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Measuring Education Inequality: Gini Coefficients of Education for Bangladesh

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Abstract: *This paper employs an education Gini index to measure educational attainment. It presents both direct and indirect methods of calculating the education Gini index. Further the study attempts to explain the Bangladesh's educational reforms on access to educational opportunities by various groups such as male and female, rural and urban, and various regions. The data of 2011 Population Census and years of schooling for population 7+ were utilized. The average years of schooling was found to be higher for male while compared to female in rural, urban and regional levels. The education Gini coefficient was found to be higher for female while compared to male in rural, urban and regional levels. Average years of schooling were found to be negatively associated with education Gini coefficient. The standard deviation of years of schooling was also found to be negatively associated with gini coefficient. The average years of schooling and its standard deviation indicated a positive relationship implying an early stage of education Kuznets curve.*

Keywords. *Bangladesh. Educational inequality, average years of schooling, gini coefficient, Lorenz curve.*
JEL Classification code*: C43, D63, I32, J24, O11, O1*

Introduction

Equal access to education is among the basic human rights to which everyone is entitled. Yet, the educational gaps between various groups in many countries are staggering, as shown by many studies. In the era of economic reforms, as the foundations of education have changed, so has the distribution of illiteracy.

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Between rural and urban areas, male and female, inequality on education has risen substantially since the reforms began If people's abilities are normally distributed, then a skewed distribution of education opportunities represents large welfare losses. As with land and machinery, an equitable distribution of human capital (basic literacy and nutrition/health) constitutes a precondition for individual productivity and ability to rise above poverty. Furthermore, an equitable distribution of opportunities is preferable to a redistribution of existing assets or incomes. This is because education builds new assets and improves social welfare by its spillover effect, without making anyone worse off. Ensuring access to educational opportunities by attending to both the supply and demand sides is a win-win policy gaining support in industrial and developing countries. To support such an effort, an indicator that can be easily calculated and monitored over time would be useful. In order to find a measurement of this inequality, a new indicator for the distribution of human capital and welfare have come up with an education Gini index that also facilitates comparison of education inequality across countries and over time (Thomas et al, 2001, Appiah-Kubi, 2002, Digdowiseiso, 2010, Senadza 2012, Tomul, 2009). An unequal dispersion of human capital is expected to have a negative effect on economic growth through two channels. First, education inequality leads to an inefficient allocation of resources. Secondly, education inequality has a negative impact on the rate of human capital accumulation.

The goal 10 of Sustainable Development Goals (SDGs) says 'Reduce inequality within and among countries' (UNGA, 2015). The paper uses the education Gini coefficient, computed on the basis of years of schooling of individuals, to assess education inequality in Bangladesh.

Objectives

The main objective of the study is to investigate the inequality in education according to gender and spatial background in Bangladesh.

Data

The analysis has been carried out by using the years of schooling of population age 7+ of the Population Census 2011(BBS, 2012) and Household Income and Expenditure Surveys(BBS, 2012).

Methodology

For the purpose of estimating education inequality direct method has been applied

to obtain education Gini coefficient, average years of schooling, and standard deviations of education. In addition, Lorenz curve based on the cumulative proportion of population and that of schooling shall be presented in indirect method.

Direct Method

The direct method states that the education Gini is defined as "the ratio to the mean (average years of schooling) of half of the average over all pairs of the absolute deviations between all possible pairs of people" (Deaton 1997). Thomas et al (2001) developed Deaton's formula, which is shown in equation 1.

$$E_L = (\frac{1}{\mu})\sum_{i=2}^{n}\sum_{j=1}^{i-1} p_i \left|y_i - y_j\right| p_j \qquad (1)$$

E_L is the education Gini based on educational attainment distribution, large population;

μ is the average years of schooling for the concerned population;
ρ_t and ρ_t stand for the proportions of population with certain levels of schooling;
γ_t and γ_t are the years of schooling at different educational attainment levels;
n is the number of levels/categories in attainment data, and n = 7 in this paper.

Barro and Lee (1991) divided the population into seven categories include no schooling or illiterate, partial primary, complete primary, partial secondary, complete secondary, partial tertiary, and complete tertiary. In the present study, population was divided into seven categories according to educational attainment: never been to school, partial primary school, complete primary school, partial secondary school, complete secondary school, complete higher secondary school and complete tertiary school or university.

The value of Gini is sensitive to population size N if the population size is too small. The sensitivity is reflected by a factor of [N/(N-1)]. The education Gini formula for a small population is shown in equation 2.

$$E = \left(\frac{N}{N-1}\right) * \left[(\frac{1}{\mu})\sum_{i=2}^{n}\sum_{j=1}^{i-1} p_i \left|y_i - y_j\right| p_j\right] = \left(\frac{N}{N-1}\right) * E_L \qquad (2)$$

Where,

E is the education Gini based on educational attainment distribution;

N is the number of individuals in the concerned population.

Multiplying equation (1) with a factor of [N/(N-1)] gives us the detailed summation process for the second education Gini formula of equation (2).

Theoretically, when population size N approaches infinite, [N/(N-1)] =1, and the second formula becomes the first formula. Practically, when population size is large enough, the first formula is good enough to achieve a high level of accuracy. The beauty of the first formula is that the exact number of the population size is irrelevant to the value of Gini as long as we know the concerned country has a large population.

AYS and Standard Deviation

The average years of schooling(AYS) and standard deviations of schooling can be calculated in formulae 3 and 4 respectively.

$$\mu = AYS = \sum_{i=1}^{n} p_i y_i \qquad (3)$$

$$\sigma = SDS = \sqrt{\sum_{i=1}^{n} p_i (y_i - \mu)^2} \qquad (4)$$

Expanding equation (1) we get the detailed summation process of the first education Gini formula, shown in equation (5).

$$E_2 = (1/\mu)\,[p_2(y_2 - y_1)p_1 + p_3(y_3 - y_1)p_1 + p_3(y_3 - y_2)p_2 + \ldots\ldots\ldots\ldots\ldots\ldots + p_7(y_7 - y_1)p_1 + p_7(y_7 - y_2)p_2 + p_7(y_7 - y_3)p_3 + p_7(y_7 - y_4)p_4 + p_7(y_7 - y_5)p_5 + p_7(y_7 - y_6)p_6]$$

Where,

ρ_1, is the proportion of population with no schooling,

ρ_2 is the proportion of population with partial primary education;

ρ_7 is the proportion of population with complete tertiary education.

γ_1, is years of schooling for an individual with no schooling, =0;

$\gamma_2$is years of schooling for an individual with partial primary education;

γ_7, is years of schooling for an individual with complete tertiary education.

The formula for calculating the years of schooling at the seven levels of education:

(5.1) Illiterate $y_1 = 0$

(5.2) Partial-Primary: $y_2 = y_1 + 0.5\,C_p = 0.5C_p$

(5.3) Complete-Primary: $y_3 = y_1 + C_p = C_p$

(5.4) Partial-Secondary: $y_4 = y_3 + 0.5\,C_S = C_p + 0.5C_S$

(5.5) Complete-Secondary: $y_5 = y_3 + C_S = C_p + C_S$

(5.6) Higher Secondary: $y_6 = y_5 + Chs = C_p + C_S + Chs$

(5.7) Tertiary: $y_7 = y_6 + C_t = C_p + C_s + Chs + Ct$

Where,

Cp is the cycle of the primary education = 5 years;

C_S is the cycle of the secondary education =5 years;

Chs is the cycle of the higher secondary education = 2 years; and

Ct is the cycle of the tertiary education= 5 years.

The data on cycles of schooling (Cp , Cs , Chs Ct) is obtained from Population Census Reports of Bangladesh (BBS 2012). Secondary education is divided into two tiers- grade 6-8 comprises junior secondary certificate and grade 9-10 makes the secondary school certificate. People who receive partial education is assumed to get half of the schooling cycle in their years of schooling, shown in equation (5.2), and (5.4).

Findings

Average Years of Schooling: Gender and Regions

Although Bangladesh has a long history of census taking and collecting information on literacy, we have very scanty information on average years of schooling. However the 2001 Population census reports provides us with information regarding average years of schooling according to gender and residence background. Table 1. The average years of schooling for both sex was found to be 3.63, while that value for male was 4.09 and female had 3.13 years of schooling. At the national level there is a gender gap of 0.96 mean years of schooling. The average years of schooling in the urban area was 5.15 which was 2.01 years higher than the average years of schooling in rural area having its value

Table 1: Average Years of schooling for population 7+ by sex and locality. Bangladesh 2001-11.

Census	National			Urban			Rural		
	Total	Male	Female	Total	Male	Female	Total	Male	Female
2001	3.63	4.09	3.13	5.15	5.74	4.46	3.14	3.53	2.74
2011	4.34	4.69	4.00	6.10	6.61	5.54	3.79	4.05	3.55
Change	0.71	.60	0.87	0.95	0.87	1.08	0.65	0.52	0.81
Rate of change (%)/a	1.95	1.47	2.78	1.84	1.51	2.42	2.07	1.47	2.96

a/annual rate of change(Per cent). Author's computation. Source. BBS

as 3.14.The average years of schooling for the Population census data of 2011 computed in the present study was 4.34 for both sex, 4.69 for male and 4.00 for female. At the national level there is a gender gap of 0.60 years in the average years of schooling which is 0.36 years less than the gender gap of 0.96 obtained in 2001.

Gender ratio and rural-urban ratio in educational attainment

In all the administrative divisions the average years of schooling for male was higher for male while compared to female in both rural and urban areas. The gender ratio was found to be lowest- 81.5 per cent in Rangpur division and highest- 90.5 per cent for Barisal division. The overall national gender ratio was found to be 85.3 per cent. The average years of schooling were considerably higher in urban area while compared to rural area in all the administrative divisions. The lowest rural urban ratio of 57.8 per cent was observed for Dhaka division and the highest rural urban ratio was observed for Chittagong division followed by about 68 per cent for Barisal and Khulna division. The overall national value of rural urban ratio was found to be 62.1 per cent. It is mentionable here that a value of 100.0 for gender ratio and rural urban ratio would indicate gender and spatial parity in educational attainment. The various educational programmes adopted in Bangladesh has been successful in minimising gender ratio but more efforts are in order to reduce the rural urban ratio in educational attainment. The prevailing inequality in Bangladesh requires increased public

Table 2: Gender and Rural-urban ratio in Average years of schooling by Divisions.

Region/ Divisions	Female (A)	Male (B)	Rural (C)	Urban (D)	Gender ratio (A)/(B) Per cent	Rural-urban ratio (C)/(D) Per cent
Total	4.00	6.69	3.79	6.10	85.3	62.1
Barisal	4.39	4.85	4.28	6.26	90.5	68.3
Chittagong	4.21	4.71	4.02	5.76	89.4	72.9
Dhaka	4.19	5.03	3.70	6.43	83.3	57.5
Khulna	4.12	4.83	4.12	6.06	85.3	68.0
Rajshahi	3.70	4.41	3.66	5.83	83.9	62.8
Rangpur	3.49	4.28	3.60	5.67	81.5	63.5
Sylhet	3.32	3.79	3.23	5.32	87.6	60.7

Note. Author's computation. Source. BBS

attention and proper policy targeting towards improving educational facilities in rural areas and female schooling. Table2.

Table 3: Average Years of schooling for Bangladesh and South Asia.

Region	Average years of schooling(AYS)		Gender Ratio
South Asia (population 15+)	Female(A)	Male(B)	(A/B) Per cent
1950	0.41	1.54	26.6
1960	0.52	1.71	30.4
1970	0.88	2.32	37.7
1980	1.38	3.29	42.1
1990	2.28	4.51	50.7
2000	3.16	5.31	59.5
2010	4.29	6.25	68.6
Change: 2000-2010	1.13	0.94	9.1
Bangladesh (population 7+)			
2001	3.13	4.09	76.5
2011	4.00	4.69	85.3
Change 2001-2011	0.87	0.60	8.8

a/ For South Asia the AYS is for Population age 15+, for Bangladesh it is for population age 7+. South Asia included seven countries (Afghanistan, Bangladesh, India, Maldives, Nepal, Pakistan and Sri Lanka).

Barro, R. J. and J-W Lee. 2011 .A New Data Set of Educational Attainment in the World, 1950–2010.

With an aim to compare the performance of Bangladesh's efforts in enhancing the access to education we have presented some findings from Barro and Lee (2010) in table 3. The south Asian countries have improved 2.6 folds in the last six decades from 26.0 per cent in 1950 to 68.6 per cent in 2010. Although we do not have data for previous census years, the gain in average years of schooling in Bangladesh has been 0.60 for male which is much lower than the corresponding gain of 0.94 in south Asian countries, while the gain of 0.87 in average years of schooling for female in Bangladesh is also much lower than the gain of 1.13 of south Asian countries. As a result improvement in gender ratio in Bangladesh and South Asia has been more less similar, about 9 per cent during the decade 2001-2011.

Gini Coefficient: Gender and Divisions

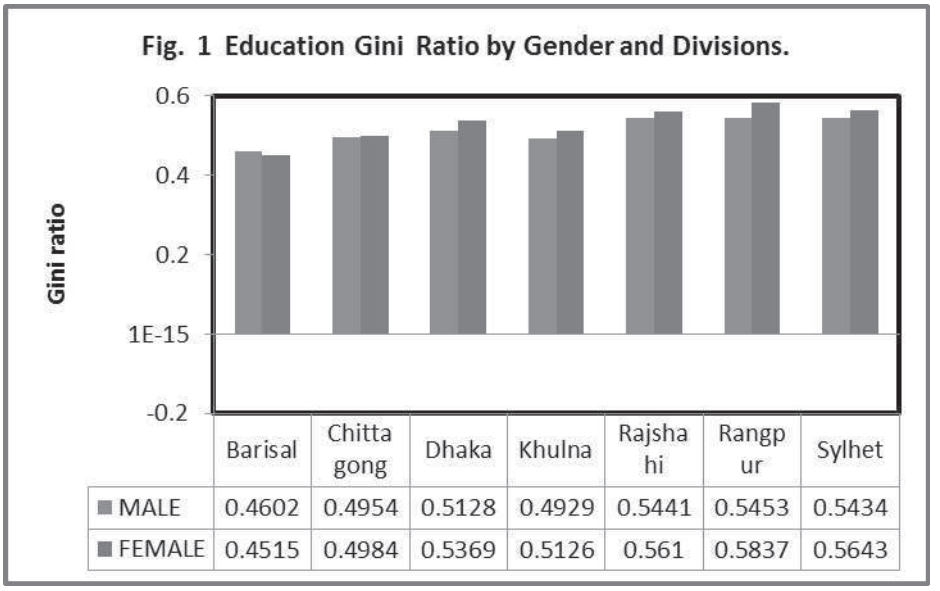
The Gini coefficient according to gender, rural-urban and regional locations are presented in table 5.

The national Gini ratio is 0.5255 and the Gini ratio for rural area is 0.5403 and for the urban area Gini ratio is found to be 0.4578 suggesting a concentration at the lower end of the years of schooling in rural areas while compared to urban area. The Gini coefficient for female has been all along higher while compared to the Gini coefficient for male suggesting intra-concentration of inequality for female

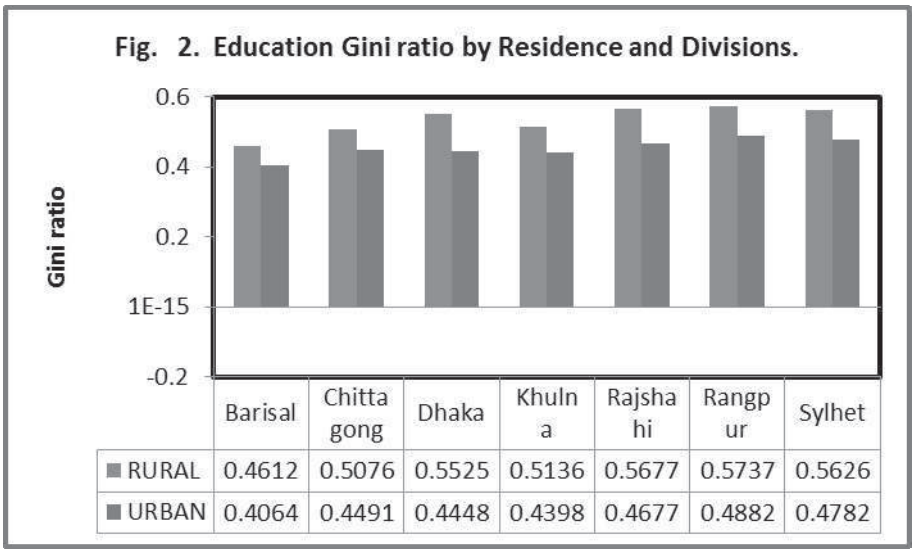
Table 4: Education Gini Coefficient by Sex , Division and Residence 2011

Region/		Total			Rural			Urban	
Division	Total	Male	Female	Total	Male	Female	Total	Male	Female
							Findings:		
Total	.5255	.5156	.5322	.5403	.5319	.5455	.4578	.4366	.4635
Barisal	.4572	.4602	.4515	.4612	.4656	.4558	.4064	.4037	.4054
Chittagong	.4981	.4954	.4984	.5076	.5069	.5080	.4491	.4413	.4534
Dhaka	.5258	.5128	.5369	.5525	.5431	.5596	.4448	.4277	.4620
Khulna	.5043	.4929	.5126	.5136	.5038	.5219	.4398	.4261	.4511
Rajshahi	.5531	.5441	.5610	.5677	.5580	.5756	.4677	.4553	.4760
Rangpur	.5658	.5453	.5837	.5737	.5542	.5914	.4882	.4675	.5070
Sylhet	.5548	.5434	.5643	.5626	.5509	.5724	.4782	.4631	.4912

Note. Author's computation. Source. BBS



in all the locations. This pattern of differentials in Education Gini ratio is prevalent in all the divisions. Among the divisions Rajshahi, Rangpur and Sylhet had the higher value of Gini concentration ratio while Barisal, Chittagong and Khulna regions were on the lower value of Gini ratio. The Gini ratio of Dhaka division was in the mid way. Table 4 and Figure 1 and 2.



The Indirect Method through the Construction of Lorenz Curve

The indirect method first constructs the education Lorenz curve, with the cumulative percentage

of the schooling years on the vertical axis, and the cumulative percentage of the population on the horizontal axis. The forty-five degree line is the education egalitarian line for it represents a completely equality of schooling. The Gini coefficient is defined as the ratio of the area formed by the Lorenz curve and the egalitarian line to the area of the entire egalitarian triangle. Figure 3.

The Education Lorenz Curve

The education Lorenz curve in Figures 3 to 5 is constructed by putting the cumulative proportion of population on the horizontal axis, and by putting the cumulative proportion of schooling on vertical axis. The cumulative proportion of population at each level is as the following.

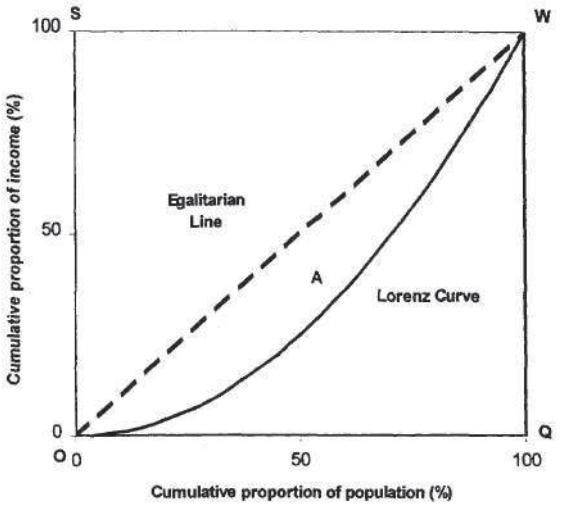


Fig 3: Education Lorenz Curve

$$GINI = \frac{\text{Area of A(between Egalitarian line and Lorenz Curve)}}{\text{Area of OWQ (Egalitarian Triange)}} \quad (6)$$

(6.1) Illiterate: $Q_1 = p_1$

(6.2) Partial-Primary: $Q_2 = p_1 + p_2$

(6.3) Complete-Primary: $Q_3 = p_1 + p_2 + p_3$

(6.7) Complete-Tertiary: $Q_7 = p_1 + p_2 + p_3 + p_4 + p_5 + p_6 + p_7 = 100\%$

The cumulative proportion of schooling at each level of schooling is as follows.

(7.1) Illiterate: $S_1 = (p_1 y_1)/\mu = 0$

(7.2) Partial-Primary: $S_2 = (p_1 y_1 + p_2 y_2)/\mu$

(7.3) Complete-Primary $S_3 = (p_1 y_1 + p_2 y_2 + p_3 y_3)/\mu$

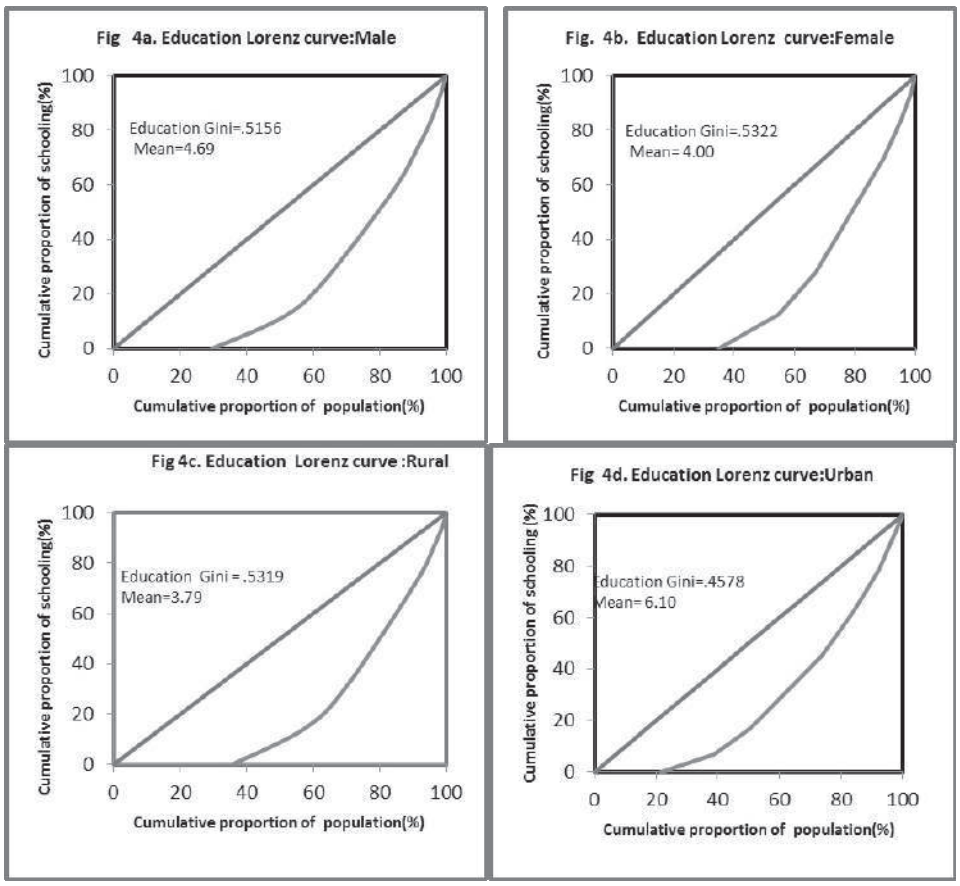
(7.7) Complete-Tertiary: $S_7 = (p_1 y_1 + p_2 y_2 + p_3 y_3 + p_4 y_4 + p_5 y_5 + p_6 y_6 + p_7 y_7)/\mu$

The cumulative proportion of schooling at each level of schooling is as follows.

After constructing the education Lorenz curve, the calculation of education Gini is Straight forward based on equation (2).

The Education Lorenz curves generated following the above procedure are shown in Figures 4a to 4d. From the Figures 4a and 4b we observe that for female there is higher proportion of illiterate while compared to male. Similarly we see that

there are greater proportion illiterate persons in rural are while compared to urban population in Figures 4c and 4d.



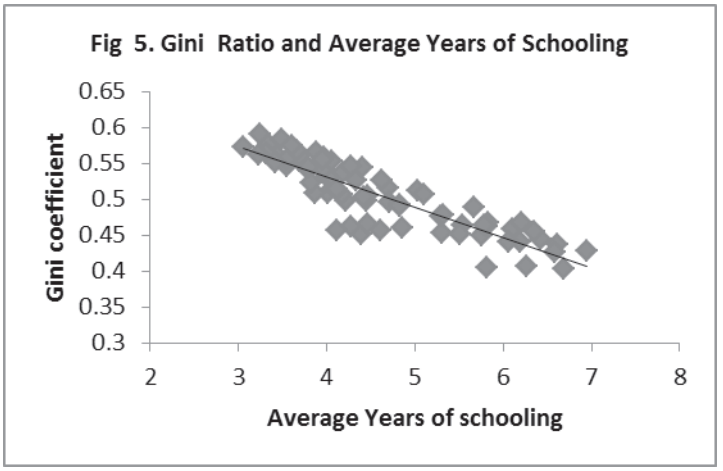
Relationship Among AYS, Standard Deviation of AYS and Education Gini

We have used the data points generated in table 4 and 5 obtained for different segments of the study population to explpore the following relationships of AYS and Education Gini, Education Gini and standard deviation of AYS, AYS and standard deviation of AYS.

Relationship between AYS and Education Gini

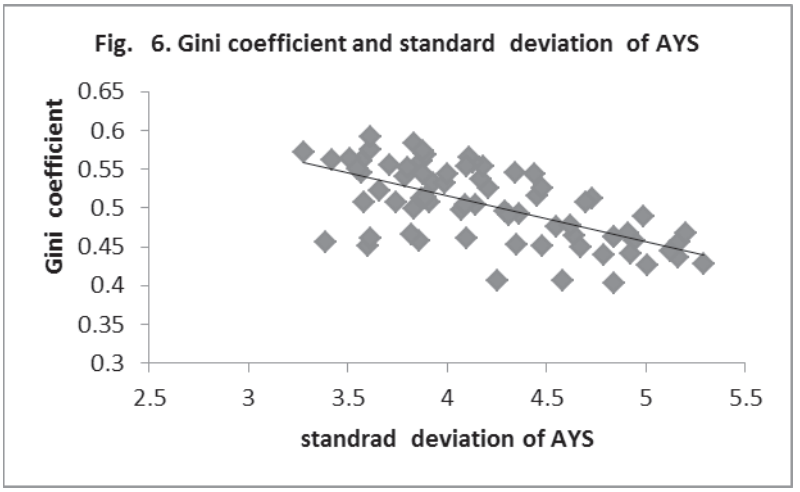
Here we find inverse relationship between average years of schooling and Education Gini. Similar relationships have been found in several other studies (Thomas et al. 2001, Digdowiseiso, 2010).This implies that the populations with higher average years of schooling are most likely to achieve a more equitable

education than those with a lower average years of schooling. This is similar to the finding in Castelló and Doménech (2002), who show a negative relationship between average education levels and human capital inequality for a wide group of countries using the Barro-Lee dataset (Barro and Lee, 2001). Figure 5.



Gini and Standard deviation of AYS

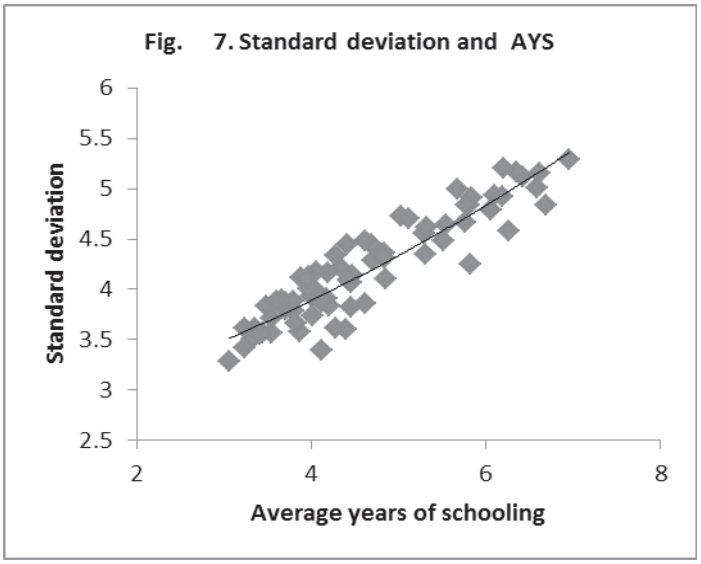
The nature of relationship between Education Gini Coefficient and standard deviation of average years of schooling is also found to be inverse. Logically, if there is any improvement on Gini coefficient of education, education inequality will increase represented by the increasing in standard deviations of schooling. Of course, it is very contrast to the principle of equality distribution of education.



Intuitively, the standard deviation of schooling seems to be a more volatile, and sometimes misleading, indicator. It does not provide a consistent picture of whether the distribution of education in a country is improving or not. Therefore, standard deviation of schooling is not appropriate measure to describe educational equality (Thomas et al, 2001). Figure 6.

Relationship between AYS and Standard Deviation of Schooling. Education Kuznets Curve

The relationship between average years of schooling and standard deviation AYS has been found to be positive. Empirical findings in national and cross country analysis indicates that at the early stage of educational attainment the standard deviation of attainment increases with the increase in average attainment. But once the average attainment reaches a certain level, e.g. 7 years or so the standard deviation shall start decreasing suggesting a kind of relationship known as education Kuznets curve. Our study finds average years of educational attainment of 4.34 years for Bangladesh in 2011, so our inequality in education is expected to increase in some more coming years when we shall have a higher value of average years of attainment and experience a decline in the standard deviation of the average educational attainment. Table 5 and Figure 7.



An inverted U-shape for the relationship between the standard deviation of schooling and the average years of schooling are reported in cross country studies (Ram, 1990; Thomas, Wang and Fan, 2000).

Poverty and Education Gini

The incidence of poverty(Head count rate: HCR) according to lower poverty line and Education Gini ratio according to administrative divisions and rural and urban breakdown are presented in table 6 and Figures 8 and 9. The estimates of HCR in 2010 using the lower poverty line show that Chittagong division has the lowest incidence of poverty of 13.1 percent followed by Khulna division at 15.4 percent and Dhaka division at 15.6 percent. The highest reduction of incidence of poverty using the lower poverty line in 2010 occurred in Khulna division which was 16.2 percentage points followed by Barisal division by 8.9 percentage points relative to 2005. On the other hand, poverty incidence in Sylhet division using the lower poverty line remained almost unchanged in 2010 and 2005 which were 20.7 percent and 20.8 percent respectively.

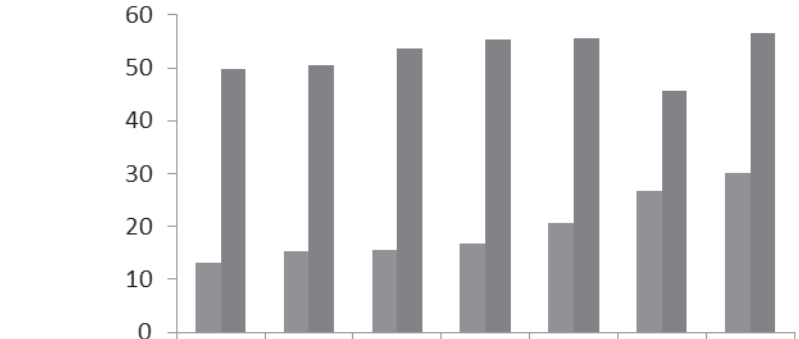
Table 6 .Incidence of Poverty(Head Count Rate) using Lower Poverty Line:HIES 2010

Division	Incidence of Poverty			Education Gini		
	Total	Rural	Urban	Total	Rural	Urban
Total(National)	17.6	21.1	7.7	.5255	.5403	.4578
Barisal	26.7	27.3	24.2	.4572	.4612	.4064
Chittagong	13.1	16.2	4.0	.4981	.5076	.4491
Dhaka	15.6	23.5	3.8	.5258	.5525	.4448
Khulna	15.4	15.2	16.4	.5043	.5136	.4398
Rajshahi	16.8	17.7	13.2	.5531	.5677	.4677
Rangpur	30.1	30.8	24.0	.5658	.5737	.4882
Sylhet	20.7	23.5	5.5	.5548	.5626	.4782

Source: HIES 2010. Author's computation.

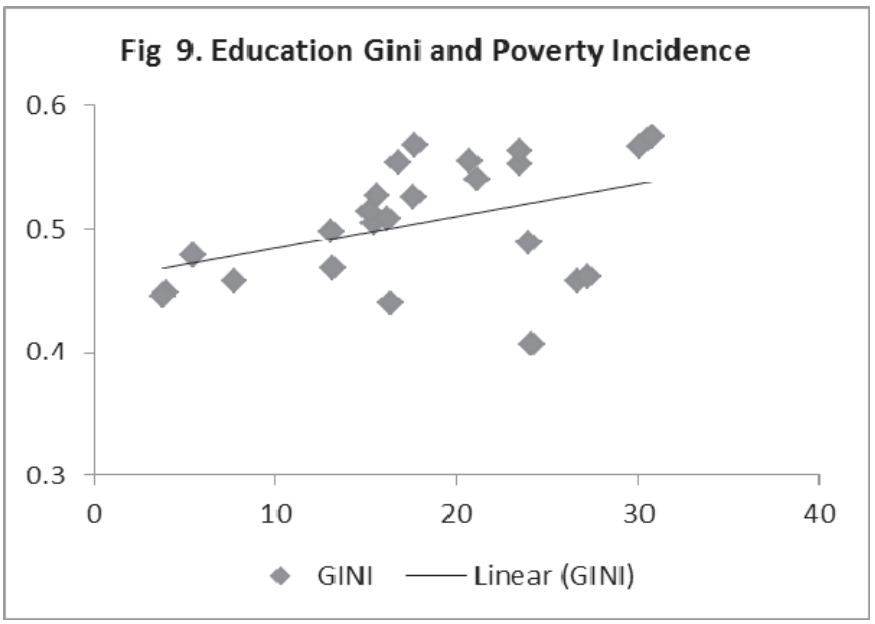
In all the administrative divisions, the value of Gini coefficient increased with the increase in the incidence of poverty except Barisal Division. Figure 9. In Barisal division the value of Gini coefficient was the lowest (0.4572) while the incidence of poverty was quite higher (26.7%). It is worth mentioning here that all the indicators of educational attainment such as literacy rate 7+, adult literacy rate have been found to be higher in Barisal division in comparison to other regions in other studies. The analysis of data points in table 6 yields a positive correlation coefficient between Education Gini and Poverty incidence (r=0.41, P = .048) but was statistically significant only at 10 per cent level.

Fig. 8. Poverty incidence and Gini ratio by divisions.



	Chittagong	Khulna	Dhaka	Rajshahi	Sylhet	Barisal	Rangpur
POVERTY(%)	13.1	15.4	15.6	16.8	20.7	26.7	30.1
GINI(%)	49.8	50.4	53.6	55.3	55.5	45.7	56.6

Fig 9. Education Gini and Poverty Incidence



Conclusions

The findings on gender gap and regional disparities in educational attainments corroborate the similar findings in other developing countries. Lack of

comparable data on educational attainment served as a constrained to make any trend or comparative analysis on the average years of schooling and education Gini ratio. The purpose of the education gini index is to find a new additional indicator to measure the distributional dimension of human capital and welfare that facilitates cross countries comparisons and comparisons over time. Unlike the standard deviation, which had in the past been used as a measure of education inequality, but scarcely used these days due to its tendency to give misleading interpretation of inequality trends, education gini index reflects a more effective indicator for measuring the improvement in the equality of education across countries and over time. Together with other stock and quality variables they can give a better and complete picture on the educational development of a country and provide a better basis for developing better education programmes for targeting at the hitherto deprived.

The prevailing inequality in Bangladesh requires increased public attention and proper policy targeting towards improving educational facilities in rural area and female schooling.

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