Construction of Education Index for the Blocks of Paschim Medinipur District: An Appraisal through the Application of Average Correlation Method

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Abstract

This article is carrying the objective to assess the role of education as a development indicator for all the 29 blocks of undivided Paschim Medinipur district for a selected period of 2005–06 to 2014–15. This purpose is fulfilled through the construction of Education Index (EI) in which the weights of the underlying indicators are determined by the application of Iterative Average Correlation Method (Mondal, Mookherjee & Pattanayek, 2017; International Journal of Management and Development Studies, 6[10], 28–36). The EI, thus constructed, is observed to have data-driven weights of 35.35% for gross enrolment index (GEI) and 64.65% for adult literacy index (ALI). Moreover, this EI is experiencing high inter-block and high inter-temporal variations for the said period. These variationsare explained by some of the selected factors of educational attainment, namely, Population Growth Rate (PGR), Non-Agricultural Labour Ratio (NAGL), Scheduled Caste Scheduled Tribe Ratio (SCSTR), Poverty Ratio (POVR) and Pupil Teacher Ratio (PTR) by applying fixed effect model and random effect model in the panel data framework and by applying pooled data model to obtain their relative statistical importance on the basis of their ortho-partial correlation (Mondal, 2008; Communication in Statistics—Simulation and Computation, 37[4], 713–730) and average correlation values. From the pooled regression results, it appears that the SCSTR is the most important factor with the relative importance of 0.3336 out of 0.7888.

Keywords: *Education index, iterative average correlation method, ortho-partial correlation, averagecorrelation, relative importance*

1. Introduction

Education is considered as one of the fundamental indicators of social development as well as human development for a society. It is treated as a crucial factor in determining the level of social development of a region directly and the level of economic development of the region indirectly. Education development being multi-faceted and is to build human capabilities and to enlarge human opportunities. It helps the human beings achieving one of the most important aspects of human life, i.e., human skill and

importing knowledge. It not only imparts knowledge and skills that enable individuals to raise economic productivity but also furnishes values, ideas, attitudes and aspirations which act as the agents of economic and social change. In the present day context, education is perhaps the single most important means for individuals to improve personal skills, capacity building, overcome constraints and in the process, widen their existing set of opportunities and options for improving their standards of living.

Accomplishing education in each and every field of success, a trial is being given to construct Education Index (EI) for the blocks of Paschim Medinipur District (West Bengal, India) during the period 2005-06 to 2014-15.The index can be reflected by a number of partial achievements and ends like enrolment ratio, drop-out rate (inversely), literacy rate, adult literacy rate, female literacy rate, literacy rate of weaker sections etc. and a number of accomplishments like availability and access to schools, pupil teacher ratio, teacher-school ratio, student school ratio, student classroom ratio, proportion of professionally qualified teachers, male female teacher ratio along with availability of basic amenities or infrastructures like classrooms, safe drinking water facility, proper sanitation facility, playground, library, computers etc.

Keeping in mind the above mentioned issues and facilities, two reliable and available indicators had been used by UNDP in its Human Development Report (1995). It had combined - *gross enrollment ratio* (GER) and *adult literacy rate* (ALR) as the two basic dimensions of educational attainment - in the form of education index by assigning arbitrarily (1/3) weight to GER and (2/3) weight to ALR. On the other side, we have witnessed that, Government of India in its Human Development Report of 2001 has given (2/3)weight to *average general literacy rate* (7 years and above) and (1/3) weight to the *intensity of formal education*; whereas in 2011 it has given (2/3) weight to *average general literacy rate* (7 years and above) and (1/3) weight to the *adjusted mean years of schooling*, for calculating EI. In another observation, it was found that, the Government of West Bengal (2004) has assigned (2/3) weight to *general literacy rate* and (1/3) weight to *school enrolment ratio* of the children for the age group 6 to 14 years. Thus, it may be inferred like that, both the Governments of India and West Bengal have put lesser emphasis on the indicators of - intensity of formal education, adjusted mean years of schooling and school enrollment ratio, as the case may be arbitrarily in comparison to general literacy rate. In this article, we have tried to assign non-arbitrary weights to the underlying indicators of the composite EI by applying the relatively new Iterative Average Correlation Method (IACM). For the said purpose, we have selected two indicators - the *gross enrollment ratio* (GER) for the age-group of 5 to 14 years and the *adult literacy rate* (ALR) for the age group of 15 years and above, which is seemingly demonstrating education. One may consider the indicators like *mean years of schooling* (MYS) and *expected years of schooling* (EYS) as better demonstrators of educational attainment in an area, but due to unavailability of adequate data on MYS and EYS, we are compelled to contemplate on GER and ALR. Later, high inter-block and inter-

temporal variations are observed in our computed EI for the blocks. However, these variations can very well be explained by a number of factors in both pooled and panel data frameworks and that part is also attempted in this work.

2. A Brief Review of Concepts and Methodologies applied so far

The Concept of Education Index (EI): The United Nations Development Programme (UNDP), in its Human Development Reports (HDRs), has introduced the concept of Education Index (EI) as an integral part of Human Development Index (HDI) to evaluate the level of educational attainment of different countries since 1990. In its first report (1990), *adult literacy* was the only chosen variable in educational attainment. In 1991, the *mean years of schooling* (MYS) was added as a second component with (1/3) weight leaving (2/3) weight for *adult literacy* (ALR). During 1995 to 2009, the MYS of the children from 6-14 years was replaced by *gross enrollment ratio* (GER) in primary, secondary and tertiary sectors of formal education. The EI, this time, was constructed as a weighted average of GER and ALR with respective weights of (1/3) and (2/3), which were put forward by subjective value judgment. Since 2010, the ALR was replaced by MYS and GER by expected years of schooling (EYS). During 2010 to 2013, the UNDP used Geometric Mean (GM) as the aggregation method in both HDI constructionand EI computation. However, since 2014, though GM is used as the aggregation method in HDI, a simple arithmetic mean (AM) of MYS and EYS is used in the construction of EI.

The Concept of Educational Development Index (EDI): The UNESCO has developed 'Education for All' Development Index (EDI) in order to scrutinize each country's progress over time with regards to the EFA's goals set in the Dakar Framework for action since 2000. The composite EDI measures four of the six EFA goals, selected on the basis of data availability which are identified by using a specific indicator, and then each component is assigned to an equal weight in the overall index. Thus, EDI for a given country is estimated by taking the arithmetic mean of the four indicators such as (i) total primary net enrollment ratio, (ii) adult literacy rate, (iii) survival rate to Grade V and (iv) the average of three gender parity index for primary education, secondary education and adult literacy. In India, since 2005-2006 and onwards The National University of Educational Planning and Administration (NUEPA), New Delhi, with the concern of District Information System for Education (DISE) for the Government of India (MHRD, Department of School Education and Literacy) have introduced and calculated a composite Educational Development Index (EDI) across the states and districts separately for primary and upper-primary levels of education and also emancipated a composite index for the entire elementary education system. The NUEPA supports a composite Educational Development Index (EDI) which is nothing but a combination of Access Index (AI), Infrastructure Index (II), Teacher's Index (TI) and Outcome Index (OI)) across the states and districts. The AI is further sectioned into (i) Percentage of Habitations not served, (ii) Number of Schools per 1000 Population and (iii) Ratio of

Primary to Upper Primary Schools/Sections at only Upper Primary level. Secondly, under the II, there are five indicators namely - (i) Average Student Classroom Ratio, (ii) Percentage of Schools with Student Classroom 60 and above, (iii) Percentage of Schools without drinking water facility, (iv) Percentage of Schools with Common Toilet and (v)Percentage of Schools with Girls' Toilet. Thirdly, The TI is comprised of six teacher related indicators-(i) Percentage of Female Teachers, (ii) Average Pupil-Teacher Ratio, (iii)Percentage of Schools with Pupil-Teacher Ratio 60 and above, (iv) Percentage of Single-Teacher Schools where the Number of Students 15 and above, (v) Percentage of Schools with less than 3 Teachers and (vi) Percentage of Teachers without Professional Qualifications. Finally, for OI, there are nine indicators (i) Over All Gross Enrollment Ratio,(ii) GER - Scheduled Caste, (iii) GER - Scheduled Tribe, (iv) Gender Parity Index in Enrollment, (v) Repetition Rate, (vi) Dropout Rate, (vii) Ratio of Exit class over Class I Enrollment (only at primary stage), (viii) Percentage of Enrollment Children Passed, (ix) Percentage of Appeared Children Passed with 60 percent and above marks are also used in outcome component in the EDI. It is important to note that during the time period 2005-06 to 2011-12, NUEPA and MHRD had used 23 indicators and since 2012-13 they have moved to 25 indicators based exclusively on the DISE data by using Principal Component Analysis (PCA) and allocating their respective weights.

3. Objectives of This Study

This particular article intends to address the following objectives:

(a) To identify the actual or proxy indicators (i.e., variables), which are supposed to act as the indicators for Education Dimension in a particular area like a block.
(b) To develop a suitable methodology for constructing anEducation Index (EI)for the blocks of Paschim Medinipur district during the study period 2005-06 to 2014-15.
(c) To examine the trend and pattern of development in education sector across the blocks of the saiddistrict over the mentioned time period.
(d) To perform a *pooled data analysis* in examining the ortho-partial (Mondal, 2008), pseudo-partial (or the 'so called' partial), semi ortho-partial correlation, simple correlation and has finally constructed the average correlation of different factors in explaining the variation in EI across the blocks and over the period, and finally
(e) To apply both *Fixed Effect Model* (FEM) and *Random Effect Model* (REM) in the available panel data and to observe which one fits better to provide results in assessing the role of different factors in explaining inter-block and inter-temporal variations in EI.

4. Data Sources and the Methodologies Applied

i) Data Sources

To prepare this article, we have used secondary data which have been collected from three reliable and authentic sources—Census of India, District Information System for

Education (DISE) and District Statistical Hand Book of Paschim Medinipur district. Census reports have been consulted for the years 1991, 2001 and 2011 (as published by the Director General of Census Commissioner, Ministry of Home Affairs, Government of India - 1991, 2001, 2011). 10 published issues of District Information System for Education (DISE) for the years 2005-06 to 2014-15 and 11 published issues of District Statistical Hand Book of Paschim Medinipur for the years 2005 to 2015 (Government of West Bengal) were also taken care of.

ii) Methodologies—Selection of Area, Period, Variables and their Values

The data, as selected and found, are made compatible for the applicability of Iterative Average CorrelationMethod (IACM) as described in detail in the latter part of this sub-section. We have tried to construct EI for all the 29 blocks of the said district from 2005–06 to 2014–15, thus having 29 × 10 = 290 observations. IACM has been used as a statistical technique for determining actual weights of the selected indicators. The composite EI, as mentioned earlier, is calculated on the basis of two dimensions – the *Gross Enrollment Index (GEI)* and the *Adult Literacy Index (ALI)*.

Absolute enrollment figures given in the DISE data are of no use unless there are sufficient educated children for primary and upper primary levels in different blocks in the relevant years. On the other hand, the Census provides information on general literacy rate. To counter the problem of data inadequacy, in this article, we may very well try to estimate GER and ALR by using both the census data and DISE data. To calculate projected population, we have used the following *log quadratic equation* $\text{Log } Y = a + bt + ct2$, where Y stands for population in a particular block and t stands for time. The parameters a, b and c are calculated by using population of the block for the years 1991, 2001 and 2011. Population of any other required year is then estimated by taking the antilog of the calculated value of $\text{Log } Y$ for corresponding value of t. Gross enrolment ratio is then calculated as the ratio between the enrollment figures obtained from DISE and the projected population in the age group of 5 to 14 years from the Census data. From it is the number of children never attending school is subtracted and subtracted value is subtracted from the projected literates for the said years to arrive at an estimate of adult literates. Adult literacy rate is calculated as the ratio between this and projected population in the age group of 15 years and above. These two rates are combined to make an index and this index can be used to arrive at the Education Index (EI). Later, in both the cases, indexing is done by following the standard principle.

iii) Selection of Goalposts for Indexing

Choice of weights is a crucial problem for the construction of EI as well as for the dimension indices.However, the principle of indexing on the basis of normalized variables is no less important than the problem of selection of weights. Generally, we have two types of indexing methods and both of them suggest that the variables are to be

normalized by either observed goalposts method or by normative goalposts method. In observed method, respective observed maximum and minimum values of the data set for a particular year are considered and used to construct index through standard practice, whereas in normative method, the idealistic maximum and minimum values of a variable are considered as goalposts and in some cases these values are settled as normative maximum at 100 and the normative minimum at 0 (zero). If observed minimum and observed maximum for a particular year are used as goalposts, they are required to be changed when we move from one year to another year. On the other hand, if normative minimum and maximum like 0 and 100 are used, inter-temporal and inter-block comparisons become easily possible. But, in the use of normative minimum and maximum like 0 and 100, the index values are likely to be either over-estimated or under-estimated if the actual values do not lie widely and evenly between 0 and 100. We should search for rational maximum and minimum values which are supposed to be a compromise between the observed extremes and normalized extremes. This is needed because, firstly, we do not properly know whether the changes in the EI values of a block take place because of its improved performance or because of shifting of goalposts. Secondly, since the values of observed maximum and minimum do alter from year to year representing changes in the goalposts themselves, meaningful inter-temporal comparisons are not possible. Thus, fixation of goalposts for the indicators, by using appropriate methodology is very much required to carry out meaningful trend analysis.

To find a way-out for this problem, we have done a backward projection of given data set for 5 years and also a forward projection of same kind to obtain a normative range of both observed minimum value and observed maximum value. Focusing on this reason, we have settled the goalposts of the concerned variables, that minimum value, which is supposed to lie in between the extended range of years, considering backwardly projected 5 years and forwardly projected 5 years from the study period and that maximum value, which is supposed to lie in between the same range as mentioned and those are made fixed for meaningful inter-temporal and inter-block analyses of the EI (Mondal, 2005).

iv) Application of Average Correlation Method

The method of average correlation is used in this article in determining the actual weights of the underlying components of the EI. In fact, this method is used in iteration (i.e., in repetitive manner) to settle for final weights. As mentioned in Mondal, Mookherjee and Pattanayek (2017), we can reiterate that, neither the Equal Weight Principle (EWP) nor the Principal Component Analysis (PCA) satisfies us in determining actual weights as EWP is purely based on subjective value-judgement and PCA is based mainly by taking into consideration the variability of a particular data range, not its actual explanatory power. Moreover, the method of average correlation is also used to determine relative importance of all the chosen independent variables when the analysis is done in pooled data framework.

We know that 'average correlation' of a particular variable (or dimension) is defined as the average value of its all sorts of correlations, that is, its simple correlation, its ortho-partial correlation (Mondal, 2008) and its semi ortho-partial correlation(s), if any. The detailed methodology for understanding average correlation and its significance and necessity are mentioned in the articles authored by Mondal, Mookherjee and Pattanayek (2017) and Mookherjee and Mondal (2019). In brief, it can be uttered that, if the underlying dimension indices are mutually interrelated, then their variances and their pair-wise co-variances must have some effective role in determining their respective weights. If it is assumed that there are three DIs to determine the final index, then among them DI_1 will have higher weight than DI_2, and DI_2 will have higher weight than DI_3if the correlation between DI_1 and DI_2 is greater than that between DI_1 and DI_3, and the correlation between DI_1 and DI_3 is greater than that between DI_2 and DI_3. Larger the difference between these correlations, larger will be the difference of the weights of the dimensions. This weighting principle is based on the assumption that the correlation between any two indices is due to their interdependence and we may not have any specific (and prior) knowledge about the nature of this dependence. Thus, a high degree of correlation between DI_1 and DI_2 is supposed to lead towards higher weights for both of DI_1 and DI_2. To eliminate this problem, simple correlations between the respective dimension indices and the final index cannot be used and the average correlation of them with the final index, as mentioned earlier, can be used to determine their proper weights.

As the final index cannot be calculated unless the weights are determined and as the weights (or the average correlations) cannot be calculated unless the final index is determined, they are to be calculated simultaneously through an iterative process. The process starts with some arbitrarily fixed weights of the individual indices. On the basis of these weights, a final index is determined. In the third step, average correlations of the individual indices with the final index are obtained and these are used as weights to arrive at the new final index. In the next step, we are to have new average correlations and new weights and thereby, another new final index is to be obtained. The process is to be repeated until the values of average correlations do converge to their earlier values and the final weights along with the final development index are to be calculated. All these calculations, in relation to this method proposed, can be obtained only through the application of specific computer programming. We have developed such programming and on the basis of that, we have performed the empirical analysis given below.

v) Selection of Factors Affecting Education Index

To explain the variability of Education Index (EI) over time and across the concerned blocks of Paschim Medinipur District, a number of factors like *demographic structure, employment status of people, social status of the people, economic status of the people and educational infrastructure* in the region are considered. The *demographic structure* has been accounted by Population Growth Rate (PGR), whereas the *employment status of*

the people is to be measured by non-agricultural labourers (NAGL). Moreover, ratio of schedule caste and scheduled tribe population to total population (SCSTR) has been included as an indicator of *social status of people* in the region, Poverty Ratio (POVR) has been included as an indicator for economic status of the people, and finally, Pupil Teacher Ratio (PTR) has been included as a proxy variable of *educational infrastructure* in the region. In this context, we have used the Census data for total population, schedule caste and schedule tribe ratio of the concerned blocks and used DISE data for pupil, teacher etc. The District Statistical Hand Books for BPL household and areas of different blocks etc.

Given the structure of the data, factor analysis is done through multiple regressions, for explaining the variation in EI, both in panel and pooled data frameworks. In factor analysis through multiple regressions, whether that is prepared in panel data framework or in pooled data framework, the importance of explanatory variables taken together is properly expressed by R^2 and the significance is tested by an F-statistic. Significance of the individual variable is tested by t-statistic, though it fails to judge the relative importance of them – it helps having their marginal importance only. In panel data regression we have three types of R^2 – ***overall R^2***, ***within R^2***and ***between R^2***. In pooled regression, on the other hand, we have only an ***overall R^2*** which is very close to the ***overall R^2*** in panel regression. The advantage of pooled regression over panel regression is that the former has a larger degree of freedom. Here we shall perform pooled regression for another reason. In this regression we shall try to evaluate relative importance of individual factors in terms of their simple, partial and ortho-partial correlations with Education Index (EI).

While simple correlation between any factor and the EI measures the degree of linear association (strength and direction) between them, it fails to reflect true importance of the factor because of the overlapping nature of its explanatory power with that of other factors. It also fails to reflect the partial importance or the relative importance of the factor. Partial correlation, on the other hand, is used in existing literature to judge the partial importance of the factor, but in effect, it fails to do so, leading to several confusions. It helps judging only the marginal importance of the factor. Ortho-partial correlation, as introduced by Mondal (Mondal, 2008) gives us the true partial importance or correct partial correlation of the explanatory factor. Ortho-partial correlation of any factor with the EI measures the proportion of variability of EI explained by that part of the explanatory factor which is not linearly explained by other explanatory factors. On the other hand, partial correlation of the factor with EI measures the proportion of variability of that part of EI which is not linearly explained by other explanatory factors explained by that part of the explanatory factor which is not linearly explained by other explanatory factors. Thus, if X_1 and X_2 are two mutually uncorrelated factors of Y and if the squared simple correlation of X_1 with Y is 0.70 and that of X_2 with Y is 0.07, the squared multiple correlations will be 0.77. True partial correlations of these two variables

are 0.70 and 0.07 respectively as are given by their ortho-partial correlations. Partial correlations of these variables, as are used in the existing literature, will be calculated at 0.753 (0.70 out of 0.93) and 0.233 (0.07 out of 0.30), and they fail to reflect their true partial importance. True relative importance of an explanatory variable can be obtained by averaging squared simple correlation and squared ortho-partial correlation in case of two explanatory variables and by averaging squared simple correlation, a series of squared semi ortho-partial correlations and squared ortho-partial correlation in case of more than two explanatory variables with proper choice of weights for them.

Finally, we have used the standard approach of *panel data regression* to explain the role of different factors in explaining (i) between-group or inter-block variations of EI taking all the time periods together, (ii) within-group or inter-temporal variation of the same and finally (iii) the overall variation in EI.

5. Construction of Education Index (EI) by using IACM

We have tried to make a comprehensive evaluation on the nature and variation of attainment of education in 29 blocks of undivided Paschim Medinipur district over the period 2005-06 to 2014-15. The combined Education Index is analyzed with the help of two indicators i.e., Gross Enrolment Index (GEI) and Adult Literacy Index (ALI), in which the respective weights of the dimensions are obtained by applying IACM as 35.35% and 64.65% and by using these weights respective Education Index for the blocks are considered (Ref: Table 3) andthe component of GEI and ALI are presented in Table 1 and Table 2 respectively.

From**Table 1**, it is observed that the rate of growth of GEI for the mentioned period was highest in KharagpurI (17.09) followed by Medinipur (8.96) and GopiballavpurI (8.28), whereas it was lowest in Daspur II (0.17) preceded by Sabong (2.78) and Pingla (3.97). If we compare the GEI indices of different blocks for 2005-06 and 2014-15, we observe very erratic behavior of the indices. Keshpur, which occupied 14th position in 2005-06, had moved to the top in 2014-15 while Mohanpur, which was in the sixth position in 2005-06, had fallen back to the 24thspotin 2014-15. Another noticeable change was that, Daspur-II had fallen to the 28th place in 2014-15 from 3rd in 2005-06 whereas Nayagram had moved to 8th place in 2014-15 from 25th place in 2005-06.

It is inspected from the above analysis that most of the blocks of the district are good performers regarding gross enrolment index and some are not that good. Few blocks have been worsened its condition of education as it is seen that during the study period there is a downward trend in GEI. If we consider the district of Paschim Medinipur as a whole (last row in the table) regarding GEI, we see that, initially at 2005-06, it was 0.567 with an uprising trend till 2007-08 with GEI at 0.602. Later, this value has come down to 0.574 in 2008-09 for certain reasons. However, since then, it again has shown an increasing trend till 2014-15 and finally showing a growth rate of 6.23 as a whole for the entire period. It can therefore be stated that the performance of the district in caring about

enrolment is increasing and we are hopeful that it will bring most positives in that field in coming years.

Table 1: Computation of GEI for 29 blocks of Paschim Medinipur for 2005-06 to 2014-15 withtheir Respective Growth Rates and Levels of Significance

Block	2005 -06	2006 -07	2007 -08	2008 -09	2009 -10	2010 -11	2011 -12	2012 -13	2013 -14	2014 -15	Growth Rate	P-value
Jhargram	0.560	0.560	0.600	0.583	0.894	0.878	0.890	0.893	0.937	0.992	7.27	2.5E-04
Binpur -I	0.540	0.600	0.681	0.609	0.860	0.873	0.879	0.860	0.934	0.972	6.46	1.6E-04
Binpur -II	0.596	0.606	0.632	0.592	0.922	0.943	0.969	0.959	0.959	0.994	6.91	7.4E-04
Jamboni	0.595	0.588	0.619	0.576	0.803	0.809	0.806	0.867	0.942	0.949	6.18	8.0E-05
Nayagram	0.499	0.558	0.620	0.594	0.992	0.941	0.951	0.966	0.959	0.991	8.22	7.7E-04
Sankrail	0.607	0.617	0.670	0.618	0.974	0.980	0.929	0.943	0.945	0.980	6.20	1.8E-03
Gopiballavpur-I	0.513	0.529	0.555	0.560	0.814	0.856	0.841	0.868	0.961	0.997	8.28	3.6E-05
Gopiballavpur-II	0.652	0.660	0.678	0.668	0.837	0.844	0.884	0.854	0.894	0.950	4.55	7.4E-05
Salboni	0.612	0.611	0.635	0.626	0.938	0.949	0.926	0.942	0.996	0.980	6.55	5.9E-04
Keshpur	0.595	0.616	0.615	0.608	1.000	1.000	1.000	1.000	1.000	1.000	7.27	1.5E-03
Garbeta-I	0.524	0.546	0.593	0.628	0.985	1.000	0.977	0.927	0.975	0.985	8.07	1.0E-03
Garbeta-II	0.554	0.586	0.648	0.617	0.841	0.886	0.887	0.872	0.897	0.983	6.53	9.9E-05
Garbeta-III	0.574	0.579	0.608	0.546	0.920	0.967	0.989	0.940	0.992	0.986	7.66	1.3E-03
Medinipur	0.490	0.510	0.533	0.494	0.845	0.864	0.906	0.907	0.920	0.972	8.96	3.5E-04
Debra	0.477	0.449	0.483	0.465	0.733	0.767	0.735	0.730	0.759	0.790	7.09	1.0E-03
Pingla	0.701	0.717	0.748	0.710	0.917	0.930	0.911	0.909	0.945	0.966	3.97	5.3E-04
Keshiary	0.638	0.649	0.695	0.613	1.000	1.000	0.957	0.983	0.998	0.998	6.13	2.3E-03
Dantan-I	0.553	0.526	0.512	0.476	0.857	0.863	0.807	0.808	0.885	0.931	7.40	2.6E-03
Dantan-II	0.580	0.576	0.611	0.561	0.939	0.944	0.875	0.860	0.915	0.959	6.55	2.5E-03
Narayangarh	0.540	0.543	0.567	0.557	0.903	0.911	0.883	0.884	0.916	0.951	7.51	8.2E-04
Mohanpur	0.647	0.640	0.694	0.602	0.821	0.835	0.808	0.777	0.875	0.917	4.11	1.6E-03
Sabong	0.828	0.833	0.811	0.798	1.000	1.000	1.000	0.991	0.993	0.997	2.78	4.0E-03
Kharagpur-I	0.134	0.152	0.195	0.173	0.438	0.462	0.476	0.459	0.506	0.529	17.09	2.8E-04
Kharagpur-II	0.495	0.522	0.578	0.520	0.843	0.865	0.846	0.852	0.882	0.945	7.83	3.9E-04
Chandrakona-I	0.634	0.653	0.628	0.620	0.839	0.839	0.842	0.833	0.931	0.988	5.34	2.1E-04
Chandrakona-II	0.596	0.635	0.648	0.611	0.849	0.881	0.891	0.900	0.968	0.992	6.28	8.3E-05
Ghatal	0.542	0.572	0.568	0.552	0.682	0.689	0.687	0.683	0.748	0.784	4.12	7.5E-05
Daspur-I	0.653	0.657	0.670	0.620	0.757	0.763	0.749	0.738	0.792	0.818	2.66	1.4E-03
Daspur-II	0.688	0.651	0.656	0.621	0.705	0.693	0.666	0.655	0.673	0.677	0.17	7.0E-01
Paschim Medinipur	**0.567**	**0.577**	**0.602**	**0.574**	**0.854**	**0.865**	**0.856**	**0.850**	**0.889**	**0.916**	**6.23**	5.6E-04

Sources: (i) Census of India: 1991, 2001 and 2011.
(ii) Government of India, DISE- 2005-06 to 2014-15.

From**Table 2,** it is observed that the rate of growth of ALI for the mentioned period was highest in Nayagram (16.24) followed by Gopiballavpur I (8.86) and Gopiballavpur II

(7.13), whereas it was lowest in Kharagpur I (-1.70) preceded by Daspur II (1.60) and Debra (2.20).

Table 2: Computation of ALI for 29 blocks of PaschimMedinipur for 2005-06 to 2014-15 withtheir Respective Growth Rates and Levels of Significance

Block	2005 -06	2006 -07	2007 -08	2008 -09	2009 -10	2010 -11	2011 -12	2012 -13	2013 -14	2014 -15	Growt h Rate	P-value
Jhargram	0.361	0.388	0.414	0.426	0.447	0.487	0.512	0.516	0.525	0.530	4.41	1.7E-06
Binpur -I	0.290	0.278	0.281	0.304	0.336	0.336	0.341	0.309	0.354	0.369	2.83	1.4E-03
Binpur -II	0.266	0.291	0.306	0.336	0.350	0.375	0.398	0.414	0.424	0.442	5.63	5.8E-08
Jamboni	0.281	0.304	0.311	0.322	0.358	0.362	0.378	0.447	0.423	0.443	5.28	1.6E-06
Nayagram	0.084	0.078	0.073	0.122	0.179	0.183	0.217	0.230	0.255	0.286	16.24	2.4E-05
Sankrail	0.334	0.357	0.356	0.372	0.426	0.444	0.469	0.485	0.510	0.522	5.34	2.2E-07
Gopiballavpur-I	0.142	0.164	0.180	0.209	0.220	0.236	0.257	0.282	0.301	0.324	8.86	1.2E-08
Gopiballavpur-II	0.239	0.265	0.287	0.304	0.320	0.336	0.362	0.403	0.436	0.466	7.13	1.1E-09
Salboni	0.367	0.403	0.422	0.460	0.486	0.493	0.516	0.418	0.549	0.588	4.09	2.6E-03
Keshpur	0.378	0.402	0.443	0.489	0.512	0.524	0.550	0.522	0.607	0.638	5.34	6.5E-06
Garbeta-I	0.411	0.427	0.430	0.438	0.486	0.506	0.526	0.512	0.566	0.611	4.24	2.2E-06
Garbeta-II	0.431	0.444	0.464	0.470	0.502	0.519	0.538	0.516	0.550	0.557	2.90	4.0E-06
Garbeta-III	0.339	0.365	0.377	0.396	0.461	0.477	0.509	0.505	0.525	0.551	5.55	1.4E-06
Medinipur	0.270	0.291	0.310	0.342	0.370	0.374	0.415	0.427	0.458	0.471	6.28	1.6E-08
Debra	0.718	0.761	0.766	0.803	0.824	0.838	0.840	0.779	0.899	0.920	2.20	1.1E-03
Pingla	0.707	0.714	0.735	0.748	0.765	0.797	0.820	0.832	0.873	0.896	2.71	8.7E-09
Keshiary	0.389	0.417	0.426	0.515	0.286	0.366	0.460	0.500	0.549	0.606	4.01	9.6E-02
Dantan-I	0.372	0.416	0.428	0.455	0.491	0.505	0.529	0.475	0.560	0.590	4.38	6.0E-05
Dantan-II	0.609	0.642	0.653	0.669	0.736	0.756	0.768	0.727	0.828	0.839	3.42	1.9E-05
Narayangarh	0.536	0.559	0.570	0.606	0.686	0.724	0.759	0.755	0.789	0.789	4.87	5.0E-06
Mohanpur	0.603	0.629	0.641	0.669	0.713	0.731	0.746	0.763	0.766	0.773	2.94	2.7E-06
Sabong	0.634	0.661	0.705	0.718	0.755	0.770	0.786	0.766	0.800	0.833	2.72	1.3E-05
Kharagpur-I	0.864	0.780	0.637	0.548	0.586	0.612	0.639	0.612	0.667	0.690	-1.70	2.8E-01
Kharagpur-II	0.471	0.482	0.485	0.493	0.538	0.543	0.546	0.513	0.594	0.638	2.90	4.0E-04
Chandrakona-I	0.511	0.529	0.576	0.612	0.617	0.629	0.640	0.633	0.672	0.711	3.20	1.9E-05
Chandrakona-II	0.359	0.371	0.404	0.421	0.456	0.471	0.477	0.538	0.575	0.639	6.12	7.6E-08
Ghatal	0.660	0.665	0.691	0.725	0.747	0.768	0.769	0.746	0.812	0.820	2.39	2.0E-05
Daspur-I	0.652	0.679	0.702	0.714	0.741	0.747	0.790	0.831	0.841	0.867	3.17	8.1E-09
Daspur-II	0.779	0.824	0.838	0.876	0.843	0.864	0.892	0.909	0.910	0.917	1.60	9.0E-05
Paschim Medinipur	**0.484**	**0.501**	**0.511**	**0.533**	**0.558**	**0.577**	**0.600**	**0.592**	**0.640**	**0.664**	**3.45**	3.3E-08

Source: (i) Census of India:1991, 2001 and 2011.
(ii) Government of India, DISE- 2005-06 to 2014-15.

If we compare the ALI values of different blocks for 2005-06 and 2014-15 we do observe

an abnormal behavior. Debra, which was 3rd in 2005-06 with ALI (0.718), had moved to the top in 2014-15 with ALI (0.920) while Kharagpur-I which occupied the 1st position in 2005-06 with ALI (0.864), had slipped to 11th in 2014-15 with ALI (0.638). Chandrakona-II had improved its position to 12th(in 2014-15) from 20th in 2005-06, while Binpur-I had moved down to 27th in 2014-15 from its 23rd in 2005-06. One thing is to be noted that Nayagram and Gopivallabpur-I blocks did not show major changes in their relative positions in between 2005-06 and 2014-15 though adult literacy rates had increased in these blocks over the time.

If we consider the district of Paschim Medinipur as a whole (as shown in the last row of Table 2) regarding ALI, we see that, initially at 2005-06, it was 0.484 with an uprising trend till 2011-12 with ALI at 0.600. Later, it has come down to 0.592 in 2012-13 for certain reasons. However, since then, it again has shown an increasing trend till 2014-15 with an ALI value of 0.664 and an over-all growth rate of 3.45 for the entire period. It can therefore be stated that the performance of the district is satisfactory and we are hopeful that this increasing trend will continue.

Finally, analyzing **Table 3**, we may state that the rate of growth of composite Education Index (EI)for the mentioned period was found highest in Nayagram (10.34) followed by Gopiballavpur I (8.48) and Medinipur (7.64), whereas it was found lowest in Daspur II (1.17) preceded by Kharagpur I (1.71) and Sabong (2.74).

Table 3:Computation of EI, by using IACM, for 29 blocks of Paschim Medinipur for 2005-06 to 2014-15 withtheir Respective Growth Rates and Levels of Significance

Block	2005 -06	2006 -07	2007 -08	2008 -09	2009 -10	2010 -11	2011 -12	2012 -13	2013 -14	2014 -15	Growth Rate	P-value
Jhargram	0.431	0.449	0.480	0.481	0.605	0.625	0.646	0.649	0.671	0.693	5.76	2.0E-05
Binpur -I	0.378	0.392	0.422	0.412	0.521	0.526	0.531	0.504	0.559	0.582	4.86	9.9E-05
Binpur -II	0.383	0.402	0.421	0.426	0.552	0.576	0.600	0.607	0.613	0.637	6.32	3.4E-05
Jamboni	0.392	0.404	0.420	0.412	0.515	0.520	0.529	0.595	0.606	0.622	5.76	4.8E-06
Nayagram	0.231	0.248	0.266	0.289	0.466	0.451	0.476	0.490	0.504	0.535	10.34	9.0E-05
Sankrail	0.430	0.449	0.467	0.459	0.620	0.633	0.632	0.647	0.664	0.684	5.77	1.2E-04
Gopiballavpur-I	0.273	0.293	0.313	0.333	0.430	0.455	0.463	0.489	0.534	0.562	8.48	1.0E-06
Gopiballavpur-II	0.385	0.405	0.425	0.433	0.503	0.516	0.547	0.562	0.598	0.637	5.69	3.5E-08
Salboni	0.454	0.477	0.497	0.519	0.646	0.654	0.661	0.603	0.707	0.727	5.28	1.3E-04
Keshpur	0.455	0.478	0.504	0.531	0.684	0.692	0.709	0.691	0.746	0.766	6.23	5.0E-05
Garbeta-I	0.451	0.469	0.488	0.505	0.662	0.681	0.685	0.659	0.711	0.743	5.97	1.0E-04
Garbeta-II	0.474	0.494	0.529	0.522	0.622	0.649	0.661	0.642	0.673	0.708	4.53	2.7E-05
Garbeta-III	0.422	0.441	0.459	0.449	0.623	0.650	0.679	0.659	0.690	0.705	6.57	1.4E-04
Medinipur	0.348	0.368	0.389	0.396	0.538	0.547	0.589	0.597	0.621	0.648	7.64	1.4E-05
Debra	0.633	0.651	0.666	0.684	0.792	0.813	0.803	0.762	0.850	0.874	3.61	1.1E-04
Pingla	0.705	0.715	0.740	0.735	0.819	0.844	0.852	0.859	0.898	0.921	3.17	2.0E-06
Keshiary	0.477	0.499	0.521	0.550	0.538	0.590	0.636	0.671	0.708	0.745	5.00	9.8E-08

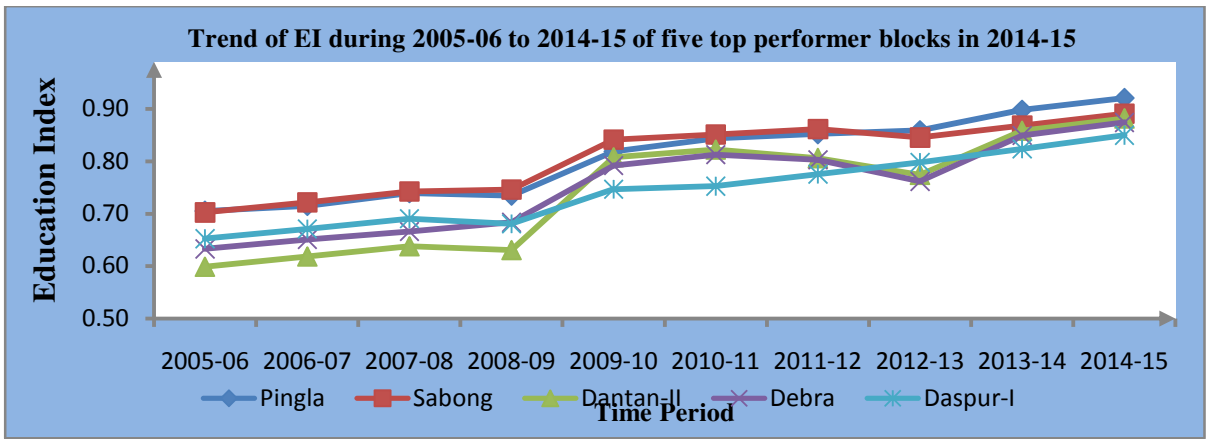
Dantan-I	0.436	0.455	0.458	0.462	0.620	0.632	0.627	0.593	0.675	0.711	5.69	1.7E-04
Dantan-II	0.599	0.619	0.638	0.631	0.808	0.822	0.806	0.774	0.859	0.881	4.54	2.4E-04
Narayangarh	0.537	0.553	0.569	0.589	0.763	0.790	0.803	0.801	0.834	0.846	5.84	8.5E-05
Mohanpur	0.619	0.633	0.660	0.645	0.751	0.768	0.768	0.768	0.805	0.824	3.37	2.7E-05
Sabong	0.703	0.722	0.742	0.746	0.842	0.851	0.862	0.846	0.868	0.891	2.74	7.0E-05
Kharagpur-I	0.606	0.558	0.481	0.415	0.534	0.559	0.581	0.558	0.610	0.633	1.71	2.4E-01
Kharagpur-II	0.479	0.496	0.518	0.503	0.646	0.657	0.652	0.633	0.696	0.747	4.94	8.8E-05
Chandrakona-I	0.554	0.573	0.594	0.615	0.695	0.703	0.711	0.704	0.764	0.809	4.06	2.8E-06
Chandrakona-II	0.443	0.464	0.490	0.488	0.595	0.616	0.623	0.666	0.714	0.764	6.19	3.7E-07
Ghatal	0.618	0.632	0.648	0.664	0.724	0.740	0.740	0.724	0.789	0.807	2.95	8.0E-06
Daspur-I	0.652	0.671	0.691	0.681	0.747	0.753	0.776	0.798	0.824	0.850	2.99	2.0E-07
Daspur-II	0.747	0.763	0.774	0.786	0.794	0.804	0.812	0.819	0.826	0.832	1.17	6.4E-08
Paschim Medinipur	**0.513**	**0.528**	**0.543**	**0.547**	**0.663**	**0.679**	**0.690**	**0.683**	**0.728**	**0.753**	**4.59**	**1.8E-05**

Source: (i) Census of India: 1991, 2001 and 2011.
(ii) Government of India, DISE- 2005-06 to 2014-15.

The EI values for the blocks lead us to state that Kharagpur-I had relegated from 8th place in 2005-06 to 25th in 2014-15. Ghatal block also suffered this time as it moved from 7th in 2005-06 to 10th in 2014-15. Jhargram maintained the similar 20th position during the entire period of 2005-06 to 2014-15. The average Education Index (EI) of Paschim Medinipur district (except the municipal areas), is obtained as 0.636 implying rural area of the district has achieved 63.6% success in educational attainment, with a growth rate of meager 4.59.

From the block-level analysis of EI and its components, GEI and ALI, it is clear that though some blocks have shown high values in enrollment and literacy, some are lagging behind. It is also evaluated that, most of the blocks had increased the value of EI over time and also the district average, which is shown in the last row of the table 3. As for example, it can be observed that, in 2005-06, the EI for the district as a whole was 0.513, it increased to 0.528 in 2006-07, to 0.543 in 2007-08 and so on, which indicate a progress towards achievement of better attainment of education for the district concerned over the study period.

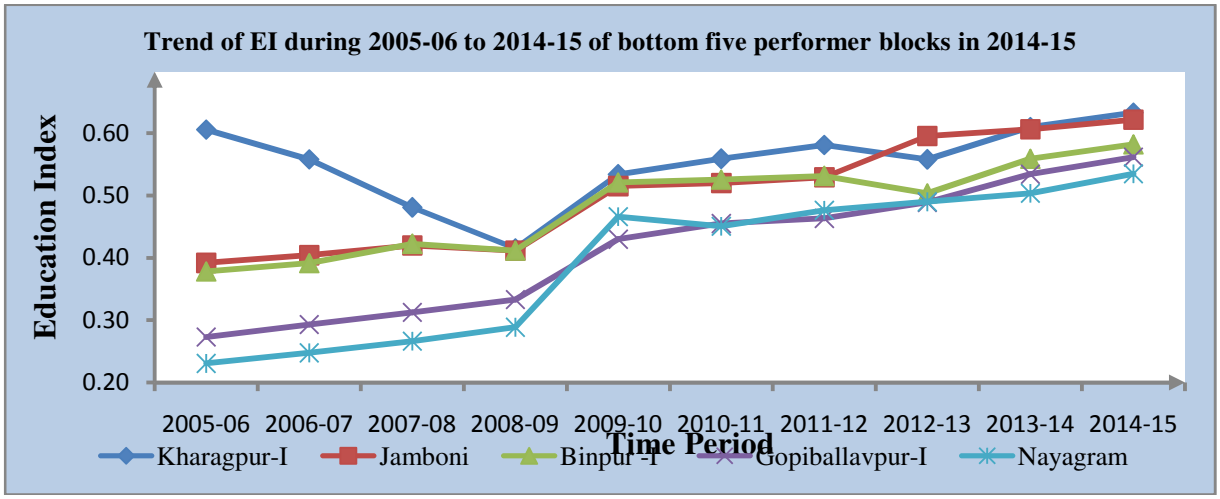
Figure 1: Trend of EI during 2005–06 to 2014–15 of Top Five Performer Blocks in 2014–15



Source: Authors' own calculation.

In Figure1, the trend of EI of top five performers in 2014-15 with reference to the period 2005-06 to 2014-15 has been highlighted. The trend shows that the five top performers are Pingla, Sabong, Dantan-II, Debra and Daspur-I which are upward rising. Some intersections are also witnessed throughout this period.

Figure 2: Trend of EI during 2005–06 to 2014–15 of Bottom Five performer blocks in 2014–15



Source: Authors' own calculation.

In Figure 2, the trends of bottom five performer blocks in EI with reference to the period 2005-06 to 2014-15 are shown. The trend shows that the five bottom performers are Nayagram, Gopiballavpur-I, Binpur-I, Jamboni and Kharagpur-I, amongst which high

fluctuations in trend was observed for Kharagpur I. KharagpurI was highly placed (rank 8th) with EI value 0.606 in 2005-06, but came down to 0.558 in 2006-07, to 0.481 in 2007-08 and to 0.415 in 2008-09 in an unlikely consistent manner due to some reasons. Later, from 2009-10, it has started to rise again for relatively higher EI values.

6. Factor Analysis of Education Index by Pooled Data and Panel Data:
Factors seemingly affecting the Educational Status

Educational status of a region, as given by Education Index (EI), depends on a number of factors that represent the socio-economic status of the region, block or a district or a state or a country. The factors may be classified under the following the broad headings elaborated precisely.

(i) Demographic Structure, measured through Population Growth Rate (PGR):

Demographic structure of any region is one of the basic elements that determine the level of attainment of education of its population. Demographic structure includes the age distribution of the population, family size, population growth rate, etc. Here we consider population growth rate as a factor affecting educational status. Rapid increase in population growth reduces the extent of education that children receive. Kuznets (1973) argued that this negative impact is more acute in less-developed countries (LDCs). The overall impact of fast population growth affects education adversely as Government is not able to provide education fairly to large extent of population. Thus, it can be hypothesized that *population growth rate* (PGR) has a negative impact upon Education Index (EI).

(ii) Preference regarding Employment, measured through Non-Agricultural Labour Ratio (NAGL)

Employment status of an economy shows interacted effects of education on the economy. It further reflects the light towards non-agricultural workers & work participation rate, etc. Non-Agricultural Labour represents that working population which basically constitutes industrial workers and others (pursuing service sector). These kinds of workers probably earn money in a greater amount than the agricultural labourers. It emphasizes the fact that,a person's earning is related to education andone of such kind is able to spend more for the betterment of their children.Hence, we can hypothesize that there is a positive relationship between *Non Agricultural Labourers* (NAGL) and Education Index (EI).

(iii) Social status of the people, measured through Scheduled Caste and Scheduled Tribe Ratio(SCSTR)

Social status is the position or rank of a person or group within the society. Status can be determined in two ways. One can earn their social status by their own achievements

which are known as achieved status. Alternatively, one can be placed in the stratification system by their inherited position, which is called ascribed status. Historically, Scheduled Caste and Scheduled Tribes (SCST) are economically backward, mostly very poor, concentrated in low-skill occupations and primarily rural. These kind of people are likely to have less human and physical capital than other people; it is also the fact that SCST people earn very low amount of money and that is why they largely fail to invest money for educational and other purposes. The educational attainment of the SCST people is found to be less as compared to the people of the other category because of their lower asset endowment. Though it is noticed that SC and ST does not invest much in their educational qualification but it is found that the block wise variation in terms of SCST categories and their literacy rate are relatively high as compared to the other categories in this district. This inspires us to consider the SCST people separately in this study.Here we hypothesize a negative relationship between the *ratio of SCST people* (SCSTR) and attainment in education (EI).

(iv) Economic Status of the people, measured through Poverty Ratio (POVR):

Economic status is the financial standard of an individual to nourish their perpetual basic needs that leads to a descent life. It further uplifts social prestige to make a stand in society in sophisticated manner. Poverty can be defined as the scarcity or the state of an individual which lacks a certain amount of material possessions or money to satisfy their basic and facilitated necessities. The *poverty ratio* enunciates the number of household whose income falls below the poverty line to the total number of household. The poverty ratio (based on the Monthly Per Capita Expenditure (MPCE) of Rupees 816 for rural areas and Rupees 1000 for urban areas in 2011-2012 at all India level), has declined from 37.2 per cent in 2004-2005 to 21.9 per cent in 2011-2012. Further, the low income group cannot expend more for their children's education which forces them to become child labour. As a result, in future, they are to belong to the group of illiterates affecting educational status negatively.

(v) Educational Infrastructure, measured through Pupil Teacher Ratio (PTR):

Educational infrastructure is considered as one of the influencing conditions of education and it affects the society deeply. It is related to number of schools, the proportion of pupil teacher ratio,student school ratio, student classroom ratio, proportion of professionally qualified teachers, male-female teacher ratio etc. and availability of basic amenities or infrastructures like classrooms, safe drinking water facility, proper toilet facilities for both boys and girls, ramp, kitchen-shed, library, computers, play-grounds etc. Here we may consider *pupil teacher ratio* (PTR) as an important factor among all the others. Pupil teacher ratio refers to the number of pupils who attend a school (primary or upper-primary) divided by the number of teachers in any educational institution. If number of students is relatively with inadequate number of teachers then proper guidance cannot be

imparted. As a result, a negative impact can be spread upon leading ourselves to hypothesize a negativity of pupil teacher ratio (PTR) on Education Index (EI).

Empirical Methodology

Now we shall examine the impact of Population Growth Rate (PGR), Non-Agricultural Labour Ratio (NAGL), Scheduled Caste Scheduled Tribe Ratio (SCSTR), Poverty Ratio (POVR) and Pupil Teacher Ratio (PTR) on Education Index (EI) for the blocks of Paschim Medinipur District in West Bengal, India for the period 2005-06 to 2014-15. We do consider 'ordinary least squares(OLS)' specifications and try to estimate the simple, partial, ortho-partial and relative importance of different determining factors of Education Index (EI).

Thus, our empirical specification can look like

$$Y=\alpha+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\varepsilon_i$$

Where, Y stands for the Education Index (EI), $X_1$is Population Growth Rate (PGR), X_2 is Non-Agricultural Labour Ratio, X_3 is Scheduled Caste Scheduled Tribe Ratio (SCSTR), X_4 is Poverty Ratio(POVR) and X_5 is Pupil Teacher Ratio (PTR). α is the intercept parameter and ε_i is the disturbance term. The coefficient of X_i, denoted by β_i, measures the amount of change in Y for one unit change in X_i, the values of all other explanatory variables remaining constant; the coefficient is thus known as the *partial regression coefficient*.

Results of Pooled Data Analysis: Relative Importance of Explanatory Factors

Table 4 shows the results of pooled regression of Y (EI) on X_1 (PGR), X_2 (NAGL), X_3 (SCSTR), X_4 (POVR) and X_5 (PTR).We observe that the coefficient of determination, i.e., R^2 is 0.7888, which is statistically significant (level of significance 1.15E-93). Here coefficients of all five factors, viz., PGR, NAGL, SCSTR, POVR and PTR are statistically significant as are found from their t-values and p-values obtained from multiple regression. PGR, SCSTR, POVR and PTR are inversely related to EI while NAGL is directly related to EI. These t-values indicate squared correlations of the factors with EI ($r^2 = t^2/(t^2 +$ degree of freedom)) and in the existing literature they are known as partial correlation of the explanatory factors.

Here we observe that SCSTR is the most significant factor which explains partially 57.52% of the variability of Y, followed by PTR which explains about 43.57% of the variability of Y. NAGL is the third significant variable which explains about 10.74% of the variability of Y. POVR is the fourth significant variable which explains about 1.35 % of the variability of Y. PGR is the least significant variable and it explains about 1.08 % of the variability of Y. However, these are not true partial correlations as explained by Mondal (Mondal, 2008). For example, the partial correlation of SCSTR is 0.5752 which implies that that part of SCSTR which is not linearly explained by other four factors is able to explain 57. 52 % of the variability of that part of EI which is not linearly

explained by those other four factors. Here, other four factors explain 50.29 % of the variability of EI. Therefore, that part of SCSTR which is not linearly explained by other four factors is able to explain 28.59% (78.88 % - 50.29 %) of the variability of EI which is 57.52 % of 49.71% (=100% - 50.29%), the part of EI which is not linearly explained by other four factors. Thus, SCSTR is partially explaining 28.59% of the variability of EI or 57.52% of the variability of that part of EI which is not linearly explained by other four factors and this 28.59% is its true partial correlation named as ortho-partial correlation by Mondal (Mondal, 2008). Thus, partial correlation (henceforth, we shall call it pseudo partial correlation) of any variable actually overestimates true partial correlation or ortho-partial correlation of the variable. Ortho-partial correlations of other four factors, i.e., X_1, X_2, X_4 and X_5 are 0.0023, 0.0254, 0.0029 and 0.1630 respectively (these are actually values of r-square (i) in the regression of Y on the residue of X_1 obtained from the regression of X_1on X_2, X_3,X_4 and X_5; (ii) in the regression of Y on the residue of X_2obtained from the regression of X_2on X_1,X_3,X_4 and X_5; (iii) in the regression of Y on the residue of X_4obtained from the regression of X_4on X_1,X_2,X_3 and $X_5$and (iv) in the regression of Y on the residue of X_5obtained from the regression of X_5on X_1,X_2,X_3 and X_4 respectively).

Ortho-partial correlations differ from their respective simple correlation due to overlapping nature among the variables or due to multi-collinearity. In our case we observe that for variables X_1 (PGR), X_2 (NAGL), X_3 (SCSTR), X_4 (POVR) and X_5 (PTR) simple correlations are greater than ortho-partial correlations. This is due to multi-collinearity with no enhancement-synergism or due to positive overlapping. For all five variables ortho-partial correlations underestimate whereas simple correlations overestimate the relative importance of the variables. Thus, neither the simple correlations nor the ortho-partial correlations can properly estimate the relative importance of the explanatory factors. Partial correlations are always greater than ortho-partial correlations, so they overestimate the true partial correlations and may either underestimate or truly estimate or overestimate the relative importance of the explanatory factors. Several attempts are made in the literature to evaluate relative importance of the explanatory factors. We, in reference to one such attempt, shall try to evaluate the relative importance of explanatory factors explaining the variability of EI.

Relative Importance (Average Squared Correlation) of Explanatory Factors

True relative importance of an explanatory variable can be obtained by averaging squared simple correlation and squared ortho-partial correlation in case of two explanatory variables and by averaging squared simple correlation, a series of squared semi ortho-partial correlations and squared ortho-partial correlation in case of more than two explanatory variables with proper choice of weights for them. This task is equivalent to the decomposition of explained variation of the dependent variable among the relevant explanatory variables. This is the average weights of simple, semi ortho-partial and

ortho-partial (Mondal, 2008) correlations of different explanatory variables. Here we shall apply this methodology to evaluate the relative importance of different explanatory variables. To explain how the method actually works we shall proceed step by step.

In this way, we consider five explanatory factors (PGR, NAGL, CSSTR, POVR & PTR) simultaneously in Table 4 where we articulate that squared simple correlations of PGR (X_1), NAGL (X_2), SCSTR (X_3), POVR (X_4) and PTR (X_5) with EI (Y) are respectively r_1^2 = 0.0178, r_2^2 = 0.3185, r_3^2 = 0.4134, r_4^2=0.2424 and r_5^2=0.2694. NAGL, SCSTR, POVR and PTR are statistically highly significant but PGR is statistically significant at less than 5 percent level. Squared ortho-partial correlations of PGR, NAGL, SCSTR, POVR and PTR with EI (Y) are respectively 0.0023, 0.0254, 0.2859, 0.0029 and 0.1630. NAGL, SCSTR and PTR are statistically significant but PGR and PTR are not.

Table 4: Results from Pooled Regression of EI on Its Determinants

Variable	Coef.	'T' Value	'P' Value	Sq. Partial Correlation	Coef.	'T' Value	'P' Value	Sq. Simple Correlation
PGR	-0.0188	-1.76	7.97E-02	0.0108	-0.0460	-2.28	2.31E-02	0.0178
NAGL	0.0060	5.85	1.38E-08	0.1074	0.0173	11.60	8.55E-26	0.3185
SCSTR	-0.0065	-19.61	9.95E-55	0.5752	-0.0069	-14.25	3.15E-35	0.4134
POVR	-0.0009	-1.97	4.93E-02	0.0135	-0.0067	-9.60	4.15E-19	0.2424
PTR	-0.0057	-14.81	3.73E-37	0.4357	-0.0062	-10.31	2.08E-21	0.2694
R^2	**Adj R^2**	**F-Value**	**P-Value**					
0.7888	0.7851	212	1.15E-93					
Variable	**Coef.**	**'T' Value**	**'P' Value**	**Sq. Orthopartial Correlation**		**Variable**	**Relative Importance**	**'T' Value of Relative Importance**
PGR	-0.0188	-0.81	4.16E-01	**0.0023**		**PGR**	**0.0186**	-2.34
NAGL	0.0060	2.74	6.51E-03	**0.0254**		**NAGL**	**0.1396**	6.83
SCSTR	-0.0065	-10.74	7.54E-23	**0.2859**		**SCSTR**	**0.3336**	-12.01
POVR	-0.0009	-0.92	3.61E-01	**0.0029**		**POVR**	**0.0898**	-5.33
PTR	-0.0057	-7.49	8.48E-13	**0.1630**		**PTR**	**0.2073**	-8.68

Source: Own calculation by statistical techniques

Note: Bold values indicate ortho-partial correlation and relative importance(Average Squared Correlation).

Here we see that the t-values of PGR, SCSTR, POVR and PTR are negative (-ve) in simple, partial and ortho-partial regressions and those for NAGL is positive. Enhancement-synergism is mildly present at some semi ortho-partial level.

As we have already said the relative importance of an explanatory variable lies between the squared ortho-partial correlation and the squared simple correlation, the relative importance of the variable can be calculated by averaging these two through a series of squared semi ortho-partial correlations. For example, for the first variable, i.e., PGR has

the squared ortho-partial correlation of 0.0023 which is less than squared simple correlation of 0.0178; the relative importance of the variable is calculated to be 0.0186 with a significant negative t-value. This is occurs because some semi ortho-partial correlations exceed its simple correlation value.

In fact, relative importance is considered as the real contribution of a particular factor in explaining the dependent variable (i.e., the final index). There might be some sort of overlapping in the values of simple correlation, whereas ortho-partial correlation indicates typical segmented non-overlapping value of a factor, leaving aside the conjoint areas of explanation. Hence, the average of all three forms of correlation (i.e., the simple, the ortho-partial and the semi ortho-partial, if any) is needed for a particular factor to establish its relative importance amongst all in explaining the dependent variable.

In this way relative importance of other four explanatory variables, NAGL, SCSTR, POVR & PTR are calculated at 0.1396, 0.3336, 0.0898 and 0.2073 respectively. Thus the multiple R^2 of 0.7888 that implies an explanatory power of 78.88% is decomposed among the explanatory factors in the following way: 1.86% of the variability of EI is explained by PGR, 13.96% by NAGL, 33.36% by SCSTR, 8.98 % by POVR and 20.73% by PTR and except PGR all of them have t-values statistically significant at less than 1% level of significance. In this connection it can be noted that partial correlations underestimate relative importance of PGR, NAGL and POVR, and overestimate relative importance of SCSTR and PTR.

Even if pooled data analysis is providing satisfactory explanation regarding the behavior of the determining factors of EI, we are also interested in knowing the inter-temporal (i.e., within group) and inter-block (i.e., between groups) variations in EI. As we are enriched with both time series and cross section observations on the variables in our study, we can use the panel data framework to undergo the same and obtain some results.

Results of Panel Data Analysis

In this section we have considered the prominence of the five factors in terms of short panel regressions. We suppress panel data regression to explain the role of different factors in explaining within-group (inter-temporal), between-group (inter-block) variation and also overall variation in EI for all concerned periods taken together. Panel data regressions are very useful in the sense that it encompasses both the time series and cross section data and its underlying heterogeneity helps significantly to understand the nature of the influential factors. This type of regression analysis further simplifies computation and inference, gives more informative data, more sample variability, evaluates the effectiveness, proposes micro foundations for aggregate data analysis, shows less co-linearity among variables, greater capacity for capturing complexity and more efficiency which can profusely detect and measure effects that are not found effectively in pure cross section or pure time series data. The regression model of panel data can be estimated by three fashionable and convenience techniques viz., the random effect model

(REM), the fixed effect model (FEM) and the pooled regression model (OLS). We cannot arbitrarily choose any one technique from these three for estimation. For selecting the best fitted model, we have used two very popular tests viz., the Breusch-Pagan LM test for random effect and the Hausman specification test, in which Breusch-Pagan LM test estimates whether the random effect model is better fitted than pooled regression model or not. If there is a significant χ^2-value of Breusch-Pagan LM test or the P-value of χ^2 is less than a specified level of significance, then random effect model is better fitted than pooled regression model. Hausman specification test also estimates whether fixed effect model is better fitted than random effect model or not. If there is a significant χ^2-value of Hausman specification test or the P-value of χ^2 is less than a specified level of significance, it indicates that there is no systematic difference in coefficients which portfolios that fixed effect model is better fitted than random effect model.

In **Table 5** we present panel data results from the regression of EI on the five variables separately. All these regressions are run under random effect model. Here we observe that SCSTR has highest overall explanatory power (OverallR^2= 0.4134) followed by NAGL (OverallR^2= 0.3185).PTR is the third important factor (Overall R^2= 0.2694). PGR has lowest overall R^2 (0.0178) preceded by POVR (0.2424).

Table 5: Results from Separate Panel Regressions of EI on Its Determinants

EI	Coefficient	S.E.	Z	P>|Z|	Within R^2	Between R^2	Overall R^2
PGR	-0.1307	0.0137	-9.57	0.0000	0.2847	0.1298	0.0178
NAGL	0.0254	0.0019	13.49	0.0000	0.4124	0.3060	0.3185
SCSTR	-0.0083	0.0012	-7.09	0.0000	0.4218	0.6492	0.4134
POVR	-0.0215	0.0010	-21.17	0.0000	0.7270	0.2108	0.2424
PTR	-0.0070	0.0002	-35.13	0.0000	0.8285	0.0748	0.2694

Source: Calculation by the Author by applying statistical package

Here we also analyze that PTR is the most significant factor (Z-value is -35.13) and the second significant factor is POVR (Z-value is -21.17).The third significant factor is NAGL (Z-value is 13.49) followed by PGR (Z-value is -9.57) and the least significant factor is SCSTR (Z-value is -7.09).

When all five variables are considered in short panel regression, it is traditional to run both the FEM and the REM, to test whether they are giving significant fit or not, to test whether they are giving better fit than OLS or not and if all these are satisfied then to test whether REM is significantly giving a better fit than FEM or not. The last test is performed by the Hausman specification test for model selection.

Results for both fixed effect model and random effect model are presented in **Table 6** and **Table 7** respectively for five explanatory variables (i.e., PGR, NAGL, SCSTR, POVR and PTR). From Table 6 it is evaluated that FEM is itself a significant model for explaining the variability of education index (P-value of the F-statistic is close to 0), and FEM carries higher significance over OLS because the P-value of the corresponding F-

statistic is also close to 0. This designates that FEM is better fitted than OLS. We also examine that the overall R^2 is low (0.6670) in comparison to REM and the factor of NAGL is statistically insignificant (level of significance is 18.00 percent).

Table 6: Results from Panel Regression of EI on PGR, NAGL, SCSTR, POVR and PTR for the Blocks of Paschim Medinipur during 2005-06 to 2014-15(Fixed Effect Model)

EI	Coefficient	S.E.	T	P>|t|	Within R^2	Between R^2	Overall R^2
PGR	-0.0201	0.0072	-2.78	0.0060	**0.8582**	**0.6966**	**0.6670**
NAGL	0.0019	0.0014	1.34	0.1800			
SCSTR	-0.0139	0.0046	-3	0.0030			
POVR	-0.0062	0.0015	-4.14	0.0000			
PTR	-0.0047	0.0004	-12.09	0.0000			
FE Model Significance				F(5,256)	309.75	P>F	0.0000
FE Model Significance over OLS				F(28, 256)	25.03	P>F	0.0000

Source: Calculation by the Author by applying statistical package

Table 7 represents that the REM is itself a significant model for explaining variability of education index (P-value of $\chi 2$ is close to 0) and REM carries higher significance over OLS because it's P-value of $\chi 2$ is also close to 0. Finally, from the Hausman specification test, it is found that there is no systematic difference in coefficients which is statistically significant and so the random effect model turns out to be better fitted than the fixed effect model. Hence, we analyze the results of short panel regression under random effect model of Table7. From Table 7 we observe that the overall explanatory power (R^2) of the above mentioned five factors taken together is 76.81 %, within group (here within-block and basically inter-temporal) explanatory power (R^2) is 85.44 % and between groups (here between blocks) explanatory power is 71.31 %. It is observed that PTR is partially the most significant factor (Z-value is -18.34) in explaining the variability of Education Index (EI) followed by SCSTR with Z- value at -7.15. The third partially significant factor is PGR (Z-value is -3.48) followed by POVR (Z-value is -3.06). The least partially significant factor is NAGL (Z-value is 2.19). PGR, SCSTR, POVR and PTR are statistically significant at less than 1% level of significance but NAGL is statistically significant at less than 5% level of significance. It is also observed that EI is negatively associated with PGR, SCSTR, POVR and PTR, whereas it is positively associated with NAGL.

Table 7: Results from Panel Regression of EI on PGR, NAGL, SCSTR, POVR and PTR for the Blocks of Paschim Medinipur during 2005-06 to 2014-15(Random Effect Model)

EI	Coefficient	S.E.	Z	P>|Z|	Within R^2	Between R^2	Overall R^2
PGR	-0.0245	0.0070	-3.48	0.0000			
NAGL	0.0028	0.0013	2.19	0.0290			
SCSTR	-0.0065	0.0009	-7.15	0.0000	**0.8544**	**0.7131**	**0.7681**
POVR	-0.0032	0.0010	-3.32	0.0010			
PTR	-0.0054	0.0003	-18.34	0.0000			
RE Model Significance			Wald-chi-sq(5)		1573.85	P>chi-sq	0.0000
RE Model Significance over OLS			B-P LM test: chibar- sq(1)		597.59	P>chibar-sq	0.0000
RE-FE Model Comparison			Hausman-chi-sq(5)		10.90	P> chi-sq	0.0535

Source: Calculation by the Author by applying statistical package

In both pooled and panel data analysis, nearly 77% (overall R^2 is 0.7681) to 79% (multiple R^2 is 0.7888) of total variation (inter-temporal variation and between blocks variation) of Education Index (EI) is explained by the five factors, namely, Population Growth Rate (PGR), Non-Agricultural Labour Ratio (NAGL), Scheduled Caste Scheduled Tribe Ratio (SCSTR), Poverty Ratio (POVR) and Pupil Teacher Ratio (PTR). In both models EI is positively associated with NAGL whereas it is negatively associated with PGR, SCSTR, POVR and PTR. All the factors are originated to be statistically significant as revealed by the t-statistic and Z-statistic. It goes beyond saying that higher work participation in non-agricultural sector of any locality is bound to increase the relative earning capacity of the households as well as the status of the households and thereby enhances their attitude towards better education. It leads to higher enrolment of children in elementary education which is one of the important dimensions of EI. Hence the positive relationship between NAGL and EI is conceived in this analysis. Secondly, the negative association between POVR, as conceived by us and EI, is justified in this context. It's a fact that high poverty ratio constitutes low financial submersion and thereby very low financial endowment for spending in education purpose in any constituent block. Same is the case for any single family lying under BPL. Thirdly, the negative association between EI and PGR, as we have found, might be due to high population growth in the backward blocks (Nayagram, Keshiary, Binpur-I etc.) where the people are illiterate and are from tribal base (i.e., SC and ST people) as compared with other blocks. Probably for this reason the PGR affects EI negatively for the studied district. Fourthly, the ratio of pupils to teachers should be in a balanced form, so that a teacher can guide maximum number of students properly. If the number of students is large enough than the number of required teachers, then the teaching, guidance and other virtues of the teachers cannot be sufficiently spread to the students. As a result, a negative impact of PTR is been observed on education index. Finally, we have found that there exists a negative relationship between the SCSTR and the EI in our study. It is a historical fact that, in India, the SCST people are generally less educated and are

primarily engaged in agricultural sector; and those people are not in a position to think or visualize about a better or higher way of living. Our study area is no exception. Hence, we can argue that, if there prevails a significant portion of SCST people in the area, there is a possibility that the EI of that area might be low.

7. Concluding Remarks

We have successfully computed an appropriate composite Education Index (EI) by using Iterative Average Correlation Method (IACM) on the basis of all important and stimulating indicators of educational attainment for the blocks of Paschim Medinipur in West Bengal over the period 2005-06 to 2014-15. Among all the blocks Pingla, Sabong, Dantan-II, Debra are the overall top performers and Nayagram, Gopiballavpur-I, Binpur-I, Jamboni, etc. are bottom-level performers in attainment of education. Our study reveals that most of the blocks of Paschim Medinipur have achieved improvement in respect of attainment in education over time. It is also seen that both inter-block variation and inter-temporal variation of EI are significant though inter-block variation is more significant than inter-temporal variation. This both way variations of EI is observed to be significantly explained by various socio-economic and demographic factors like Population Growth Rate (PGR), Non-Agricultural Labour Ratio (NAGL), Scheduled Caste Scheduled Tribe Ratio (SCSTR), Poverty Ratio (POVR) and Pupil Teacher Ratio (PTR). We have also tried to calculate the pseudo partial importance (through squared partial correlation), true or correct partial importance (through squared ortho-partial correlation) and relative importance (through squared average correlation) of the explanatory factors by using the pooled regression framework and the pseudo partial importance (through partial correlation) of the explanatory factors by using the panel regression framework. From the pooled regression results, it appears that the SCSTR is the most important factor with relative importance of 0.3336 out of 0.7888. This factor is observed to affect the Education Index (EI) negatively. This means that general education policy fails to achieve inclusive education system especially for the people belonging to the backward categories. It is needed to introduce a special education policy with a greater emphasis on that section of the people who are not able to access education facilities. Awareness campaign regarding the importance of education, incentive payments and generation of employment opportunities may contribute to improve the situation. The policy implication of this is that, efforts should be made to extend the above mentioned facilities to the rural areas to improve the EI. Pupil Teacher Ratio (PTR) has come out as the second important factor with relative importance 0.2073 out of 0.7888. This factor is observed to affect EI negatively. If the number of pupil is large and the number of teachers is relatively lower than the required number, then the negative impact is bound to happen. The negative impact could be removed from the society if the government would take some effective steps. The places where PTR is not in a balanced form, the government should take a bold step to address the problem. From

the pooled regression results, it appeared that the NAGL is the third important factor with relative importance of 0.1396 out of 0.7888. This factor is observed to affect EI positively as sanctioned and regular income comports the basic utility with appropriation to a minimum satisfaction level. This will gradually enclose educational development and social life towards the growth of economy. Thus, the policy implication of this is that efforts should be made to extend the above mentioned facilities to the rural areas. A discussion of similar nature is available in Pattanayek, Mookherjee and Mondal (2019) in which an assessment of Standard of Living Index for the same blocks of undivided PaschimMedinipur district is presented.

From the analysis of Panel regression we observe that the above mentioned five factors are significant in explaining the variability of EI. The signs of the coefficients of these factors are same as those which are obtained through pooled regression. From the significance of the individual coefficients nothing can be said about their relative importance because the significance here is based on pseudo partial correlations. What we can say is that they are jointly significant in explaining both the across-block and within-block variation in EI. Thus, the policy implications mentioned above in the context of pooled regression may also apply in the context of panel regression. Finally, it can be said that the list of selected factors that are affecting EI is not exhaustive. The future researchers, working in this area can take up the issue in a broad spectrum and carry on with better implications.

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