAT*, *ODARAT*, *AIDRAT* and *IRAT*. But their coefficients were insignificant and to conserve space these estimates are not reported. Our preferred equation is the equation in column (4). Estimates for *TFP*2 are in the Appendix in Table 5A and its results are similar to those in Table 5.

6. Policy Implications and Simulation

Our estimates imply that to increase *TFP* no single policy seems to be a pragmatic option. For example to make *TFP* slightly more than 3% it is necessary to reduce *GRAT* from its average of about 5% in 2000-2007 to about 2%. Similarly to achieve this target for *TFP* by increasing only *EXRAT* it is necessary to increase the average *EXRAT* from 16% to well above 60%. Such policy changes are somewhat difficult to achieve. Therefore, we shall perform a policy simulation to achieve approximately a 3.5% target for *TFP*. We believe that our choice of policy targets is not difficult to achieve and using our framework other alternative targets can also be explored. This would still leave about 3% average growth rate to be achieved by factor accumulation for doubling per capita incomes in 15 years. We shall assume that this growth rate through factor accumulation can be achieved by the policy makers since this is much less than what has been achieved during 2000-2007. In our simulation exercise we will show the implied growth rate to be achieved through factor accumulation to maintain an overall growth rate 6.5% of *GDP*. To give an indication of the broad implications of our estimates of the determinants of *TFP,* it is possible to achieve a 3.5% target for *TFP* if *GRAT* and *PRAT* can be decreased by 15% and *M2RAT* and *EXRAT* can be increased by 40% over their mean values during 2000-2007. The details are given in Table 6.

Table 6
Policy Simulation to Double Per Capita Income
in 15 and 10 Years

	DLY	*TFP1*	Growth due to factors	Growth of Capital	*GRAT*	*PRAT*	*M2RAT*	*EXRAT*
1971-2007	3.52%	0.01%	3.51%	4.72%	4.51%	11.03%	26.46%	9.11%
2000-2007	5.62%	0.42%	5.20%	7.90%	5.02%	3.90%	68.23%	16.36%
Target Averages for 15 and 10 Years								
	DLY	*TFP1*	Growth due to factors	Growth of Capital	*GRAT*	*PRAT*	*M2RAT*	*EXRAT*
2008-2022	6.50%	2.83%	3.67%	5.58%	4.27%	3.32%	95.52%	22.90%
2008-2017	9.10%	4.51%	4.48%	6.81%	3.77%	2.93%	95.52%	22.90%
15 Years	**2008**	**2010**	**2012**	**2015**	**2018**	**2020**	**2021**	**2022**
Growth due to *TFP*	8.47%	3.90%	3.27%	2.33%	1.39%	0.76%	0.44%	0.13%
Growth due to factors	-1.97%	2.59%	3.23%	4.17%	5.11%	5.74%	6.06%	6.37%
10 Years	**2008**	**2010**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Growth due to *TFP*	9.27%	4.62%	4.00%	3.68%	3.37%	3.06%	2.74%	2.43%
Growth due to factors	-0.27%	4.37%	5.00%	5.32%	5.63%	5.95%	6.26%	6.57%

Notes: Rows (1) and (2) contain the average values of the variables in 1973-2007 and 2000-2007. The latter are used in the simulation exercises. In Rows (3) and (4) the average values for 15 and 10 year simulation results are shown. In the rest of the rows values for *TFP* and the implied growth due to factor accumulation are tabulated for selected years.

There has been significant improvement in the performance of the Bangladesh economy since the late 1990s and the early 2000s. The higher growth rate since the 2000s is partly caused, besides a higher rate of growth of capital of near 8%, by the decrease in the average rate of inflation to about 4% from 11%, progress in the financial sector as measured by *M2RAT*, from 26.5% to 63%, and improved export performance *EXRAT* to 16% from 9%. If the policy makers can maintain these improved averages and further reduce *GRAT* and *PRAT* by 15% and increase *M2RAT* and *EXRAT* by 40%, then it is possible to double per capita incomes in 15 years. The target vales for the aforesaid 4 variables are shown in row 3 in Table 6. We believe that these targets are not difficult to achieve. However, two other achievements are necessary. Firstly, since the underlying autonomous trend *TFP* is negative at about -0.3, it is necessary to improve year by year the efficiency of the economy by a small amount. Hopefully these measures will eventually make the underlying trend of *TFP* zero or turn into a small positive magnitude over the 15 year period. It is hard to identify the reasons for this negative trend in *TFP*. But we may conjecture that this may be due to a number of factors like frequent natural disasters, political instability, lack of institutional reforms, outmoded machinery and management practices, migration of skilled labour force and deterioration in education and training standards etc. Our data are inadequate to examine their effects on *TFP* but improvements to reduce their adverse effects are necessary. Otherwise Bangladesh's growth rate will become increasingly dependent on factor accumulation. This is obvious from our simulation results in the last few columns. Secondly, it is necessary to achieve on the average a 3.7% growth rate through factor accumulation, which is 30% less than that has been achieved during 2000-2007. We believe that these two objectives are not hard to achieve over a 15 year period.

Table 6 has also simulation results to double per capita incomes in 10 years, which needs a target rate of growth of 9% for the GDP. This is harder to achieve, but not impossible, if the government can maintain a high growth rate of 4.5% due to factor accumulation. In this simulation we have kept the same targets for *M2RAT* and *EXRAT*, but assume that *GRAT* and *PRAT* are decreased by 25%, i.e., an additional 0.5 points each, instead of 15% in the previous simulation exercise. However, if *GRAT* and *PRAT* cannot be decreased by more than 15%, then the same target growth rate can also be achieved by increasing *M2RAT* and *EXRAT* by 50% over their 2000-2007 average values, implying that they should, respectively, be 102% and 25%. There is no need to increase growth through factor accumulation above the 4.5% rate. Although the higher targets for *M2RAT* and *EXRAT* seem to be difficult to achieve in a short period of 10 years, this fast track growth option needs further study by others interested in the development issues of Bangladesh.

7. Conclusions and Limitations

In this paper we have used the extended versions of the Solow (1956) growth model by MRW (1992) and the growth accounting framework of Solow (1957), as used by Senhadji (2000), to derive policies to increase the long run growth rate of Bangladesh. Our paper is perhaps the first paper, to use these extensions to derive policies for long run growth with country specific time series data. Our growth accounting exercise showed that much of the growth in GDP of

Bangladesh was due to factor accumulation. *TFP*'s contribution was zero before 1990 and became positive only after 1990.

Our results imply that to double per capita income in Bangladesh within 15 years it is necessary to maintain its recent record of higher growth rate since 2000 and make a small effort to decrease *GRAT* and *PRAT* by 15% and increase *M2RAT* and *EXRAT* by 40%. However, there should also be some effort to decrease the negative trend in *TFP* and ensure that factor growth contributes on the average 3.8% growth to *GDP*. These policies are not hard to achieve. An important finding of our paper is that remittances by workers do not seem to have any significant growth effects. However, remittances may improve financial development and may indirectly contribute to growth. We conjecture that these growth effects would be small but concede that they are worth examining in a separate paper. It is also possible to double per capita incomes in 10 years but this needs further improvements in policies to ensure that *TFP* is maintained at 4..5% and growth due to factor accumulation is also maintained at this rate.

There are some limitations to our paper. Its purpose is mainly to present broad orders of magnitude for variables that influence growth performance. The range of our estimates of the share of profits with the production function is a bit high although this did not yield conflicting results on the contribution of factor accumulation to growth or the significance of the long run coefficients of the determinants of *TFP*. The main weakness in this and similar papers is that it is difficult to quantify the unobservable long run equilibrium growth rate. Our proxy with *TFP* from the growth accounting exercise is an alternative and other alternative estimates are worth exploring. We hope that these weaknesses will be improved by other investigators working on the growth and development issues.

Data Appendix

Variables	**Definition**	**Source**
CRAT1	Domestic credit provided by banking sector (% of GDP)	World Development Indicators (WDI) 2008
CRAT2	Domestic credit to private sector (% of GDP)	World Development Indicators (WDI) 2008
EXRAT	Export of goods and services (% of GDP)	World Development Indicators (WDI) 2008
FDIRAT	Foreign direct investment to GDP ratio.	World Development Indicators (WDI) 2008
GRAT	General government final consumption expenditure to GDP ratio.	World Development Indicators (WDI) 2008
H	Human capital; An average of the Barro-Lee and Cohen-Soto data set and it incorporates a 7 percent rate of Return to each year of education.	Barro-Lee and Cohen-Soto data set.
IMRAT	Import of goods and services (% of GDP)	World Development Indicators (WDI) 2008
IRAT	Gross domestic fixed investment to GDP ratio.	World Development Indicators (WDI) 2008
K	Capital Stock; Derived using perpetual inventory method $K_t = .95 * K_{t-1} + I_t$. I_t is real gross domestic fixed investment	International Financial Statistics, IMF
L	Labour Force	World Development Indicators (WDI) 2008
M2RAT	Money and quasi money (M2) to GDP ratio.	World Development Indicators (WDI) 2008
ODARAT	Overseas development aid to GDP ratio.	World Development Indicators (WDI) 2008
PRAT	Inflation, (GDP deflator) annual percentage	World Development Indicators (WDI) 2008
REMRAT	Workers’ remittances and compensation of employees to GDP ratio. Workers' remittances and compensation of employees comprise current transfers by migrant workers and wages and salaries earned by non-resident workers. Workers’ remittances are classified as current private transfers from migrant workers who	World Development Indicators (WDI) 2008

	are residents of the host country to recipients in their country of origin. They include only transfers made by workers who have been living in the host country for more than a year, irrespective of their immigration status. Compensation of employees is the income of migrants who have lived in the host country for less than a year.	
TRAT	Sum of export plus import of goods and services to GDP ratio.	World Development Indicators (WDI) 2008
WRRAT	Workers' remittances to GDP ratio. Workers' remittances are current transfers by migrants who are employed or intend to remain employed for more than a year in another economy in which they are considered residents.	World Development Indicators (WDI) 2008
Y	Real Gross Domestic Product	World Development Indicators (WDI) 2008, World Bank

Variables	Table 4A								
	Equations								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	TFP2	*Long run coefficients*	TFP2	*Long run coefficients*	TFP2	TFP2	TFP2	TFP2	*Long run coefficients*
Intercept	0.138 (8.26)	0.138 (8.28)	0.091 (4.70)	0.091 (4.70)	0.091 (4.70)	0.173 (5.23)	0.164 (5.82)	0.091 (4.70)	0.091 (4.71)
Trend	-0.004 (-8.14)	-0.004 (-7.80)	-0.004 (-5.67)	-0.004 (-5.50)	-0.004 (-5.50)	-0.005 (-5.45)	-0.007 (-6.53)	-0.004 (-5.67)	-0.004 (-5.50)
$GRAT_t$		-1.285 (-6.37)							
$GRAT_{t-2}$	-1.285 (-6.37)								
$AIDRAT_t$						-0.586 (-2.34)			0.000 ---
$AIDRAT_{t-2}$			0.000 (-4.72)	0.000 ---	0.000 (-4.72)	0.000 (-6.86)	0.000 (-9.56)	0.000 (-4.72)	
$PRAT_t$	-0.097 (-5.54)	-0.209 (-7.39)	-0.083 (-3.63)	-0.097 (-2.98)	-0.083 (-3.63)	-0.106 (-4.45)	-0.122 (-5.56)	-0.083 (-3.63)	-0.097 (-2.98)
$PRAT_{t-1}$			0.062 (3.90)		0.062 (3.90)			0.062 (3.90)	
$PRAT_{t-2}$	-0.112 (-6.71)		-0.076 (-5.07)		-0.076 (-5.07)	-0.075 (-5.08)	-0.056 (-3.56)	-0.076 (-5.07)	
$M2RAT_t$						0.152 (3.64)			
$M2RAT_{t-2}$	0.124 (6.37)	0.124 (6.36)							
$EXRAT_t$			0.008 (3.17)		0.008 (3.17)			0.008 (3.16)	0.008 (4.25)
$EXRAT_{t-1}$			0.008 (2.99)	0.010 (4.25)	0.008 (2.99)	0.007 (3.06)	0.006 (2.47)	0.008 (2.99)	
$EXRAT_{t-2}$			-0.006 (-2.18)		-0.006 (-2.18)	-0.005 (-1.86)	0.011 (3.83)	-0.006 (-2.17)	
$IMRAT_t$			-0.005 (-3.18)	-0.005 (-3.20)	-0.005 (-3.18)	-0.003 (-2.01)	-0.005 (-2.91)	-0.005 (-3.18)	-0.005 (-3.20)
$IMRAT_{t-1}$							-0.005 (-3.56)		
$WRRAT_t$						-0.840 (-2.33)			
$WRRAT_{t-1}$							0.663 (1.93)		
$\bar{R}^2$	0.857		0.870		0.870	0.868	0.861	0.870	
SEE	0.013		0.013		0.013	0.013	0.013	0.013	
χ^2_{nn}	2.336 [0.31]		1.567 [0.45]		1.567 [0.45]	1.164 [0.56]	3.034 [0.22]	1.567 [0.45]	
$\chi^2_{sc(1-4)}$	0.704 [0.59]		2.418 [0.08]		2.418 [0.08]	4.058 [0.01]	2.392 [0.08]	2.418 [0.08]	

See notes for Table 4.

Table 5A					
	Equations				
Variables	*(1)* *OLS* *TFP2*	*(2)* *OLS* *TFP2*	*(3)* *IV* *TFP2*	*(4)* *IV* *TFP2*	*(5)* *IV* *TFP2*
Intercept	0.125 (5.00)	0.138 (7.89)	0.132 (7.30)	0.130 (6.83)	0.131 (6.41)
Trend	-0.004 (-4.05)	-0.004 (-5.43)	-0.004 (-8.22)	-0.003 (-7.52)	-0.004 (-7.58)
$GRAT_{t-2}$	-0.734 (-1.66)	-1.453 (-5.24)	-1.380 (-4.61)	-1.230 (-3.31)	-1.328 (-3.25)
$PRAT_t$	-0.093 (-4.01)	-0.090 (-4.94)	-0.089 (-9.59)	-0.092 (-7.76)	-0.087 (-6.71)
$PRAT_{t-1}$	0.036 (1.83)				
$PRAT_{t-2}$	-0.097 (-5.55)	-0.118 (-7.47)	-0.108 (-6.54)	0.106 (-6.26)	-0.107 (-5.57)
$M2RAT_{t-2}$	0.063 (1.61)	0.101 (2.71)	0.098 (4.05)	0.124 (3.33)	0.111 (1.98)
$IMRAT_t$	-0.301 (-1.41)				
$EXRAT_t$	0.431 (1.47)	0.227 (1.27)			
$EXRAT_{t-1}$	0.655 (2.56)		0.465 (3.47)	0.438 (3.27)	0.464 (3.47)
$EXRAT_{t-2}$	-0.508 (-2.10)	-0.173 (-0.90)	-0.362 (-2.91)	-0.337 (-2.81)	-0.366 (-3.06)
DUM2		-0.034 (-2.58)	-0.031 (-10.55)	-0.032 (-8.77)	-0.032 (-6.21)
$WRRAT_t$				-0.383 (-0.92)	
$REMRAT_t$					-0.063 (-0.27)
$\bar{R}^2$	0.724	0.729	0.765	0.836	0.761
SEE	0.012	0.012	0.011	0.011	0.011
DW	2.441	2.351	2.348	2.508	2.395
$F_{(zero\ slopes)}$	9.922 [0.00]	12.415 [0.00]	6303.62 [0.00]	5914.31 [0.00]	5508.40 [0.00]
$F_{(Over\ Ident)}$	--	--	1.103 [0.39]	1.249 [0.31]	1.232 [0.32]
See notes for Table 5.					

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