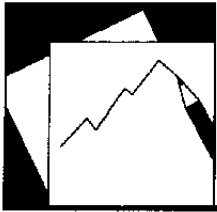


# Working Paper

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## Convergence of Per Capita Output Levels Across Regions of Bangladesh, 1982-97

*Akhtar Hossain*

**IMF Working Paper**

IMF Institute

**Convergence of Per Capita Output Levels Across Regions of Bangladesh, 1982-97**

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Authorized for distribution by Reza Vaez-Zadeh

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**Abstract**

<p>The views expressed in this Working Paper are those of the author(s) and do not necessarily represent those of the IMF or IMF policy. Working Papers describe research in progress by the author(s) and are published to elicit comments and to further debate.</p>
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This paper has examined the phenomenon of convergence of per capita output levels across regions of Bangladesh during 1982–97. The main finding is that most of the regions of Bangladesh experienced strong convergence of per capita output levels during 1982–91. There are two other findings within the domain of convergence. First, a few poorer regions of the country did not demonstrate any output convergence for the full or part of the sample period. Second, no evidence has been found for regional convergence of per capita output levels during 1991–97 that coincided with opening up the economy.

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## I. INTRODUCTION

The existence and persistence of regional income disparity, caused by either structural or policy reasons or both, has economic as well as political implications for developing countries. There are a plethora of examples in Asia and Africa where the people of depressed economic regions have demonstrated their resentment and engaged in secessionist movements of one form or the other. Even if regional income disparity does not always lead to a secessionist movement, it can slow down national integration and retard the process of economic development. Therefore, it is widely acknowledged that regional development is as important as national development on the grounds of both equity and political sustainability.<sup>2</sup>

When it gained independence in 1971, Bangladesh was hailed as a homogeneous economic and political entity. Although this was far from reality, its socioeconomic differences across regions remained somewhat hidden until the 1974 famine that caused a havoc to some of the poorer regions, such as Faridpur, Jessore, Mymensingh, Rangpur and Dinajpur. By then it became apparent that neither infrastructural nor socioeconomic development was uniform across regions of Bangladesh. In fact, in the absence of planned development programs, most modern economic activities were concentrated to a few metropolitan centers, such as Chittagong, Dhaka, Khulna and Rajshahi. There were of course a few urban satellites as well, but they were far from being called the growth poles. In short, the North-West regions were in particular economically depressed and socially and culturally underdeveloped, while the economic fortunes of most of the South and South-West deltaic regions were at the mercy of the mighty *Padma* and its tributaries. All these underdeveloped regions have indeed been the fertile ground of radical politics.<sup>3</sup> A large number of underground political parties in fact flourished during the early

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<sup>2</sup> Different regions of a country can benefit differently during the early stages of development. This could be due to differences in production structure or economic policies or both. While this may be acceptable from an economic viewpoint (given the possibility of output convergence across regions with the maturing of the growth process), it could be unsustainable politically in the short or medium term unless the people of all regions receive growth dividends in one form or the other. The situation may become complex if the country has ethnic, religious or other differences with regional configurations.

<sup>3</sup> The term radical politics is used to represent the activities of different communist parties whose professed goal was to destabilize (or overthrow if possible) the constitutional government by waging a proletarian class struggle. The Jatiya Samajtantric Dal under Abdur Rab and Major Jalil, the Sarbohara Party under Siraj Sikdar, the Sammobadi Dal under Mohammad Toaha, and the East Pakistan Communist Party (Marxist-Leninist) under Abdul Huq were the main political parties that were engaged in the armed struggle during the early 1970s (Maniruzzaman, 1980). Although since then some of these parties have begun constitutional politics, there are still some communist parties that remain engaged in the armed struggle of one form or the other. Their activities are largely concentrated in Jessore, Faridpur, Kushtia, Pabna, Noakhali, Mymensingh and Rajshahi.

1970s and challenged the authority of the Dhaka-based political establishment. Therefore, regional development has become both an economic and a political issue since the early 1970s and also featured prominently in the early strategy of development within a socialist paradigm (Islam, 1977).

Although Bangladesh's macroeconomic performance since then has not been impressive, the general contention is that its aid-financed development programs have given priority to both infrastructural and social development and that might have benefited the poorer regions more than the richer ones in a relative sense. Moreover, under various administrative decentralization and socioeconomic development programs, there have been regional catching up processes in economic and social affairs, including agricultural modernization, industrialization, urbanization, education and health care. Some sociocultural and political changes are also afoot. The younger generation that observed the political events of the early 1970s and also experienced the trauma of the 1974 famine has become desperate for upward mobility - social, economic and political. This has generated both social and political unrest that has been manifested in various forms. The rise in labor mobility has been one of them. The increased rural-to-urban migration has in particular contributed to the rapid urbanization of the country. It is indeed significant that many younger people have responded to overseas employment opportunities, especially in the Gulf countries<sup>4</sup>, from the mid-1970s and thus helped to bring changes in the economy through inflows of foreign capital, technology, and entrepreneurial skills and initiatives. As various studies have already indicated, all these factors have jointly and individually unleashed both economic and sociopolitical forces that contributed to a steady growth of the economy at the rate of around 5 per cent per annum from the mid-1970s (Hossain, 1996). This has, in turn, brought a structural change in both output and employment and caused some integration of regional economies.

This paper formally investigates the question of whether there has been any convergence of per capita output levels across regions of Bangladesh since the early 1980s. Insofar as I am aware of, there has been no study on this and other related issues for Bangladesh despite their wide range of policy implications. Importantly, as the Bangladesh economy has gradually been integrated into the global economy since the mid-1980s (Hossain, 2000), the issue that has gained significance is whether economic openness has provided growth impetus to different regions evenly given their factor endowments and structural characteristics. The rest of the paper is organized as follows. Section 2 outlines the phenomenon of convergence in an historical context. Section 3 defines three concepts of convergence that are used for empirical analysis. Section 4 reviews the rank and relative mobility of the regions of Bangladesh during the period 1982 to 1997. Section 5 tests for convergence of per capita output levels across regions of Bangladesh for different time intervals. Section 6 highlights some economic and non-

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<sup>4</sup> With the spread of modern transport and communication facilities, the social and economic costs of migration have decreased considerably since the early 1970s. This has induced thousands of young people to avail themselves of overseas employment opportunities, especially in the Gulf countries (Siddiqui, 1986).

economic developments that provide plausible explanations for aspects of output convergence across regions of Bangladesh. Section 7 summarizes the major findings and draws policy implications within a broader perspective. The paper has an appendix that estimates the speed of convergence of per capita output levels across regions of Bangladesh for different time intervals and also identifies some regions that can be considered outliers for the present purpose.

## II. THE PHENOMENON OF CONVERGENCE

The word convergence has been used by scholars to mean different things in different contexts (Abramovitz, 1986). However, as Baumol (1986:1075) points out, the phenomenon of convergence in economic history has an unambiguous meaning: "that forces accelerating the growth of nations who were latecomers to industrialization and economic development give rise to a long-run tendency towards convergence of levels of per capita product or, alternatively of per worker product". David Hume suggested technology transfers as an explanation for the tendency of poorer countries or regions to catch up the richer ones: "technology transfer creates a natural tendency for poor countries to converge toward rich ones, and rich countries benefit from the convergence since it creates new markets for their exports and keeps the spirit of emulation alive" (Elmslie, 1995:212). He made his case on the basis of experience of England that was developed by technology transfers from its neighbors and hoped that having lagged behind, "Scotland's commercial relations with England would one day result in rapid growth of Scottish wealth" (Elmslie, 1995:213). Since then other prominent economists have been impressed with the idea of convergence of income levels across regions or nations. For example the nineteenth century economists like John Stuart Mill and Karl Marx and the twentieth century economic historians like Alexander Gerschenkron were optimistic about convergence of laggard developing nations (De Long, 1988).

The phenomenon of convergence has found a lease of life in modern growth economics that started with the Harrod-Domar or the Solow growth model (Domar, 1946; Harrod, 1939; Solow, 1956). According to the neoclassical growth model, poorer countries with lower capital-labor ratios would grow faster than richer countries with higher capital-labor ratios, especially when all these countries remain open to foreign trade and capital flows. When income differentials result from differences in technology, poorer countries would grow faster than richer countries as technological know-how would flow from technologically advanced countries to technologically lagging countries.<sup>5</sup> The neoclassical growth model, however, does not predict an

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<sup>5</sup> Romer (1996:27) summarizes three main reasons why the poorer countries can expect to grow faster than the richer ones at the early stages of development. There are at least three reasons that one might expect such convergence. First, the Solow model predicts countries converge to their balanced growth paths. Thus to the extent that differences in output per worker arise from countries being at different points relative to their balanced growth paths, one would expect the poorer countries to catch up to the richer. Second, the Solow model implies that the rate of return on capital is lower in countries with more capital per worker. Thus there are incentives for capital to flow from rich to poor countries; this will also tend to

(continued...)

absolute convergence of per capita output levels unless the rate of saving and the growth rate of population, as well as technology, are identical across countries. That means, countries with faster growing populations and lower saving rates are expected to be poorer than countries with lower growing populations and higher saving rates. It is only in a world of fully integrated markets for goods, capital and ideas that one would expect to observe absolute convergence regardless of countries' saving rates or demographics (Obstfeld and Rogoff, 1996).

Empirical evidence suggests that convergence of income levels is not a universal phenomenon. While some middle-income developing countries - the club of convergence - demonstrated convergence of per capita income levels in recent decades, most low-income developing countries showed little evidence of convergence (Zind, 1991). There are two kinds of explanations given for weak convergence of income levels between the poor and rich countries. The first explanation is that the forces of convergence work well only when political and economic institutions in poor countries are supportive of inward flows of foreign capital and technology.<sup>6</sup> The second explanation relies on the new endogenous growth theories that suggest that an initial advantage of a rich country over a poor country in the level of human capital per-worker results in a permanent difference in incomes between them. The logic is that when externalities related to human capital are strong, richer countries achieve sufficiently higher output levels due to high human capital endowment per-worker and are able to maintain their lead indefinitely by generating enough new savings and investment compared with poorer countries (Romer, 1986, 1990; Sachs and Larrain, 1993).

The factors that lead to convergence of per capita output levels across countries remain largely valid for convergence of per capita output levels across regions; that is, regions with lower per capita output levels would grow faster than regions with higher per capita output levels provided that all the regions have the same steady-state growth path per capita output. As convergence is essentially a long-term process, this feature becomes prominent at the maturing stage of development. Barro and Sala-i-Martin (1991,1992), for example, found convergence of per capita income levels across the United States during the period 1880 to 1988. When there are less cultural, ethnic, political and religious differences across regions, the speed of convergence is expected to be stronger.

In essence, the phenomenon of output convergence across regions can be justified analytically and also expected to be realized within a reasonably long period of time. Whether it happens in

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cause convergence. And third, if there are lags in the diffusion of knowledge, income differences can arise because some countries are not yet employing the best available technologies. These differences might tend to shrink as poorer countries gain access to state-of-the-art methods.

<sup>6</sup> Zind (1991) finds that the factors that contributed to income convergence within about 30 developing countries include the relative size of government, population growth and investment levels.



reality is, however, a different proposition. As Cardenas and Ponton (1995:10) point out in the context of Colombia, "convergence is not a linear process or it is not the only force at play behind the process of economic growth".

### III. THREE CONCEPTS OF CONVERGENCE

There are three interrelated concepts of convergence in growth economics: (1) *sigma* ( $\sigma$ ) convergence; (2) *beta* ( $\beta$ ) convergence; and (3) conditional *beta* ( $\beta^c$ ) convergence.<sup>7</sup> Sigma convergence concerns with cross-sectional dispersion of per capita income or productivity levels; that is, there exists a convergence if the cross-sectional dispersion of per capita income or productivity levels decreases over time.<sup>8</sup> Thus the presence of sigma convergence suggests a tendency to equalization of per capita income or productivity levels across regions or economies. The presence of sigma convergence, however, does not necessarily imply the presence of beta convergence, which suggests that poorer countries or regions grow at faster rates than richer countries or regions given that they all have the same steady-state growth path for per capita output (elaborated below). For example, Barro and Sala-i-Martin (1991) point out that cross-sectional standard deviation in  $\log y_{i,t}$  (per capita output), denoted  $\delta_t$ , falls (or rises) over time if it starts above (or below) its long run constant value  $\delta$ . The value of  $\sigma_t$  at a particular point of time can be higher than its long-term value if, for example, there are shocks to output (economic and non-economic) that raise temporarily its cross-sectional standard deviation. Subsequently, the value of  $\delta_t$  may fall and converge to its long-run value  $\delta$  that is assumed unchanged. Thus, what does the falling value of sigma suggest is how the distribution of per capita output across regions converged in the past and is likely to behave in the future.

Whether the convergence of per capita output levels, measured by sigma convergence, is due to higher growth rates of poorer regions than the richer ones can be examined by testing for the presence of beta (or conditional beta) convergence. Beta convergence, as defined in the empirical literature, concerns with cross-section regression of the time averaged income growth rate on the initial per capita income level; that is, there exists a beta convergence if the coefficient of the initial per capita income level in a cross-section regression for per capita output growth bears a negative sign. This suggests that countries or regions with higher initial income levels grow slowly than countries or regions with lower initial income levels.

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<sup>7</sup> The concepts of sigma and conditional beta convergence are attributed to Barro (1991) and Barro and Sala-i-Martin (1991,1992). Baumol (1986) has used the concept beta convergence for developed countries. In fact, his study has been instrumental to the growth of a large body of literature on convergence (Obstfeld and Rogoff, 1996).

<sup>8</sup> The standard deviation of (log of) Per Capita output is commonly used to test for sigma convergence.

The concept of conditional beta convergence concerns with cross-section regression of the time averaged output growth rate on the initial per capita output level and a set of additional explanatory variables that define the steady-state growth path for per capita output (Barro and Sala-i-Martin, 1991). Within such augmented growth regression, there exists a conditional beta convergence if the coefficient of the initial per capita output level bears a negative sign.

#### **IV. THE RANK AND RELATIVE MOBILITY OF REGIONS OF BANGLADESH**

The early 1970s were highly unstable—politically and economically—for Bangladesh. It was only in the late 1970s that some economic and political stability returned to this country. As a prelude to testing for regional convergence of per capita output levels from the early 1980s, a brief review is made here of the socioeconomic condition of people across regions of Bangladesh in and around 1981.

##### **A. Socioeconomic Indicators Across Regions of Bangladesh: 1981**

Table 1 shows that there were significant differences in the values of various socioeconomic indicators across regions of Bangladesh in the early 1980s, such as the density and growth rate of population, the adult literacy rate, the degree of urbanization, the incidence of rural landlessness, the intensity of high-yielding-variety (HYV) technology and the level of per capita agricultural output of rural population.

##### **B. The Rank and Growth of Per Capita Output Levels Across Regions of Bangladesh: 1982–97**

Table 2 reports the rank of each region by per capita gross regional product at 1984–85 market prices for three years: 1982, 1993 and 1997. In 1982, Chittagong and Chittagong Hill Tracts were the richest regions of the country, and Khulna, Sylhet, Patuakhali and Dhaka followed them. During this time Pabna, Rajshahi, Rangpur, Noakhali, Jessore, Faridpur and Comilla were the poorest regions. In 1997, although Chittagong and Chittagong Hill Tracts remained the richest regions, there were at least two regions, Faridpur and Jessore, that made a significant improvement in their relative economic position. Also, there were two traditionally prosperous regions with an agricultural base, Tangail and Mymensingh, that experienced a sharp deterioration in their relative economic position during the period 1982 to 1997. Most other regions experienced some changes in their relative economic positions during the same period.

Table 3 shows the distribution of regions by per capita output level relative to the country average for both 1982 and 1997. It is found that there was an upward mobility of some poorer regions during this period. For example the number of regions in the relative per capita output range: 0.90 or less decreased from 10 to 7 and the number of regions in the relative per capita output range from 0.91 to 1.00 increased from 3 to 8. This changed the shape of the distribution of regions from a heavily skewed to the right in 1982 toward a bell-shaped form in 1997 (Figure 1). The country map (Figure 2) reveals that most of the South and Western regions that were depressingly underdeveloped at the time of independence performed better than some of the North and Eastern regions over the sample period. The dotted regions in the map can indeed

Table 1. Socioeconomic Indicators Across Regions of Bangladesh, 1981

Region (former district)	Density of population (per sq. mile)	Inter-censal annual growth rate of rural population <sup>a</sup> (%)	Population by religion		Size of household <sup>b</sup>	Adult literacy rate (%)	Farm size (acres)	Urbanization rate (%)	Economic participation rate (%)	Farm households <sup>c</sup>	Per-capita cultivated area (acres) <sup>d</sup>	Irrigated area (% of net cultivated area) <sup>d</sup>	HYV intensity (% of area under HYVs in 1977) <sup>e</sup>	Per-capita bovine animals in farm households <sup>d</sup>	Number of bovine animals per-acre of cultivated land	Rural landlessness (% of rural households)	Per-capita agricultural output of rural population <sup>f</sup>
			Muslim (%)	Hindu (%)													
Chittagong	1907	1.5	84.5	13.0	6.4	33.8	1.6	31.1	26.2	30.3	0.15	37.2	57.6	0.22	1.5	33.6	107
Chittagong H.T.	148	2.0	32.4	11.4	5.8	26.6	n.a.	28.4	34.0	30.6	0.40	9.7	85.2	0.33	0.8	n.a.	94
Comilla	2701	1.7	91.6	8.2	5.9	29.1	1.4	8.1	24.8	37.0	0.17	30.1	28.7	0.21	1.3	11.0	82
Noakhali	1810	1.2	93.0	6.9	5.7	32.5	1.5	10.8	22.8	35.2	0.19	13.0	34.8	0.19	1.0	11.5	106
Sylhet	1152	1.6	81.3	18.0	6.2	23.6	2.5	8.8	28.3	40.4	0.28	24.8	20.5	0.29	1.0	16.1	92
Dhaka	3472	1.7	90.5	8.9	6.1	37.8	1.7	38.5	29.5	33.0	0.18	23.7	19.4	0.21	1.2	26.5	78
Faridpur	1793	1.5	80.9	18.8	5.7	26.2	2.1	7.0	25.6	46.0	0.26	4.1	5.0	0.22	0.9	11.7	65
Jamalpur	1896	n.a.	96.8	2.7	5.4	18.1	2.2	8.7	29.6	43.6	0.26	24.5	n.a.	0.24	1.0	n.a.	n.a.
Mymensingh	1760	1.8	91.8	7.4	5.5	21.5	2.2	10.0	29.3	41.7	0.26	30.5	11.8	0.26	1.0	19.8	103
Tangail	1860	n.a.	90.6	9.0	6.0	25.3	2.0	7.6	26.8	37.1	0.22	31.2	n.a.	0.29	1.3	n.a.	n.a.
Barisal	1656	1.4	84.5	15.1	5.7	40.9	1.8	12.0	25.3	39.4	0.23	5.9	13.3	0.23	1.0	14.0	97
Jessore	1584	2.0	80.3	19.6	6.4	29.5	2.8	10.8	26.8	40.2	0.31	11.4	11.3	0.28	0.9	15.9	103
Khulna	922	1.5	71.9	27.2	6.0	38.3	2.7	22.4	26.7	44.5	0.31	6.0	7.9	0.31	1.0	15.6	94
Kushtia	1726	2.1	95.1	4.5	6.4	22.3	2.7	14.5	27.4	42.2	0.28	21.5	26.9	0.22	0.8	22.9	101
Patuakhali	1166	n.a.	90.3	9.4	5.9	37.5	2.5	9.0	22.6	35.6	0.30	2.1	n.a.	0.33	1.1	n.a.	n.a.
Bogra	1817	2.2	91.1	8.4	5.6	28.3	2.2	7.4	27.8	39.1	0.26	47.2	12.1	0.29	1.1	20.8	118
Dinajpur	1262	2.5	75.9	21.9	5.5	27.4	3.3	8.6	29.0	41.2	0.39	11.9	5.2	0.38	1.0	24.1	127
Pabna	1874	2.1	92.5	7.3	6.2	24.3	2.6	11.7	27.1	38.8	0.24	20.0	3.7	0.25	1.1	24.9	89
Rajshahi	1443	2.4	88.6	9.5	6.2	26.0	2.9	10.3	24.7	44.3	0.33	23.0	5.0	0.28	0.8	25.1	94
Rangpur	1757	1.8	88.0	11.6	5.5	22.7	2.3	10.9	28.7	46.4	0.26	19.8	6.1	0.31	1.2	25.6	128
BANGLADESH	1567	1.8	86.6	12.1	5.8	29.2	2.2	15.2	27.1	39.8	0.15	19.9	14.4	0.26	1.0	19.6	100

Sources: Author's compilation/computation based on Boyce (1987); BBS, *Statistical Yearbook of Bangladesh* (various years); and BBS, *Bangladesh Census of Agriculture and Livestock: 1983-84*.

Notes: <sup>a</sup> The inter-censal rural population growth rate is for the period 1971-1981.

<sup>b</sup> The size of household is measured as the average number of persons in a household.

<sup>c</sup> Farm households are expressed as a per cent of all rural households.

<sup>d</sup> Figures for per-capita cultivated area, irrigated area, and bovine (cattle and buffaloes) animals are for the year 1983-84.

<sup>e</sup> Figures for HYV (high-yielding-variety) intensity are for *AUS* and *Aman* rice combined.

<sup>f</sup> Per-capita agricultural output (Bangladesh = 100)

n.a. Not available.

Table 2. Rank and the Growth Rate of Per Capita Gross Regional Product at 1984–85 Market Prices, 1982–97

Region	Per capita output (taka) <sup>1</sup>			Rank			Annual compound growth rate of per capita output (%) <sup>2</sup>		Relative economic position compared: 1982 and 1997
	1982	1993	1997	1982	1993	1997	1982-93	1982-97	
Chittagong	5813	7689	8465	2	2	2	2.05	2.26	Unchanged
Chittagong H.T.	17400	14400	16342	1	1	1	-0.03	-0.01	Unchanged
Comilla	3344	4587	4931	14	14	13	2.87	2.67	Marginally improved
Noakhali	3270	3935	4170	17	19	19	1.69	1.55	Marginally deteriorated
Sylhet	4325	5045	5396	4	6	6	1.25	1.68	Marginally deteriorated
Dhaka	4276	5291	5963	6	4	4	2.16	2.62	Improved
Faridpur	3292	4908	5229	15	9	7	3.56	3.01	Significantly improved
Jamalpur	4097	5194	5185	7	5	8	1.26	1.55	Marginally deteriorated
Mymensingh	3529	4199	4473	12	18	16	1.33	1.59	Significantly deteriorated
Tangail	3922	4504	4800	8	15	14	0.50	0.12	Significantly deteriorated
Barisal	3861	4842	4951	9	10	12	2.22	1.55	Significantly deteriorated
Jessore	3286	4949	5172	16	8	9	3.95	3.33	Significantly improved
Khulna	4461	5627	5985	3	3	3	2.01	2.17	Unchanged
Kushtia	3402	4755	5115	13	12	11	3.56	2.83	Improved
Patuakhali	4305	5010	5627	5	7	5	1.67	1.60	Unchanged
Bogra	3723	4793	5146	10	11	10	2.47	2.27	Unchanged
Dinajpur	3547	4698	4689	11	13	15	2.59	2.08	Significantly deteriorated
Pabna	3152	3728	3868	20	20	20	0.09	1.20	Unchanged
Rajshahi	3170	4313	4471	19	16	17	2.63	2.42	Improved
Rangpur	3201	4232	4450	18	17	18	1.90	1.74	Unchanged
Country Average	3932	4989	5344				2.09	1.92	

Sources: Data for per capita gross regional product at 1984–85 market prices are taken from BBS (1993) and BBS, Statistical Yearbook of Bangladesh 1997.

<sup>1</sup> Taka is Bangladesh's currency unit.

<sup>2</sup> The compound growth rate (g) of per capita output (y) for each region was calculated by estimating the following generic regression equation:

$$\ln y_t = \alpha + \beta t + \varepsilon_t, \text{ where } \alpha = \ln(y_{t-T}), \beta = \ln(1+g), t \text{ is time, such that } g = e^\beta - 1, \text{ and } \varepsilon \text{ is the random error term.}$$

Table 3. The Distribution of Regions by Per Capita Output Relative to the Country Average:  
1982 and 1997

Per-capita output relative to that of the country average: 1997				
1982 ↓ 1997 →	0.90 or less	0.91–1.00	1.01–1.10	1.11 and above
0.9 or less Comilla Noakhali Faridpur Mymensingh Jessore Kushtia Pabna Dinajpur Rajshahi Rangpur	Noakhali Tangail Mymensingh Pabna Dinajpur Rajshahi Rangpur			
0.91–1.00 Bogra Barisal Tangail			Comilla Jamalpur Kushtia Jessore Bogra Barisal Patuakhali Faridpur	
1.01–1.10 Sylhet Dhaka Jamalpur Patuakhali			Sylhet	
1.11 and above Chittagong Chittagong, H.T. Khulna				Chittagong Chittagong, H.T. Dhaka Khulna

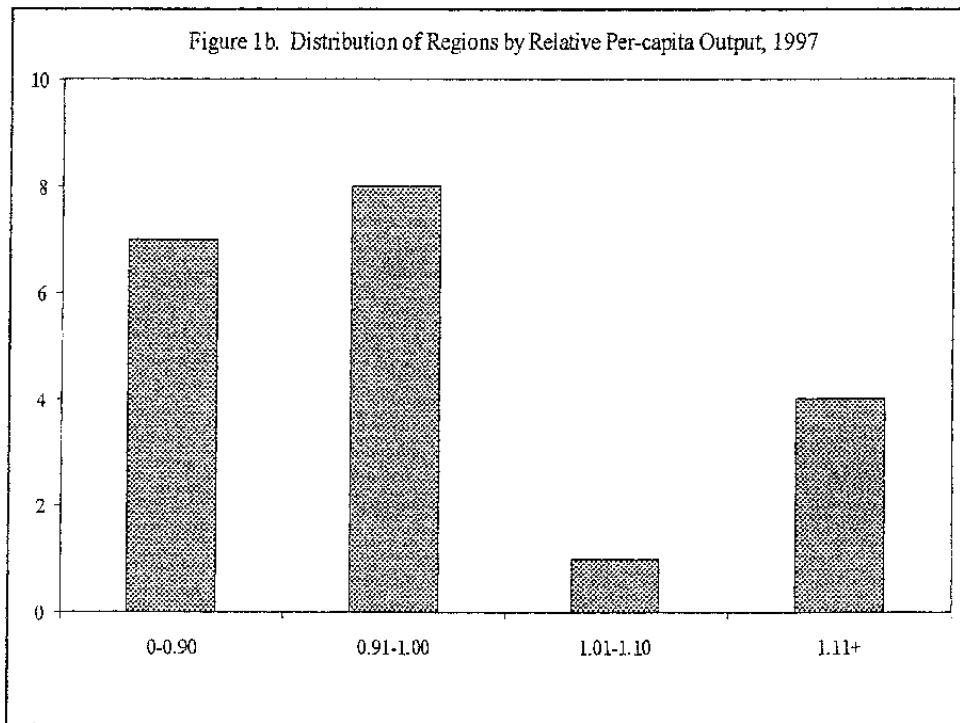
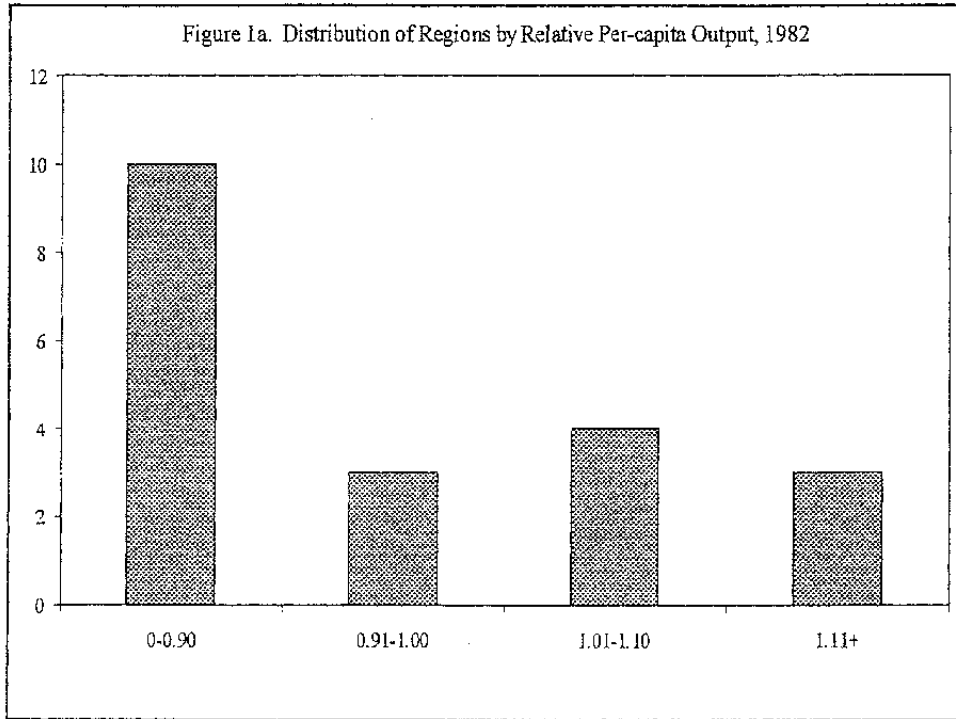
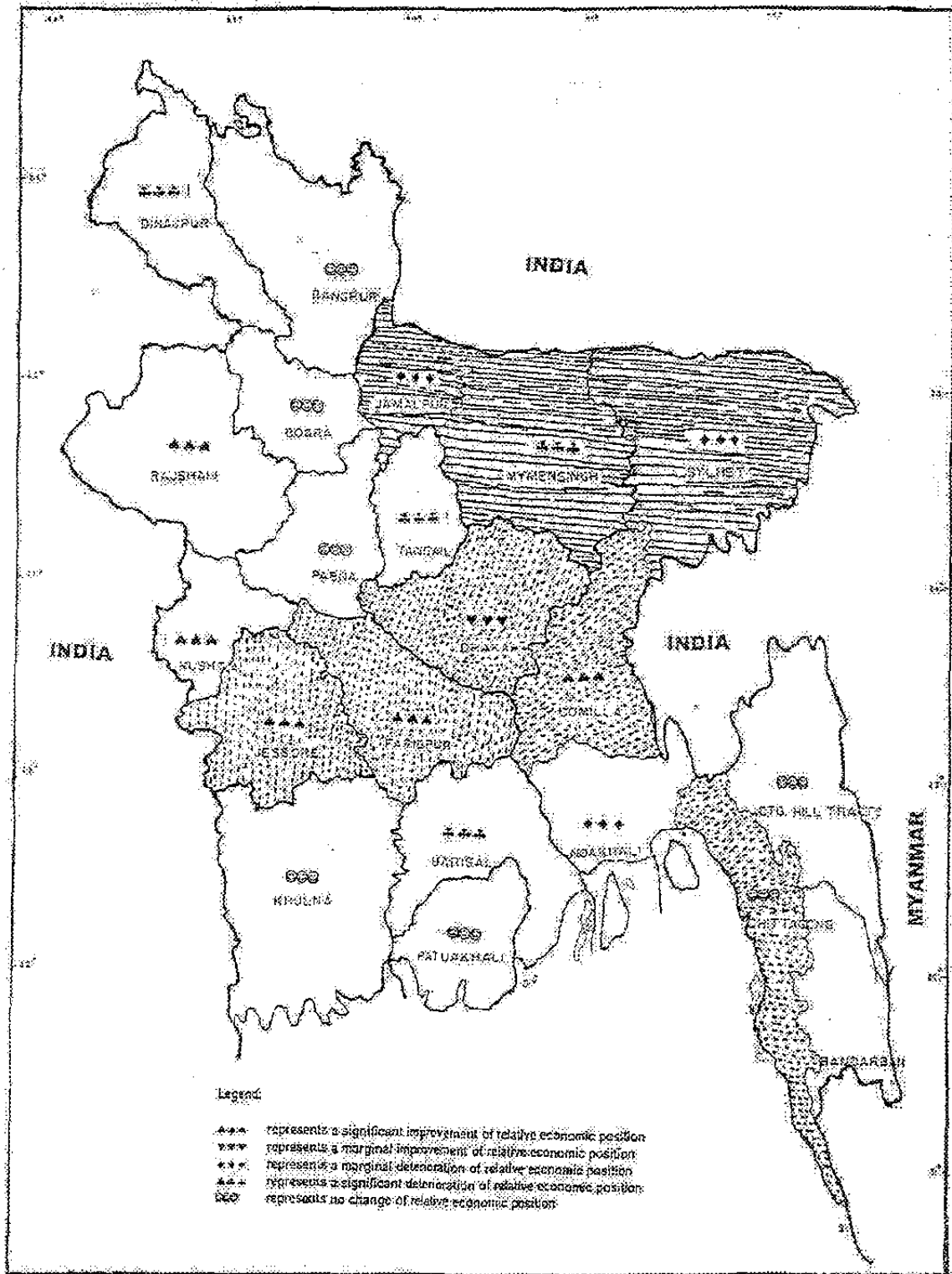


Figure 2. The Country Map Showing the Change in the Relative Economic Position of Regions: 1982-97



Source: Adapted from BBS (1986, Vol. II:104).

be roughly considered the growth poles. By contrast, the Northern regions with an agricultural base (shaded with parallel lines in the map) have now become economically depressed.

## V. TESTS FOR CONVERGENCE

### A. Sigma ( $\sigma$ ) Convergence

In order to test for sigma convergence the standard deviation ( $\sigma$ ) of (log of) per capita output across regions has been computed for each year for the period 1982 to 1997. The calculated sigma value has been found to show a negative trend from 0.38 in 1982 to 0.31 in 1997. This was, however, not a linear process. In fact the following non-linear trend equation has been found to fit the data best:

$$\begin{array}{rcccc} \sigma_t & = & 0.359 & - 0.013 T & + 0.0006 T^2 \\ & & (t\text{-ratio}) & (32.96) (4.52) & (3.79) \end{array}$$

Sample: 1982-1997  $R^2 = 0.62$  DW = 1.33 (T = 1 for 1982, 2 for 1983 and so on)

Figure 3 plots the mean value of (log of) per capita real gross regional product (LY-Hat)  $\pm 2$ \*SIGMA. It also reveals the presence of sigma convergence of per capita output levels, especially during the early years of the sample period.

### B. Beta ( $\beta$ ) Convergence

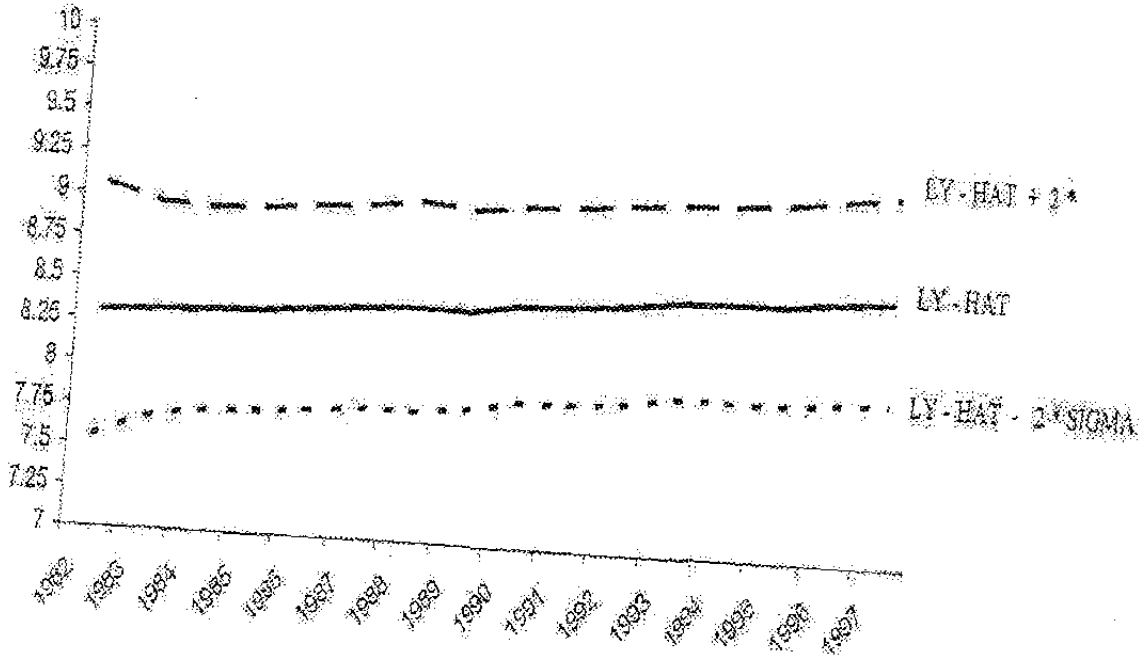
As indicated earlier, sigma convergence does not necessarily imply a beta convergence. The latter phenomenon needs to be tested by running a growth regression for per capita output across regions. Baumol (1986) has estimated a growth equation of the following kind to test for  $\beta$  convergence in the historical data (1870–79) of per capita output for 16 industrialized countries:

$$\ln (y_{i,t}/y_{i,t-T}) = \alpha + \beta \ln (y_{i,t-T}) + u_{it} \quad (1)$$

where  $y_i$  is per capita output in country  $i$ ,  $u_i$  is an error term, the subscript  $t$  indicates the end of the time interval and  $t-T$  is the beginning of the time interval. In this regression equation a significant negative sign of  $\beta$  suggests the presence of beta convergence in per capita output levels across countries: that is, countries with lower levels of initial per capita output grow faster than countries with higher levels of initial per capita output.



Figure 3. LY - HAT + or - 2 \* Sigma of (Log of) Per-capita Gross Regional Product



Although such a simple test for convergence has generated controversy (De Long, 1988; Quah, 1993), Baumol (1986:1076) argues that “a relationship such as that ... for [16 industrialized countries] is no tautology, nor even a foregone conclusion”. What is the theoretical basis for such a statistical relationship? Following the tradition of David Hume and others, Baumol interprets it as an evidence of the technological catching up hypothesis. However, Baumol’s specification is also equivalent to the transitional dynamics of per capita output that can be derived from the neoclassical growth model for closed economies (Ramsey, 1928; Solow, 1956; Cass, 1965; Koopmans, 1965). If all countries have the same steady-state growth path for per capita output, then those countries with lower initial income levels would grow faster than countries with higher income levels. Barro (1991) also points out that the tendency of low-income countries to grow at higher rates than the rich countries is reinforced in extensions of the neoclassical models that allow for international mobility of capital and technology.

### **C. Empirical Results with Bangladeshi Data**

Equation (1) has been estimated by OLS using the per capita output growth rate as the dependent variable for different time intervals. Table 4 reports two sets of beta estimates. The first is the set of estimates of beta in which 1982 is the beginning of the time interval while the end of the time interval was moved forward from 1990 by one year until the end of the sample period was reached. The estimated beta coefficient bears a negative sign and remains significant whichever time interval is used for calculation of the growth rate of per capita output. The second is the set of beta estimates in which 1991 is the beginning of the time interval while the end of the time interval was moved forward from 1993 by one year until the end of the sample period was reached. The year 1991 was significant for two reasons. First, this was the beginning of a democratic form of government after about 15 years of military or quasi-military rule. Second, although the economy was opened up in the late 1980s, the process got momentum once the civilian government was installed. Unlike the first set of estimates of beta, the second set suggests no evidence of convergence of per capita output levels across regions. This is indeed an unexpected finding that needs further investigation and reconciliation with theory and evidence.

To begin, one fundamental assumption behind absolute beta convergence is that all the regions or countries have the same steady-state growth path for per capita output. Thus the poorer regions or countries show a tendency to grow faster than the richer regions or countries. However, if the assumption that all the regions or countries have the same steady-state growth path for per capita output is relaxed, then it is possible to provide an explanation of the possibility that the growth rates of the poorer and richer regions remain the same or even the richer regions or countries grow faster than the poorer ones. This follows the idea of relative

Table 4. Crosssectional Regressions of the Growth Rate of Per Capita Output

Period <sup>†</sup>	$\beta$	t-ratio	R <sup>2</sup>	DW	95 percent confidence interval for $\beta$
1982-90	-0.26 <sup>a</sup>	5.25	0.58	1.51	-0.358 $\leq$ $\beta$ $\leq$ -0.153
1982-91	-0.25 <sup>a</sup>	5.23	0.58	1.56	-0.344 $\leq$ $\beta$ $\leq$ -0.147
1982-92	-0.25 <sup>a</sup>	4.54	0.51	1.24	-0.367 $\leq$ $\beta$ $\leq$ -0.135
1982-93	-0.26 <sup>a</sup>	5.57	0.61	2.12	-0.364 $\leq$ $\beta$ $\leq$ -0.165
1982-94	-0.25 <sup>a</sup>	5.36	0.59	1.98	-0.353 $\leq$ $\beta$ $\leq$ -0.154
1982-95	-0.24 <sup>a</sup>	4.63	0.52	1.93	-0.348 $\leq$ $\beta$ $\leq$ -0.131
1982-96	-0.22 <sup>a</sup>	4.65	0.52	1.76	-0.324 $\leq$ $\beta$ $\leq$ -0.122
1982-97	-0.21 <sup>a</sup>	4.19	0.47	1.86	-0.321 $\leq$ $\beta$ $\leq$ -0.106
1991-93	-0.03	1.05	0.01	1.57	
1991-94	-0.02	0.60	-0.03	1.71	
1991-95	0.01	0.13	-0.05	1.35	
1991-96	0.02	0.60	-0.03	1.38	
1991-97	0.04	1.05	0.01	1.36	

Notes:

<sup>†</sup> This represents the period for which the growth rate of per capita output for each region was calculated.

<sup>a</sup> Significant at the one per cent level.

convergence; that is, the growth rate of a region or country does not depend on its absolute value of per capita output, but rather on the value measured relative to its own steady-state position.<sup>9</sup>

#### D. Conditional Beta ( $\beta^c$ ) Convergence

As indicated above, there is a shortcoming in the specification (1) for testing for convergence of per capita output levels across regions or countries. Within the framework of the neoclassical growth theory, it imposes the restriction that the steady-state growth path for per

<sup>9</sup> Using the idea of relative convergence, Barro (1993) states clearly why international output convergence does not occur among the poor and rich countries. The idea is that Per Capita output growth is higher the larger the gap between steady-state per-worker output  $y^*$  and actual Per Capita output  $y$ . Consider two countries: A and B, such that  $y_a$  is twice as large as  $y_b$ . The poor country B grows faster than A if it has the same steady-state per-worker output path as A. But if  $y_a^*$  is twice as large as  $y_b^*$ , then the two countries grow at the same rate. Thus the theory implies a form of relative convergence. That is, the growth rate does not depend on the absolute value of  $y$ , but rather on the value measured relative to the country's own steady-state position.

capita output is identical for all the regions or countries. This is indeed a restrictive assumption even when the presence of convergence is investigated across regions for an apparently homogeneous country like Bangladesh. There are at least three variables that can be used to define the steady-state growth path for per capita output: (1) the rate of saving/investment; (2) the growth rate of population; and (3) the rate of technological progress. If zero restrictions are imposed on these variables in the specification for the output growth rate, the estimate of beta could be biased and may lead to misleading conclusions. Considering this, Mauro and Podrecca (1994) have estimated an equation of the following form to test for convergence across regions of Italy:

$$\ln(y_{i,t}/y_{i,t-T}) = \alpha + \beta \ln s_{it} + \gamma \ln n_{it} + \delta \ln n_{it} \quad (2)$$

where  $s_i$  is the share of saving/investment on gross domestic product for region  $i$ ,  $n_i$  is the growth rate of population for region  $i$  and  $\alpha$ ,  $\beta$ ,  $\gamma$  and  $\delta$  are parameters to be estimated.

Although the conditioning variables  $s_i$  and  $n_i$  remain crucial in the specification (2), it is possible to include other region-specific variables to test for their impacts on the growth rate of output for different time periods. For example, Barro and Sala-i-Martin (1991) have used a number of additional variables in a non-linear beta specification (see Appendix) and tested for convergence of per capita output levels across the United States and countries.

Table 5 reports the results of a number of regression equations with variables that are expected to determine the steady-state growth path for per capita output. The variables used for experimental purposes included the growth rate of population, the net migration rate, rainfall, the share of agriculture in output, the intensity of high-yielding-variety technology and the literacy rate.<sup>10</sup> For lack of data, the rate of saving/investment has not been used for experimentation. Both  $t$  and  $F$ -test results are reported to determine whether these variables, individually or jointly, are significant in the growth equation.

As Bangladesh remains predominantly an agricultural country, rainfall, the HYV technology and the share of agriculture in output can be considered key variables in the growth equation. Of these variables, rainfall and the HYV technology have been found to have significant impact on the growth rate of output. Note that rainfall is generally used as a proxy for weather and weather related factors (such as floods) that affect the growth rate of output. However, it is difficult to disentangle the net effect of floods and related variables on the growth rate of output as they have both positive and negative effects on production. For the present purpose, the net effect of rainfall has been found to have a negative effect on the growth rate of output. The share of agriculture in output (a proxy for production structure) does not have a significant impact on output growth for the complete sample period.

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<sup>10</sup> Basic data for all these variables are taken from various statistical publications of the Bangladesh Bureau of Statistics.

Table 5. Conditional Beta Convergence Regressions of Per-Capita Output<sup>+</sup>

	Equation 1		Equation 2		Equation 3		Equation 4		Equation 5		Equation 6	
	I	II	I	II	I	II	I	II	I	II	I	II
Constant	2.05 <sup>a</sup> (4.73)	2.42 <sup>a</sup> (5.96)	1.79 <sup>a</sup> (3.55)	2.30 <sup>a</sup> (4.76)	1.11 <sup>a</sup> (4.90)	2.46 <sup>a</sup> (6.02)	2.50 <sup>a</sup> (4.92)	2.65 <sup>a</sup> (5.27)	3.61 <sup>a</sup> (5.54)	3.68 <sup>a</sup> (5.77)	3.60 <sup>a</sup> (5.33)	3.66 <sup>a</sup> (5.55)
Ln yi, 1982	-0.21 <sup>a</sup> (3.82)	-0.26 <sup>a</sup> (5.13)	-0.22 <sup>a</sup> (3.94)	-0.26 <sup>a</sup> (5.01)	-0.24 <sup>a</sup> (4.00)	-0.28 <sup>a</sup> (5.00)	-0.30 <sup>a</sup> (4.06)	-0.32 <sup>a</sup> (4.27)	-0.25 <sup>a</sup> (4.38)	-0.28 <sup>a</sup> (4.92)	-0.25 <sup>a</sup> (4.19)	-0.28 <sup>a</sup> (4.76)
Ln ni	-2.27 (0.44)	-1.75 (0.36)	-0.68 (0.13)	-1.01 (0.20)	-5.01 (0.90)	-3.80 (0.72)	-5.80 (1.06)	-4.20 (0.77)				
Ln li			0.10 (1.00)	0.04 (0.49)								
Ln migi					0.09 (1.21)	0.07 (0.96)	0.10 (1.43)	0.07 (1.03)				
Ln hyvi							0.05 (1.36)	0.02 (0.69)	0.06 (2.07)	0.04 (1.35)	0.06 (2.01)	0.04 (1.35)
Ln raini									-0.18 <sup>b</sup> (2.55)	-0.16 <sup>b</sup> (2.36)	-0.18 <sup>b</sup> (2.46)	-0.16 <sup>b</sup> (2.27)
Ln sai											0.01 (0.12)	0.01 (0.37)
Tests of hypotheses: H0: Coefficient(s) of:												
Ln ni = 0	F1,17 = 0.2	F1,17 = 0.1										
Ln ni = Ln li = 0			F2,15 = 0.6	F2,16 = 0.2								
Ln ni = Ln migi = 0					F2,16 = 0.8	F2,16 = 0.5						
Ln ni = Ln migi = Ln hyvi = 0							F3,15 = 1.2	F3,15 = 0.5				
Ln hyvi = Ln raini = 0									F2,16 = 4.11	F2,16 = 2.97		
Ln hyvi = Ln raini = Ln sai = 0											F3,15 = 2.57	F3,15 = 1.92
R2	0.44	0.59	0.44	0.57	0.46	0.59	0.48	0.58	0.60	0.68	0.58	0.66
DW	1.86	2.16	1.76	2.09	1.72	2.07	1.77	2.08	1.85	2.06	1.82	1.96
SER	0.09	0.08	0.09	0.08	0.09	0.08	0.08	0.08	0.07	0.07	0.07	0.07
MEAN	0.29	0.228	0.289	0.228	0.289	0.228	0.289	0.228	0.289	0.228	0.289	0.228
Additional diagnostic test statistics for: ++												
A: $\chi^2_2(1)$	0.001	0.32	0.19	0.17	0.37	0.09	0.32	0.09	0.14	0.03	0.20	0.01
B: $\chi^2_2(1)$	0.66	0.39	0.63	0.30	0.27	0.12	0.30	0.09	1.31	0.93	1.62	1.41
C: $\chi^2_2(2)$	0.99	0.53	0.91	0.64	1.69	0.83	2.26	0.94	2.25	1.30	2.37	1.49
D: $\gamma^2(1)$	0.005	0.02	0.58	0.10	0.38	0.51	0.12	0.34	0.35	0.72	0.34	0.63

Notes: Equation 1 = Conditional beta convergence regression equation with the population growth rate (Ln ni).

Equation 2 = Conditional beta convergence regression equation with the population growth rate (Ln ni) and the literacy rate (Ln li).

Equation 3 = Conditional beta convergence regression equation with the population growth rate (Ln ni) and the net migration rate (Ln migi).

Equation 4 = Conditional beta convergence regression equation with the population growth rate (Ln ni), the net migration rate (Ln migi), and the HYV technology (Ln hyvi).

Equation 5 = Conditional beta convergence regression equation with the rainfall and the HYV technology (Ln hyvi).

Equation 6 = Conditional beta convergence regression equation with the rainfall, the HYV technology (Ln hyvi) and the share of agriculture in output (Ln sai).

+ I(II) represents the regression equation for the growth rate of per-capita output for the time interval 1982-1997 (1982-1993). The figures in parentheses below the coefficients are absolute t-ratios.

++ A: Serial correlation; B = Functional form; C: Normality; and D: Heteroskedasticity.

<sup>a</sup> Significant at the one percent level.

<sup>b</sup> Significant at the five percent level.

Three other variables that have been used for experimentation are the net migration rate, the population growth rate and the literacy rate. The coefficient of the net migration rate bears a positive sign but is not significant at the conventional 5 per cent level. Note that the data used for this variable are for the 1970s as data for later years are not available at the regional level. The later discussion will suggest that this variable remains important in the specification for the growth rate of output as labor mobility has increased significantly in Bangladesh since the early 1980s.<sup>11</sup> Contrary to the *a priori* expectations, neither the population growth rate nor the literacy rate has been found to have any significant impact on the growth rate of per capita output.

While all the conditioning variables in the growth equation provide some information on factors that explain variation in regional output growth, the variable of interest for the present purpose is the initial income level. The coefficient of this variable bears a negative sign and remains significant irrespective of which conditioning variables are used in the regression. This result is consistent with the view that there was conditional beta convergence of per capita output levels across regions of Bangladesh, especially during the 1980s.

## VI. FACTORS BEHIND CONVERGENCE OF PER CAPITA OUTPUT LEVELS ACROSS REGIONS OF BANGLADESH

The phenomenon of convergence in growth economics remains controversial as there is no consensus on factors that lead to convergence of output levels across regions or countries. Economic theorists postulate that both economic and non-economic factors cause the poorer regions to grow faster than the richer ones. As indicated earlier, there are two broad analytical frameworks that can explain the phenomenon of output convergence across regions or countries. The first is the technological catching up hypothesis that emphasizes the spread of technology from the technologically-advanced regions to the technologically-backward regions as a factor causing convergence of per capita output levels. David Hume considered foreign trade as the major conduit of technology transfers and argued for freer trade and other laissez-faire policies with the hope that such policies would promote convergence of incomes across regions or countries. Within the modern context, a body of literature has grown around this hypothesis (Abramovitz, 1986,1990; Baumol, 1986; Baumol and Wolff, 1988; De Long, 1988; Dowrick and Nguyen, 1989; Maddison, 1987,1991; and Soete and Verspagen, 1993). The second hypothesis is derived from the transitional dynamics of the neoclassical growth model. This analytical approach has become prominent in the works of Mankiw, Romer and Weil (1992), Barro (1991) and Barro and Sala-i-Martin (1991,1992,1994). They show that if different regions or countries have different capital-labor ratios, their growth paths would eventually converge to a steady-state growth path because of diminishing returns to reproducible capital but would exhibit different growth

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<sup>11</sup> For example, Barro and Sala-i-Martin (1991:153) write: "a greater degree of labor mobility leads theoretically to a higher convergence coefficient [ $\beta$ ]. This effect means that the rates of  $\beta$  convergence would be higher for the regions within countries than for across countries".

rates during the transition phase. The process of such convergence relies on natural forces in markets and hence any failure of convergence could be attributed to distortions in both labor and capital markets. Along with these two analytical approaches, there is another explanation for convergence of per capita output levels across countries that economic growth is contagious (Baumol, 1994). The phenomenal growth of East Asian economies has given some credibility to the phenomenon of convergence based on contagion.

This section reviews major economic and non-economic developments in Bangladesh from the early 1970s with a view to identifying factors that may provide explanations for convergence of per capita output levels across regions, especially in the 1980s. It then highlights the rapid opening up the economy since the early 1990s that might have contributed to the slowing down of the process of convergence.

#### **A. Diffusion of the HYV Technology**

The introduction of the modern methods of agricultural production (or simply the HYV technology) has been the major agricultural development in Bangladesh since the mid-1970s. Until then, agricultural production was heavily dependent on monsoons (Faaland and Parkinson, 1976). The diffusion of the HYV technology was both supply and demand determined. The government provided subsidies on seeds, irrigation facilities and pesticides, and low interest bank credits to facilitate the diffusion of this technology (Hossain, 1988). At the same time, there were at least two reasons why farmers became receptive of this technology. First, the 1974 famine created an urgency for raising the quantum of food production to feed the rapid growth of population. The introduction of the HYV technology then became necessary for raising food production in a land-scarce country. Second, from both the private and public sources, farmers became aware that high rates of return could be gained from the introduction of the HYV technology in food production.

Although the HYV technology spread rapidly throughout the country from the mid-1970s, as of 1977 the rate of its adoption varied significantly across regions (Table 6). Some regions, such as Chittagong, Chittagong Hill Tracts, Comilla, Noakhali and Kushtia, already had high rates of adoption of this technology. By contrast, in most of the poorer regions, such as Faridpur, Jessore, Rajshahi and Rangpur, the rate of its adoption was low. There was thus a technological catching up process in operation in the poorer regions from the mid-1970s. As agriculture contributed more than 50 per cent of GDP in most of the poorer regions, the contribution of the HYV technology to the growth of output was higher in these regions than the richer ones.

Table 6. Diffusion of the HYV Technology in Agriculture Across Regions of Bangladesh, 1977-84

Region	Rank in terms of per capita output, 1982	HYV intensity <sup>1</sup> in 1977 (per cent)	Percentage change in irrigated area of farm households to cultivated area, 1977-84 <sup>2</sup>
Chittagong	2	57.6	0.8
Chittagong, H.T.	1	85.2	n.a.
Comilla	14	28.7	36.2
Noakhali	17	34.8	17.0
Sylhet	4	20.5	17.7
Dhaka	6	19.4	77.8
Faridpur	15	5.0	289.6
Mymensingh	12	11.8	32.7
Tangail	8	n.a.	233.8
Barisal	9	13.3	34.9
Jessore	16	11.3	261.7
Khulna	3	7.9	190.4
Kushtia	13	26.9	139.1
Patuakhali	5	n.a.	-13.3
Bogra	10	12.1	120.1
Dinajpur	11	5.2	298.3
Pabna	20	3.7	426.9
Rajshahi	19	5.0	89.3
Rangpur	18	6.1	354.7
Country Average		14.4	18.1

Notes and Sources:

<sup>1</sup> HYV intensity in 1977: Author's computation based on BBS, Statistical Yearbook of Bangladesh, and BBS, Agricultural Yearbook of Bangladesh.

<sup>2</sup> Percentage change figures for irrigated area to cultivated area: BBS (1986: Vol. 1).

## B. Development of Economic and Social Infrastructure

Bangladesh has received about US\$30 billion as foreign aid and loans since its independence. The bulk of this foreign aid and loans has been used for the development of economic and social infrastructure. There are two main reasons why infrastructural development got priority in the strategy of development. First, as there was heavy damage to infrastructure during the Independence War and later by frequent floods and other natural disasters, the government spent the major portion of its aid resources for infrastructural development. Second, the government spent a portion of its aid resources for public works programs that were designed to create non-farm employment opportunities for vulnerable groups in the



rural community. The distribution of aid resources for public works programs, however, was not uniform across regions. Some traditionally underdeveloped regions in the Western part of the country received priority in infrastructural development. Most of the metropolitan areas and industrial growth centers also received large shares of resources for infrastructural development. While there were economic reasons for such a non-uniform distribution of developmental resources, it is to be emphasized that political factors were also behind various developmental or public works programs. Chittagong, for example, remains an economically and politically strategic region. It receives priority in infrastructural development irrespective of the color or form of government.

Table 7 shows that the growth of road length (a proxy for public works programs) varied significantly across regions during the period 1986 to 1994. Although it cannot be substantiated statistically with a high degree of confidence, it can be argued that variation in developmental activities led to differences in economic performance across regions. Despite such arbitrariness of developmental and public works programs, they in general contributed to integration of rural economies with the urban centers. For example, one visible economic progress over the past two decades has been the development of transport and communication facilities. Most rural areas are now connected with the urban centers through semi-*pucca* roads that are used for plying of rickshaws and different types of motorized or wheeled transports. Similarly, as Bangladesh remains a riverine country, the introduction of motorized boats and other water transports has in some sense revolutionized the inland transport system. The impact of improvement in transport and communication facilities on economic activity has been substantial, especially in the backward areas.

In addition to aid-financed development activities, there has been an upsurge of construction activity in the private sector from the mid-1970s. This has been partly due to large-scale remittances of workers in the Gulf countries. Note that beginning from the late 1970s, about fifty thousand workers went mostly to the Gulf countries. The number of emigrating workers has increased to about 200 thousand per annum since the early 1990s. Along with about US\$2 billion aid and loans, Bangladesh receives almost an equal amount of workers' remittances each year - both officially and unofficially. One main item of expenditure from remittances has been the improvement and construction of housing in both the rural and urban areas. While such construction activities benefited the different regions differently, their marginal impact on economic growth has been high in the poorer regions.

Along with development of physical infrastructure, there has been considerable expansion of educational, health and other service facilities across regions since the early 1970s. Table 7 shows that the number of primary schools has increased by 40 per cent during the period 1986 to 1994. The numbers of secondary schools, colleges, and universities have also increased significantly. Two factors have particularly facilitated the expansion of educational institutions. First, with the democratization of politics, politicians of all colors, especially businessmen-turned-politicians, have helped to build educational institutions, health facilities and community centers as part of establishing their political credential. Second, there has been a proliferation of non-government educational institutions and health services throughout the country. It is to be

Table 7. Road Length and Primary Schools Across Regions of Bangladesh

Region	Road Length			Primary Schools		
	1986 (Kilometres)	1994 (Kilometres)	Percentage change	1981	1996	Percentage change
Chittagong	624.9	1024.8	64.0	2099	2839	35.3
Chittagong, H.T.	475.4	586.1	23.3	581	999	71.9
Comilla	620.7	871.6	40.4	3057	4255	39.2
Noakhali	489.7	866.3	76.9	1902	2187	14.5
Sylhet	1129.9	1205.9	6.7	3552	4563	28.5
Dhaka	831.7	1286.1	54.6	3499	4357	24.5
Faridpur	557.0	713.7	28.1	2471	3236	31.0
Jamalpur	312.7	451.4	44.4	1046	1556	48.8
Mymensingh	737.3	1015.4	37.7	3063	4657	52.0
Tangail	297.4	357.5	20.2	910	2174	138.9
Barisal	455.0	676.2	48.6	3256	4106	26.1
Jessore	557.2	865.3	55.3	2014	2878	42.9
Khulna	591.8	743.4	25.6	2066	3290	59.2
Kushtia	302.7	441.5	45.9	996	1500	50.6
Patuakhali	183.2	885.1	383.1	1246	1834	47.2
Bogra	303.5	618.7	103.9	1335	1921	43.9
Dinajpur	561.5	781.9	39.3	1783	3306	85.4
Pabna	407.2	557.6	36.9	1819	2582	41.9
Rajshahi	760.6	994.7	30.8	2417	3555	47.1
Rangpur	744.8	498.9	-33.0	3138	5554	77.0
Bangladesh	11184.7	15669.6	40.1	42447	61583	45.1

Source: BBS, *Statistical Yearbook of Bangladesh* (various issues).

noted that more than 8 thousand non-government organizations (local and foreign) are now active in various service-providing sectors. Although the effectiveness of these organizations in the provision of services vary significantly, it is widely accepted that these organizations have made a substantial contribution to basic literacy, health care, and other social development. The poorer regions that lacked educational facilities have particularly benefited the most from activities of the non-government organizations.

### **C. Labor Mobility**

For reasons suggested above, one significant development in Bangladesh from the early 1970s has been the rise in labor mobility from both the rural to urban areas and the relatively underdeveloped to developed regions. The big cities have particularly attracted a large number of people from the countryside. Within the framework of the neoclassical growth theory, the emigration of labor from the poorer regions with low capital-labor ratios to the richer regions with high capital-labor ratios speed up convergence of per capita output levels, provided that migrants possess no human capital<sup>12</sup> (Barro and Sala-i-Martin, 1991).

Table 8 reports data for the net migration of population across regions of Bangladesh during two census periods 1961-74 and 1974-81. It shows that during the 1960s and 1970s there were large-scale in-migrations to Sylhet, Chittagong Hill Tracts, Dhaka, Khulna and Dinajpur, while Noakhali, Faridpur, Tangail, Mymensingh, Patuakhali and Pabna experienced large-scale out-migrations. Data for the net-migrations during the 1970s have been used to examine their impact on convergence of per capita output levels across regions.

The regression results reported in Table 5 show that the coefficient of the net migration of population in the specification for conditional beta convergence bears a positive sign. It appears that the impact of the net in-migration of population on the growth rate of output in regions where they settle is positive. This finding is consistent with the idea that immigrants are generally young and possess above average human capital. While this could be a plausible explanation, it is to be recognized that the regions that grow faster also attract people from the slow-growing regions.

### **D. Economic Openness**

While the factors mentioned above appear to have contributed to convergence of per capita output levels across regions during the 1980s, the regression results in Table 4 show that the process of convergence weakened, if not stopped, during the period 1991 to 1997. As indicated earlier, the Bangladesh economy has been opened up rapidly since the early 1990s and this could be a factor behind the slowing down of output convergence across regions.

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<sup>12</sup> For example, Barro and Sala-i-Martin (1991:153) write: "a greater degree of labor mobility leads theoretically to a higher convergence coefficient [ $\beta$ ]. This effect means that the rates of  $\beta$  convergence would be higher for the regions within countries than for across countries".

Table 8. Net Migration of Population Across Regions Between 1974 and 1981<sup>1</sup>

Region	Population (in thousands)		Net migrants <sup>2</sup> (in thousands)		Net migrants as a percent of population	
	1974	1981	1974	1981	1974	1981
Chittagong	4316	5491	+53	+21	+1.2	+0.4
Chittagong, H.T.	508	580	+91	+100	+17.9	+17.2
Comilla	5819	6881	-358	+585	-6.2	+8.5
Noakhali	3234	3816	-261	-409	-8.1	-10.7
Sylhet	4759	5656	+131	+198	+2.8	+3.5
Dhaka	7612	10014	+579	+1142	+7.6	+11.4
Faridpur	4060	4764	-253	-406	-6.2	-8.5
Mymensingh <sup>3</sup>	7567	9020	-111	-248	-1.5	-2.7
Tangail	2077	2444	-97	-44	-4.7	-1.8
Barisal	3928	4667	-15	-380	-0.4	-8.1
Jessore	3327	4020	+40	+58	+1.2	+1.4
Khulna	3557	4329	+227	+285	+6.4	+6.6
Kushtia	1884	2292	+19	-4	+1.0	-0.2
Patuakhali	1499	1843	-185	-24	-12.3	-1.3
Bogra	2230	2728	-17	+2	-0.8	+0.1
Dinajpur	2571	3200	+132	+166	+5.1	+5.2
Pabna	2815	3424	-99	-105	-3.5	-3.1
Rajshahi	4268	5270	+61	+26	+1.4	+0.5
Rangpur	5447	6510	+62	-19	+1.1	-0.3
Bangladesh	71478	87120				

Source: BBS, *Statistical Yearbook of Bangladesh, 1985 and 1989*.

<sup>1</sup> Data for net migration across regions during the 1980s and 1990s are not available.

<sup>2</sup> +/- indicates net in migrants/out-migrants. The sum of net migrants of all regions is not zero due to rounding and other statistical errors.

<sup>3</sup> Mymensingh includes Jamalpur.

Here follows an elaboration of this point. Note that economic openness generally promotes output growth and accelerates the speed of income convergence across countries (Ben-David, 1993; Levine and Renelt, 1992). This could be true for Bangladesh as well. However, it appears that the richer regions gained the most from economic openness due to both structural and policy reasons. For example, foreign investment in Bangladesh has generally been concentrated to developed regions, such as Dhaka and Chittagong. Modern technology transfers to these regions have also been considerable. Thus the factors that promoted output convergence across regions during the 1980s might have been neutralized to some extent following the opening up the economy. Recall that although the share of agriculture in output

was not significant in the growth equation for the whole sample period, it was found to bear a negative sign and was significant in the growth regression for the period 1991 to 1997 (this result is not reported). This suggests the possibility that the opening up the economy has changed the steady-state growth path of per capita output levels for different regions as new factors such as knowledge-based production technology, export-oriented investment and infrastructural development have started to play a critical role in economic growth. To the extent that these factors have become important, it is possible to explain the weakening of the process of regional convergence. Note that the speed of convergence in a region depends on the gap between its actual and steady-state per capita output levels. As this gap might have narrowed over time for those regions whose steady-state per capita output levels did not rise, they have experienced lower rates of economic growth. By contrast, there are regions whose steady-state per capita output levels increased due to factors that have become prominent in the growth process after opening up the economy and this could have led to higher rates of growth in these regions despite their relatively higher initial output levels.

## VII. SUMMARY AND CONCLUSION

This paper has examined the phenomenon of convergence of per capita output levels across regions of Bangladesh for the period 1982 to 1997. Three concepts of convergence, such as *sigma* ( $\sigma$ ) convergence, *beta* ( $\beta$ ) convergence and conditional *beta* ( $\beta'$ ) convergence have been investigated. The results suggest that most of the regions of Bangladesh experienced strong convergence of per capita output levels for the period 1982 to 1991. The estimated speed of convergence for this period has been found to be around 3 per cent per annum (Appendix). However, along with this positive feature of development, the paper has identified two related developments within the domain of convergence that have important policy implications. First, a few poorer regions of the country did not demonstrate any output convergence for the full or part of the sample period. Second, no evidence has been found for convergence of per capita output levels across regions for the period 1991 to 1997 that coincided with opening up the economy.<sup>13</sup> The paper has highlighted both economic and non-economic developments within the country since the early 1970s and thus provided plausible explanations for all these features of convergence of output levels across regions.

It is possible to draw policy implications from empirical findings within a broader perspective.<sup>14</sup> At the early stages of development, convergence of national output performance vis-à-vis other

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<sup>13</sup> Empirical findings of this paper are subject to usual caveats. Besides the small sample size, there are various economic and non-economic factors that deserve to be incorporated in the growth equation to obtain robust regression results.

<sup>14</sup> The policy implications drawn are based on the view that the slowing down of the process of output convergence across regions has been associated with opening up the economy. This does not, however, mean that economic openness has been bad for the poorer regions. What it indicates is that while trade liberalization in particular has helped to integrate the national economy into the global economy and in the process has created a number of growth centers

(continued...)

countries is as important as convergence of output levels across regions. Historically, economic openness has been important for convergence of national outputs across countries. From this viewpoint, the opening up Bangladesh's economy since the early 1990s has been a major step towards its goal of achieving rapid economic growth. At the same time it is necessary to remember that at the early stages of a country's development (and international convergence), its modern economic activities remain concentrated around urban centers, which, by nature, offer the strongest incentives for investment- both domestic and foreign. This may weaken the process of regional convergence of output levels. It is even possible that international convergence is associated with regional divergence of output levels for a considerable period of time. However, over-time, rural-urban migration and intensifying capacity constraints are likely to lead to a progressive spillover of benefits to the relatively less urbanized areas. It is possible to draw two policy implications from such a pattern of development. First, opening markets for foreign products and investment tend to favor the country's higher income households and industrialized regions, implying that scale economies and spillover effects play an important role in attracting foreign direct investment. Second, safety nets and redistribution policies may need to be put in place not just to share the growth dividends from opening up the economy but also to make the process politically sustainable. Insofar as Bangladesh, policymakers should take into account the structural features of poorer regions where the process of output convergence has slowed down, if not stopped, and then introduce remedial measures for expediting their integration with the developed regions. The government should particularly take measures to enhance human capital formation and to induce technology transfers to poorer regions so that they can reap the benefits of economic openness. Rapid infrastructural development is another bet for attracting investment in the poorer areas. This may not only promote regional convergence but also relieve increasing pressure on congested urban centers.

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within the country, the poorer regions thus far have gained relatively less from the growth process. It is possible that all the poorer regions have gained economically in absolute sense. Without opening up the economy, the poorer regions could have remained stagnant and probably diverged from the richer ones. Given that the lagging regions have now been identified, it could be relatively easy for the government to design and implement structural reform policies for poorer regions to facilitate their catching up the developed ones.

### VIII. THE SPEED OF CONVERGENCE

#### 1. The Model

According to the Solow growth model, if  $y^*$  is the level of per capita output on the balanced growth path and  $y(t)$  is the level of per capita output within the neighborhood of the balanced growth path observed at time  $t$ , then  $y$  converges to  $y^*$  at the rate  $\beta$ , such that

$$\delta \ln y(t)/dt \approx -\beta (\ln y(t) - \ln y^*) \quad (A1)$$

Equation (A1) implies that  $\ln y(t)$  approaches  $\ln y^*$  exponentially:

$$\ln y(t) - \ln y^* \approx e^{-\beta t} (\ln y(0) - \ln y^*) \quad (A2)$$

where  $y(0)$  is the value of  $y$  at some initial date.

Adding  $(\ln y^* - \ln y(0))$  to both sides of (A2) and dividing by  $t$  yield an expression for the average growth rate of per capita output during the time interval  $(0,t)$

$$(1/t) (\ln y(t) - \ln y(0)) \approx - (1-e^{-\beta t}) (\ln y(0) - \ln y^*) (1/t) \quad (A3)$$

Equation (A3) implies conditional convergence of per capita output levels across countries or regions. That is, countries or regions with initial outputs that are low relative to their balanced growth paths would have higher growth rates.

Barro and Sala-i-Martin (1991) point out that the neoclassical growth model does not imply that the convergence coefficient ( $\beta$ ) would be the same in all times and places. The coefficient depends on the underlying parameters of technology and preferences, but not on differences in technologies or government policies that can be represented as proportional effects on the production function, that is, as variations in the parameter  $A$  in the function,  $Af(k)$  where  $k$  is capital per unit of effective labor. These  $A$ -type effects have important influences on the steady-state per capita output,  $y^*$ , but not on the speed with which an economy approaches its steady-state. One would also expect to observe the speed of convergence faster when the economy lies further from its steady-state. However, as already defined, the speed of convergence measured by  $\beta$  is valid only when the economy is within some neighborhood of the balanced growth path (Romer, 1996; Obstfeld and Rogoff, 1996).

Given the speed of convergence, the time required for the variable  $(\ln y(t) - \ln y^*)$  to fall in half is approximately equal to 70 divided by its growth rate in per cent. Formally, the half-life,  $t^*$ , is the solution to  $-(1-e^{-\beta t}) = 0.5$ , where  $\beta$  is the rate of decrease. Taking logs of both sides,  $t^* = -\ln(0.5)/\beta \approx 0.69/\beta$  (Romer, 1996).

## 2. Estimation

Barro and Sala-i-Martin (1991) have used the following specification for estimation of the convergence coefficient across regions by non-linear least squares:

$$1/T \ln (y_{i,t}/y_{i,t-T}) = \alpha - (\ln y_{i,t-T})(1-e^{-\beta T})(1/T) + u_{i,t} \quad (\text{A4})$$

where  $y_{i,t-T}$  is the level of per capita output in region  $i$  at the beginning of the interval,  $y_{i,t}$  is the level of per capita output in region  $i$  at time  $t$ ;  $T$  is the length of the observation interval;  $\alpha$  is a constant ( $\alpha_i = \alpha$ ) that represents the steady-state per capita growth rate,  $\beta$  is the convergence coefficient, and  $u_{i,t}$  is the stochastic error term, with zero mean and constant variance, as well as independently distributed from  $\ln y_{i,t-T}$ .

## 3. Estimation and Results

Equation (A4) has been used for estimation of the speed of convergence across 20 regions of Bangladesh for four time intervals: 1982-91, 1982-93, 1982-97 and 1991-97. The estimated values for beta are reported in Table A1. It is found that although the value of convergence coefficient is about 3 per cent per annum during the period 1982 to 1991, it is not different from zero for the time interval 1991-97. It was indicated in the text that the Bangladesh economy has been opened up rapidly from the early 1990s and this might have slowed down, if not stopped, the process of regional convergence of per capita output levels.

While checking for the randomness of residuals in the estimated equations, it was found that although the residuals were random in nature and did not show a pattern, there were five major outliers that corresponded to Faridpur, Chittagong, Noakhali, Pabna and Jessore. Table 2 in the text showed that the growth rates of per capita output for Faridpur and Jessore were unusually high. Chittagong, despite being the second richest region, also maintained a high growth rate of per capita output. Pabna is the poorest region (rank 20) and its output growth rate remained very low. The output growth rate for Noakhali, the second poorest region (rank 19), was moderate but less than the country average.

Equation (A4) has then been estimated without these outliers. Table A1 shows that the absolute value of convergence coefficient becomes higher when these outliers are excluded from the regression equation. Following the suggestion of a reviewer, the equation has been estimated for all regions with an outlier dummy. Although the results obtained from this augmented regression equation have been found to be similar to those obtained when the equation was estimated without the outliers, the inclusion of dummy has been found to create statistical problems, especially heteroskedasticity.



#### **4. The Outliers**

##### **Faridpur and Jessore**

Faridpur and Jessore are the two regions that have made a significant improvement in their relative economic position during the period 1982 to 1997. In 1982, the rankings of Faridpur and Jessore were 15 and 16. In 1997, their rankings have improved to 7 and 9. How did they improve their relative economic position within a decade or so? There are no specific reasons that can justify such a rapid improvement in their relative economic position. Traditionally, these regions were economically depressed. Faridpur in particular suffered the most from the mighty Padma and its tributaries. In an historic sense, Faridpur and Jessore were also key centers of radical politics. The way these regions are coming up thus can be considered a positive development.

There are a number of factors that can shed some light on the rapid improvement of economic condition in these regions. To begin, the people of these regions suffered heavily during the 1974 famine. It is plausible that they have responded positively to whatever economic opportunities have been created within the country since the mid-1970s. There are signs that the pressure of poverty has made the younger generation of these regions mobile, risk-taking, resilient and enterprising. For example, there has been a sharp increase in labor mobility in these regions. Many people of these regions have also emigrated to the metropolitan cities following the improvement of transport and communication facilities. There are other factors that cannot be ignored. First, Faridpur and Jessore are at the proximity of two growth centers - Dhaka and Khulna. Importantly, they constitute the route for massive smuggling of goods to and from India. It appears that a growth zone has been created around the Jessore-Faridpur-Aricha-Dhaka highway. Second, many high profile national politicians have hailed from these regions. Consequently, these regions have benefited from various public works programs designed on political considerations.

##### **Chittagong**

Chittagong has traditionally been the richest and most urbanized region of the country. It is the business capital. As the main seaport is also located here, most industries, especially the newly established export-oriented industries, have been established in and around this region. In recent years, this region has attracted large foreign investment. There are other factors that have also played a role in its rapid development. For example, given the historical tradition of sea-going population, there has been a large-scale emigration of people from this region to the Gulf countries. Their remittances have allowed this region to surge ahead and maintain its lead in business and commerce. The people of this region have indeed been traditionally business-minded and enterprising. On top of these factors, government policies have provided an impetus to its rapid development. For example, Chittagong has been politically highly important for strategic reasons. Until the Peace Accord was signed a year ago, the government faced a two decade-old tribal insurgency problem in the Chittagong Hill Tracts. This required a large-scale military presence in and around Chittagong. The region has thus gotten priority in infrastructural development.

### Pabna and Noakhali

Pabna and Noakhali are the two poorest regions of the country. They have remained so and showed no signs of output convergence during the past two decades. Noakhali's ranking in per capita output has in fact deteriorated from 17 in 1982 to 19 in 1997, while Pabna has remained at its lowest economic position (rank 20). It is puzzling why Noakhali has failed to converge in output with its bordering prosperous region Chittagong. Noakhali after all is linked with Dhaka via the main highway that connects Chittagong. It is plausible that a number of unique factors have made Noakhali structurally different from its neighboring regions. First, it has the highest density of population. The incidence of near-landlessness is also highest in this region (BBS, 1986). Second, like Faridpur, Noakhali is vulnerable to river erosion, floods and other natural disasters as it is at the proximity of the Bay of Bengal. While these factors may have a negative impact on its economic performance, there are other features that could be conducive to economic growth in this region. For example, the people of this region are known for their risk-taking and enterprising attitude. Historically, net emigration from this region has been high, given that it is at the proximity of two growth centers - Dhaka and Chittagong. Thus far the outgoing attitude of its people has been beneficial in terms of their availing of job opportunities at home and abroad.

Appendix Table A1. Estimates of the Speed of Convergence

	1982-91			1982-93			1982-97			1991-97		
	Eq. 1	Eq. 2	Eq. 3	Eq. 1	Eq. 2	Eq. 3	Eq. 1	Eq. 2	Eq. 3	Eq. 1	Eq. 2	Eq. 3
$\beta$	0.031 <sup>a</sup>	0.031 <sup>a</sup>	0.030 <sup>a</sup>	0.028 <sup>a</sup>	0.028 <sup>a</sup>	0.026 <sup>a</sup>	0.016 <sup>a</sup>	0.017 <sup>a</sup>	0.015 <sup>a</sup>	-0.001	-0.001	-0.006
(t-ratio)	(4.53)	(5.73)	(4.30)	(4.76)	(7.78)	(4.61)	(3.71)	(5.94)	(3.55)	(1.07)	(1.05)	(1.18)
R <sup>2</sup>	0.58	0.76	0.59	0.61	0.86	0.64	0.47	0.76	0.51	0.01	-0.01	-0.001
DW	1.56	1.04	1.87	2.12	2.57	2.51	1.86	1.80	2.37	1.36	1.40	1.36
Additional diagnostics												
A: $\chi^2(1)$	0.78	3.62	0.05	0.17	3.24	1.64	0.03	0.11	0.17	1.10	0.39	0.77
B: $\chi^2(1)$	0.10	1.27	0.55	0.52	0.97	1.84	0.91	0.27	2.83	0.17	0.23	0.77
C: $\chi^2(1)$	1.06	0.97	2.32	0.53	1.22	1.84	0.90	0.58	1.49	1.73	0.75	0.82
D: $\chi^2(1)$	0.94	0.01	6.38	0.02	0.06	6.25	0.02	0.84	5.13	0.05	0.11	0.44

Notes:

Equation I: For all regions.

Equation II: Excluding outliers.

Equation III: All regions with a dummy outliers

<sup>a</sup> Significant at the one percent level

### References

- Abramovitz, M., 1986, "Catching Up, Forging Ahead, and Falling Behind," *Journal of Economic History*, 46 (2): 385–406.
- , 1990, "The Catch-Up Factor in Postwar Economic Growth," *Economic Inquiry*, 28: 1–18.
- Bangladesh Bureau of Statistics (BBS), 1986, *The Bangladesh Census of Agriculture and Livestock: 1983–84 (Vols. I, II, and III)*, Dhaka: BBS.
- , 1993, *Twenty Years of National Accounting of Bangladesh* (Dhaka: BBS).
- , various years, *The Agricultural Statistical Yearbook of Bangladesh* (Dhaka: BBS).
- , various years, *Statistical Yearbook of Bangladesh*, Dhaka: BBS.
- Barro, R.J., 1991, "Economic Growth in a Cross Section of Countries," *Quarterly Journal of Economics*, 106: 407–43.
- , 1993, *Macroeconomics* (4<sup>th</sup> Edition), (New York: John Wiley and Sons, Inc).
- Barro, R.J. and X. Sala-i-Martin, 1991, "Convergence Across States and Regions," *Brookings Papers on Economic Activity*, 1: 107–58.
- , 1992, "Convergence," *Journal of Political Economy*, 100(2): 223–51.
- , 1994, *Economic Growth* (New York: McGraw Hill).
- Baumol, W.J., 1986, "Productivity Growth, Convergence, and Welfare: What the Long-Run Data Show?," *American Economic Review*, 76(5): 1072–85.
- , 1994, "Multivariate Growth Patterns: Contagion and Common Forces as Possible Sources of Convergence," in W.J. Baumol, E.N. Wolff and R. Nelson (eds.), *Convergence of Productivity: Cross-National Studies and Historical Evidence* (Oxford: Oxford University Press).
- Baumol, W.J. and E.N. Wolff, 1988, "Productivity Growth, Convergence, and Welfare: Reply," *American Economic Review*, 78 (5): 1155–59.
- Ben-David, D., 1993, "Equalizing Exchange: Trade Liberalization and Income Convergence," *Quarterly Journal of Economics*, 108 (August): 653–79.
- Boyce, J., 1987, *Agrarian Impasse in Bengal: Institutional Constraints to Technological Change* (New York: Oxford University Press).

- Cardenas, M. and A. Ponton, 1995, "Growth and Convergence in Colombia:1950-90," *Journal of Development Economics*, 47: 5-37.
- Cass, D., 1965, "Optimum Growth in an Aggregate Model of Capital Accumulation," *Review of Economic Studies*, 32: 233-40.
- De Long, J.B., 1988, "Productivity Growth, Convergence, and Welfare: Comment," *American Economic Review*, 78(5): 1138-54.
- Domar, E.D., 1946, "Capital Expansion, Rate of Growth, and Employment", *Econometrica*, 14 (April):137-47.
- Dowrik, S. and D.T. Nguyen, 1989, "OECD Comparative Economic Growth 1950-85: Catch-Up and Convergence," *American Economic Review*, 79(5): 1010-30.
- Elmslie, B.T., 1995, "The Convergence Debate Between David Hume and Josiah Tucker," *Journal of Economic Perspectives*, 9(4): 207-16.
- Faaland, J. and J. Parkinson, 1976, *Bangladesh: The Test Case of Economic Development* (London: Hurst and Company).
- Gerschenkron, A., 1962, *Economic Backwardness in Historical Perspective* (Cambridge: Harvard University).
- Harrod, R.F., 1939, "An Essay in Dynamic Theory," *Economic Journal*, 49 (March):14-33.
- Hossain, A., 1996, *Macroeconomic Issues and Policies: The Case of Bangladesh* (Delhi: The Sage Publications).
- Hossain, A., 2000, *Exchange Rates, International Economics and the Macroeconomic Performance of an Emerging Market Economy of Bangladesh* (Dhaka: University Press Limited, in press).
- Hossain, M., 1988, "Nature and Impact of the Green Revolution in Bangladesh", Research Paper 67 (Washington, D.C.: International Food Policy Research Institute).
- Islam, N., 1977, *Development Planning in Bangladesh: A Study in Political Economy* (London: Hurst and Company).
- Koopmans, T.C., 1965, "On the Concept of Optimal Economic Growth," in *The Econometric Approach to Development Planning* (Amsterdam: North Holland).
- Levine, R. and D. Renelt, 1992, "A Sensitivity Analysis of Cross-Country Growth Regressions," *American Economic Review*, 82 (September): 942-63.
- Lucas, R.E., 1988, "On the Mechanics of Economic Development," *Journal of Monetary Economics*, 22: 3-42.

- Maddison, A., 1987, "Growth and Slowdown in Advanced Capitalist Economies: Techniques of Quantitative Assessment," *Journal of Economic Literature*, 25: 649–98.
- , 1991, *Dynamic Forces in Capitalist Development: A Long Run Comparative View* (New York: Oxford University Press).
- Maniruzzaman, T., 1980, *The Bangladesh Revolution and Its Aftermath* (Dhaka: Bangladesh Books International Limited).
- Mankiw, N.G., D. Romer and D.N. Weil, 1990, "A Contribution to the Empirics of Economic Growth," *NBER Working Paper* 3541, Cambridge, Massachusetts.
- Marx, K., 1973, "The Future Results of British Rule in India", in *Surveys from Exile* (New York: Penguin). Originally published in 1853.
- Mauro, L. and E. Podrecca, 1994, "The Case of Italian Regions: Convergence or Dualism?," *Economic Notes*, 24(3):447–72.
- Mill, J.S., 1970, *Principles of Political Economy, with Some of Their Applications to Social Philosophy* (New York: Penguin. Originally published in 1848.)
- Obstfeld, M. and K. Rogoff, 1996, *Foundations of International Macroeconomics* (Cambridge, Massachusetts: The MIT Press).
- Osmani, S.R., 1990, "Structural Change and Poverty in Bangladesh: The Case of a False Turning Point," *Bangladesh Development Studies*, 18(3):55–74.
- Quah, D., 1993, "Galton's Fallacy and Tests of the Convergence Hypothesis," *Scandinavian Journal of Economics*, 95(4):427–43.
- Ramsey, F.P., 1928, "A Mathematical Theory of Saving," *Economic Journal*, 38: 543–49.
- Romer, D., 1996, *Advanced Macroeconomics*, New York: McGraw-Hill.
- Romer, P.M., 1986, "Increasing Returns and Long-Run Growth," *Journal of Political Economy*, 94: 1002–37.
- , 1990, "Endogenous Technological Change," *Journal of Political Economy*, 98: S71–103.
- Sachs, J.D. and F. Larrain, 1993, *Macroeconomics in the Global Economy* (New York: Harvester Wheatsheaf).
- Siddiqui, A.M.A.H., 1986, "The Economic and Non-Economic Impact of Labor Migration from Bangladesh," in F. Arnold and N. Shah (eds.), *Asian Labor Migration* (Boulder and London: Westview Press).

Soete, L. and B. Verspagen, 1993, "Technology and Growth: The Complex Dynamics of Catching Up, Falling Behind and Taking Over," in A. Szirmai, B. Van Ark and D. Pilat (eds.), *Explaining Economic Growth* (Amsterdam: North-Holland).

Solow, R.M. ,1956, "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics*, 70: 65–94.

Zind, R.G. ,1991, "Income Convergence and Divergence Within and Between LDC Groups," *World Development*, 19(6): 119–47.