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Social Policy and Development Centre

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Is There a Long Run Relationship Between Economic Growth and Human Development? Some Cross Country Evidence from Developing Economies

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1. INTRODUCTION

The world today is different from the one which experienced two World Wars. Though the evolutionary process has changed the composition of the earth, human beings have, nevertheless, contributed significantly in the development of the world at large. The increase in intellectual capacity, the establishment and strengthening of institutions, the inevitable technological progress and the prosperous economies are all the marvel of human endeavors. All these human achievements, no doubt, make the world a better place to live in but there is still a long way to go.

Till today, many countries in Asia and Africa are devoid of the basic necessities of life such as food, shelter, safe drinking water, curative and preventive health facilities. Why are they deprived of such facilities? While a complete and satisfactory answer to this simple question is more difficult or, perhaps, more complicated and complex, the experiences of many recently successful countries in the South East Asian region suggest one important element and that is the direction of **priority** given in formulating the long term plans. Specifically, many of these countries adopted a balanced strategy of investing in both economic infrastructure and human development (e.g., see Table 1). On the other hand, the countries in the South Asian region, by and large, followed a development strategy where initially a greater emphasis was placed on investments in economic infra-structure to expedite the economic growth and a low-key profile was adopted towards the social sector investment. Added to this strategy was the greater emphasis placed by these nations on defence services as shown in Table 1. For instance, in general, Pakistan spent over 5.5 percent of its GDP on defence activities in the sixties as well as in the nineties. These figures, by and large, exceed those of all East Asian countries considered in the paper. The consequences of such a planning strategy are now reflected in the poor quality of social sector indicators of South Asian economies in terms of lower literacy rates, pathetic health facilities, high population growth

Table 1
TRENDS IN KEY ECONOMIC AND EXPENDITURE INDICATORS: A CROSS COUNTRY PERSPECTIVE

Countries	GNP Per Capita (US $)		Real GDP Per Capita (PPP$)		Public Expenditure on Education as % of GNP		Defence Expenditure as % of GDP		Economic Sector Expenditur as % of Total Expenditure	
	1966	1992	1960	1992	1960	1990	1960	1990	1972	1990
South Asia										
Bangladesh	70	220	621	1230	0.6	2.0	-	1.6	39.3	34.4
India	90	310	617	1230	2.3	3.5	1.9	3.3	19.9	20.8
Pakistan	120	420	820	2890	1.1	3.4	5.5	6.6	21.4	12.4
Sri Lanka	170	560	1389	2850	3.8	2.7	1	4.8	20.2	16.8
East Asia & Pacific										
China	110	480	723	1950	1.8	2.3	12	-	-	-
Fiji	310	2050	2354	5410	-	5.0	-	2.5	-	-
Hong Kong	680	15710	2323	20340	-	3.0	-	0.4	-	-
Indonesia	40	680	490	2950	2.5	-	5.8	1.6	30.5	27.6
Malaysia	340	2830	1783	7790	2.9	6.9	1.9	3.6		-
Philippines	200	790	1183	2550	2.3	2.9	1.2	1.8	17.6	23.6
Singapore	590	16970	2409	18330	2.8	3.4	0.4	5	9.9	20
South Korea	130	7220	690	9250	2	3.6	6	4	25.6	17
Thailand	150	1840	985	5950	2.3	3.8	2.6	3.2	25.6	22.1
Africa					3.8	3.3				
Benin	100	410	1075	1630	2.5	-	1.1	2	-	-
Cameroon	130	830	736	2390	1.7	3.4	1.7	2.1	-	48.1
Egypt	180	650	557	3540	4.1	6.7	5.5	4.6	-	8.2
Ghana	250	460	1049	2110	3.8	3.3	1.1	0.6	15.1	19.2
Kenya	120	330	635	1400	4.6	6.8	0.5	2.4	30.1	26.6
Rwanda	50	250	538	710	0.3	4.2	-	1.7	22	-
Zimbabwe	220	580	937	1970	0.5	10.6	-	7.3	-	22.4
Southern Europe										
Turkey	310	2030	1669	5230	2.6	-	5.2	4.9	42	17.8
Latin America										
Argentina	1010	6170	3381	8860	2.1	-	2.1	3.3	-	20.5
Colombia	200	1350	1874	5480	1.7	2.9	1.2	2.7	-	-
Developed Economies										
America	3930	23830	9983	23760	5.3*	7*	8.8	5.6	10.6	10.2
France	2210	22630	2210	19510	3.6*	6*	6.3	3.6	-	5.4

Note: * *indicates Public Expenditure on Education as % of GDP*

Sources: 1) *GNP Per Capita, Real GDP Per Capita [Human Development Report (HDR) 1995 , World Table (WT) 1986]*
2) *Public Education Expenditure as % of GNP [HDR 1994]*
3) *Defence as % of GDP [HDR 1993]*
4) *Economic Sector Expenditure as % of Total Expenditure [World Development Report (WDR) 1992]*

rates, etc., as shown in Tables 2 and 3. This has also resulted in a generation of labour force which is unskilled and unprepared to meet the challenge and rapidly changing modern technology globally and, thus, this may have a negative impact on the future growth of the country.

It also needs to be emphasised that, while the economic infrastructure investments (highways, dams, bridges, etc) may usually take a long time to be completed, the impact period for the social sector investments is even longer if it is to produce results in terms of higher literacy, healthy workers, etc. Not only that, while it may even be possible to shorten the gestation period of economic infrastructure investment by allocating more resources (through borrowing or foreign aid), the same cannot be said for social sector development. Regardless of the size and pace of social sector investments, it will take a fixed number of years (say five years for a primary school) to produce a generation of educated and skilled labour force. Thus, the return of the social sector investment is a long term proposition and, therefore, its association with economic growth and development should be investigated and analysed within a framework which has a longer perspective.

Experiences of the recently developed Asian Tiger countries (e.g.,South Korea, Singapore, Hong Kong, etc.) reveal that the initial economic conditions (measured in terms of per capita income, export growth, etc., as shown in Table 1) of some of these countries in the sixties were quite comparable with those of the South Asian economies (e.g., Pakistan, India, etc.). Yet, after three decades of progress, the countries in the South Asia region lagged far behind the Asian Tiger countries so much so that the per capita differences between these group of countries on average have increased in the order of over 200 times as shown in Table 1. As indicated earlier, there is a general perception that one of the important factors that led to

Table 2
TRENDS IN LITERACY AND ENROLLMENT RATES: A CROSS COUNTRY PERSPECTIVE

Countries	Literacy rate (%)				Enrollment Ratios (out of 100)											
					Primary School						Secondary School					
	Total	*Total*	*Male*	*Female*	*Total*		*Female*		*Male*		*Total*		*Female*		*Male*	
	1960	1990	1990	1990	1960	1990	1960	1990	1960	1990	1960	1990	1960	1990	1960	1990
South Asia																
Bangladesh	22	35	47	22	47	77	26	71	68	83	8	19	1	12	15	26
India	28	48	62	34	61	98	40	84	82	112	20	44	10	32	30	56
Pakistan	15	35	47	21	30	46	13	31	47	61	11	21	3	13	19	29
Sri Lanka	75	88	93	84	95	107	90	105	100	109	27	74	16	77	38	71
East Asia & Pacific																
China	-	73	84	62	109	125	115	120	109	130	21	48	38	42	23.4	54
Fiji	-	-	-	-	85	125	78	122	92	123	15	52	9	53	21	53
Hong Kong	70	-	-	-	87	108	79	105	95	112	20	75	18	77	22	76
Indonesia	39	82	88	75	71	116	58	114	84	117	6	45	3	41	9	50
Malaysia	53	78	87	70	96	93	83	93	109	93	19	56	13	58	25	54
Philippines	72	90	90	90	95	111	93	111	97	111	26	73	25	75	27	67
Singapore	-	-	-	-	111	108	101	107	121	108	32	70	26	71	38	69
South Korea	71	96	99	94	94	107	89	109	99	105	27	88	14	87	40	89
Thailand	68	93	95	91	83	114	79	88	87	140	13	33	10	32	16	34
Africa																
Benin	8	23	32	16	27	61	15	39	39	85	2	11	1	7	3	15
Cameroon	19	54	67	43	65	101	43	93	87	109	2	28	1	23	3	33
Egypt	26	48	63	34	66	101	52	93	80	109	16	81	9	73	23	89
Ghana	27	60	70	51	38	77	25	69	51	85	5	38	3	29	7	47
Kenya	20	69	-	-	47	95	30	93	64	97	2	29	2	25	2	33
Rwanda	16	50	64	37	49	71	30	70	68	72	2	8	1	7	3	9
Zimbabwe	39	67	74	60	96	117	86	116	106	118	6	50	4	46	8	54
Southern Europe																
Turkey	38	81	90	71	75	110	58	111	92	109	14	48	8	38	20	58
Latin America																
Argentina	91	95	96	95	98	111	99	114	97	108	23	71	24	74	22	70
Colombia	63	87	88	86	77	111	77	111	77	111	12	73	11	75	13	67
Developed Economies																
America	98	-	-	-	99	104	99	104	95	105	86	90	90	90	105	87
France	-	-	-	-	144	108	143	108	145	108	46	99	48	101	44	97

Sources 1) *Enrollment Ratios [World Table (WT) 1986 & 1994]*
2) *Literacy Rate [Human Development Report (HDR) 1993 & World Development Report (WDR) 1980]*

Table 3

TRENDS IN QUALITY OF EDUCATION INDICATORS: A CROSS COUNTRY PERSPECTIVE

Countries	Teacher Pupil Ratio (out of 100)			
	Primary		Secondary	
	1960	1990	1960	1990
South Asia				
Bangladesh	2.2	1.6	4.0	3.7
India	2.2	2.1	6.3	-
Pakistan	2.6	2.3	4.2	5.3
Sri Lanka	3.2	3.4	-	-
East Asia & Pacific				
China	3.7	4.5	5.3	6.7
Fiji	2.9	3.2	5.9	5.9
Hong Kong	3.3	3.7	4.2	4.3
Indonesia	2.6	4.3	7.1	7.7
Malaysia	3.6	5.0	4.0	5.3
Philippines	2.8	3.0	3.7	3.0
Singapore	3.0	3.8	3.6	-
South Korea	1.7	2.9	2.9	4.0
Thailand	2.8	5.6	5.0	5.6
Africa				
Benin	2.4	2.9	4.3	-
Cameroon	2.1	2.0	4.0	3.8
Egypt	2.6	4.2	6.3	5.6
Ghana	3.2	3.4	6.3	5.6
Kenya	2.4	3.2	6.7	-
Rwanda	2.6	1.8	7.1	7.1
Zimbabwe	2.6	2.8	4.8	3.6
Southern Europe				
Turkey	2.2	3.3	5.3	4.2
Latin America				
Argentina	4.5	5.3	14.3	14.3
Colombia	2.6	3.3	9.1	5.0
Developed Economies				
America	2.8	4.8	5.6	7.1
France	3.4	5.0	3.8	7.1

Sources: 1) Teacher Pupil Ratio Primary & Secondary [World Table (WT) 19 & Human Development Report (HDR) 1994]

creation of the Asian Tiger miracle is the heavy emphasis placed by these countries on having a long term plan with significant **priorities** given to human development throughout and more so in the beginning of the process of their nation building.

In view of the above, the objective of the paper is to empirically test the proposition that there exists a long run stable relationship between human resource development and economic growth for developing and less developed countries in the South Asia, East Asia, South Africa and Latin American regions. We have tested the above paradigm using the "Cointegration" and "Error-Correction" techniques and "Granger Causality" test which are now commonly used to investigate long-run relationship and the direction of causations between two variables. Not only does the study consider a wide range of developing and less developed countries over a longer period (1966 to 1992) but it will also examine the association of the quality aspects of education (vocational and technical, higher levels of education, teacher to pupil ratios, etc.) with economic growth.

The format of the remaining paper is as follows. Section 2 provides a brief discussion on the existing literature on education and its impact on economic development. The model and techniques used in the paper are presented in Section 3. A discussion of the results on stationarity, cointegration and causality tests is presented in Section 4. Section 5 provides the concluding remarks.

2. LITERATURE REVIEW

Over the years, a number of both theoretical and empirical studies have been undertaken to test the relationship between human capital and infrastructure development and economic growth. The earlier version of human capital theories was developed by Schultz (1961), Denison (1962) and Becker (1964) where the

higher education of individuals was linked to the increase in economic growth through their improved productivity. Later, in the eighties and nineties, Jorgenson (1984) and Jorgenson and Fraumeni (1992) refined these theories by emphasizing that "educational investment has long run positive effects on the level of economic growth".

On the empirical front, in a cross-country analysis, Jess and Spiegel [1992] find the role of human capital in economic development insignificant by indicating that "human capital either enter insignificantly in explaining per capita growth rate or with incorrect sign". The human capital endowment or increase in human capital is a non-measurable phenomenon and its empirical assessment is difficult to explain. However, Schultz and Paul [1992] empirically proved that "human capital is an important determinant of modern economic growth and a critical factor in explaining the convergence in growth across countries". Another cross-country growth regression analysis was done by Glaeser and Edward [1994] by examining the relationship between schooling and GNP growth. They found a strong relationship between human capital and economic growth.

Recently, Meulemeester and Rochat (1995) have undertaken a study to test the long run relationship between higher education and economic growth. While the findings of this study have been quite supportive of the human development theories as a long-term paradigm, the focus of their empirical research, however, has been primarily restricted to the developed economies of the world. Not much empirical work on the long run issue of the contribution of human capital has been undertaken particularly in the developing and less developed economies.[1] Not only that, the role

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1 Few exceptions in this context are being the studies by Psacharopoulos (1980, 1981, 1985), Ichi and Hideki (1994), Khan, Shaw and Hussain (1991).

of higher education and technical and vocational education as well as qualitative aspects of education proxied by teacher/pupil ratio on economic development for developing nations within a long term framework have not been dealt with. Our study will focus on these multidimensional issues of the role of education on a broad cross-country basis within a long term framework.

3. ECONOMETRIC METHODOLOGY

Rather than using the traditional simple correlation or classical regression analysis we have used the recent econometric techniques proposed for testing long-run relationship and the direction of causality between education efforts and economic development. It has been argued [Engle and Granger (1987)][2] that traditional econometric properties of test-statistics (e.g., t-test and F-test) are predicated on the assumption that the time series generating such statistics are stationary, or else the standard interpretation of these measures (mean and variance) will break down. Intuitively, stationarity is simply the proclivity of a variable moving towards its long-run trend value after encountering a shock. In the absence of stationarity, the direct functional relationship between two or more non-stationary time series could be due to spurious correlation.

Our methodology of empirically testing the long-run equilibrium relationship and the direction of causality between economic development and education thus entails the following steps:

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2 A plethora of literature is now available on this topic and readers may refer to the original articles by Engle and Granger (1987). An excellent intuitive exposition on stationarity and cointegration is also available in Moosa (1992).

a) First, we test the stationarity of each time series variable in levels based on the commonly used Augmented Dicky Fuller (ADF) statistics with appropriate lags.[3]

b) If the time series variables are found to be stationary, we then directly apply the standard Granger-causality test to examine the importance of the causal (with lags) variable on the dependent variable after taking into account the lag effects of the latter variable.[4]

c) In case of non-stationary series, we test for the existence of cointegration.[5] If the series are cointegrated, then a modified version of Granger-causality test is applied on the cointegrated first differenced variables within the framework of an "Error-Correction" model.[6]

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3 For a technical details on stationarity test, reader may refer to Dickey and Fuller (1979, 1981).

4 The simple Granger-causality test in this paper is based on the approach proposed by Granger (1969, 1986).

5 Intuitively, the concept of cointegration is straightforward. What it implies is that even if two or more series individually may be non-stationary but it is possible that a linear combination of these series may have a long-run relationship. Thus the stochatic error-term of this cointegrating equation should be stationary. A simple ADF test can then be applied on this error-term to test for the existence of cointegration. For technical details, reader may refer to Jojansen (1988, 1991, 1992).

6 In the case of non-stationary cointegrating variables the Granger-causality test also includes an appropriate Error-correction (EC) term generated from the long-run relationship. The advantage of incorporating such an EC term in the causal equation is that it controls for "disequilibrium error (i.e., the gap between actual behaviour and the long -run relationship given by the cointegrating variables" and connects it with short-run variations of the series. [See for details Engle and Granger (1987)].

d) As for non-cointegrated and non-stationary series in levels, we simply integrate (or difference to higher order) the variable to make it stationary before applying the standard Granger-causality test.

3. RESULTS

In order to empirically test the long-run significance of education efforts on economic development on a cross country basis, we have analysed a variety of education related variables for twenty-five countries covering South Asia (4), East Asia and Pacific (9), Africa (7), Latin America (2), Southern Europe (1) and Developed Economies (2). Among the education variables, we have considered enrollment ratios by level of institutions (primary, secondary, vocational and technical and higher education) and by gender (female and male) as well as quality of education represented by teacher to people ratio. Economic development of a nation is proxied by per capita gross national product. Specific notations for these variables are given below:[7]

i)	GNPPC	Per capita gross national product in U.S. dollars
ii)	PRENRF	Primary school enrollment ratio for female students
iii)	PRENRM	Primary school enrollment ratio for male students
iv)	SEENRF	Secondary school enrollment ratio for female students
v)	SEENRM	Secondary school enrollment ratio for male students
vi)	VEPC	Vocational and technical school enrollment ratio
vii)	HEPC	Higher education enrollment ratio
viii)	TPRP	Teachers to pupil ratio for primary school
ix)	TPRS	Teachers to pupil ratio for secondary school

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7 Detailed definition and data sources are given in a separate appendix.

The results of various econometric and statistical tests applied to the above variables are discussed below:

a) Stationarity: Following the standard practice in the literature, we have applied *Augmented Dickey-Fuller* (ADF) technique to test for the stationarity of each time series variable in the study. The basic null hypothesis tested is the presence of non-stationarity (or unit root) in the series. A large negative *ADF* will establish the stationarity of the series. Estimated *ADF* test statistic and its critical values are reported in Table 4. Based on the *ADF* test statistic values, we found, as expected, almost all the time series variables to be non-stationary (184 out of 197) at the 5 percent level of significance. Given the non-stationarity behaviour of these variables, a simple correlation or regression on them, in this context, may produce results which could be termed as spurious in character unless a cointegration relationship exists between the variables.

b) Cointegration: Two or more non-stationary time series variables are considered to be *cointegrated* if the error term produced by a linear combination of these variables does not have stochatic trend and is stationary. Parameters estimated by a *cointegrating equation* can be interpreted as having a long-run relationship which is not spurious. The cointegration test between two or more non-stationary time series was performed using Johansen (1991) procedure which simply computes the likelihood ratio values for a null hypothesis of no cointegration. If the estimated likelihood ratio statistic exceeds the critical value at a stated level of significance, then the null hypothesis of no cointegration is rejected in favour of the existence of cointegration. Table 5 reports the results for both estimated likehood ratio test and eigen values performed on a cointegration equation consisting of GNPPC and a given education variable defined earlier. For instance, in Table 5,

Table 4

Stationarity Test Based on Augmented Dickey Fuller (ADF) Values

Countries	ADF Statistics								
	GNPPC	PRENRF	PRENRM	SEENRF	SEENRM	TPRP	TPRS	VEPC	HEPC
South Asia									
Bangladesh	-4.54*	-0.92	-0.63	-1.75	-2.52	-2.18	-1.05	-3.95*	-2.28
India	-2.10	-2.05	-1.85	-0.46	-1.21	-4.89*	-4.89*	0.97	0.32
Pakistan	-2.36	-1.84	-3.49	-0.40	-2.47	-3.27	-2.01	1.08	-1.82
Sri Lanka	-2.01	-3.12	-2.62	-2.12	-1.97	-2.30	-	-	1.06
East Asia and Pacific									
China	-2.17	-2.70	-2.36	-2.86	-1.91	-1.09	-1.03	-	-
Fiji	-1.83	-1.43	-2.01	-0.59	-0.82	-2.11	-3.37	1.77	0.64
Hong Kong	-0.32	-2.69	-2.11	-1.70	-2.46	-2.01	-1.83	-2.36	0.01
Indonesia	-3.27	-1.96	-2.06	-1.65	-1.73	-2.03	-3.19	0.25	-1.09
Malaysia	-2.63	-2.13	-2.49	-1.79	-1.07	-0.99	-1.34	0.54	-1.90
Philippines	-4.19*	-3.58*	-2.65	-2.59	-1.64	-2.80	-3.05	-	-2.30
Singapore	-0.32	-2.63	-2.87	-2.57	-2.64	-1.99	-1.72	-1.71	-0.52
South Korea	1.37	-2.38	-1.11	-1.96	-0.68	-3.92*	0.05	-1.93	-2.23
Thailand	-0.87	-2.06	-0.85	-2.00	-2.16	-2.55	-2.10	-2.40	-2.26
Africa									
Benin	-2.61	0.47	0.30	-2.05	-2.85	-1.07	-0.92	-	-
Cameroon	-2.33	-2.53	-3.23	-2.39	-3.60**	-1.59	-1.86	-	-
Egypt	-1.52	0.20	-0.20	0.65	-3.56	-2.41	-1.19	-	-
Ghana	-2.66	-3.95*	-3.96*	-0.97	-0.79	-2.03	-3.04	-	-
Kenya	-2.56	-0.91	-0.95	-1.93	-2.23	-4.84*	-0.58	-	-
Rwanda	-0.49	-2.76	-2.98	-1.46	-1.34	-4.24*	-2.81	-	-
Zimbabwe	-3.58*	-2.01	-1.76	-1.39	-2.43	0.02	-1.15	-	-
Southern Europe									
Turkey	-3.05	-2.72	-2.83	-1.66	-2.21	-0.52	-2.92	-	-
Latin America									
Argentina	-2.29	-1.88	-2.46	-2.31	-2.20	-2.61	-2.27	-	-
Colombia	-4.19*	-1.75	-1.48	-1.61	-1.44	-1.97	-1.15	-	-2.30
Developed Economies									
America	-1.13	1.19	-2.91	-0.23	-2.24	-2.17	-2.40	-	-
France	-3.62*	-1.37	-1.76	-1.20	-2.02	-4.49*	-4.81*	-	-

Note: 1) All the variables are Non-stationary at 5% level with the exception of the ones marked by an asterisk.
2) Critical Value at 5% is -3.5731

figures such as 4.65 and 0.15 in parenthesis, respectively, represent estimated likelihood ratio and eigen value for a cointegrating equation between GNPPC and PRENRF for Pakistan. Asterisk on the likelihood ratio value, in this context, implies the rejection of no cointegration null hypothesis at the 5 percent level of significance.

Based on the statistical significance of estimated likelihood ratios, figures in Table 5 clearly indicate that the hypothesis of no cointegration between GNPPC and each of the education variables individually is rejected for all the countries considered in the paper. This implies that there exists a long-run relationship between economic development and education indicators across all the countries considered in the study.

Although Meulemeester and Rochat's (1995) paper found the absence of a long-run "stable and precise relationship between education and economic development", it should, however, be noted that their study differs from ours in two important ways. First, it was based on only developed countries (six of them) and, secondly, they considered higher education as the only indicator of economic development. Not only that, the explanation given by the authors in support of their findings "that higher education systems are typically multi-objective organizations, characterised by time-inconsistency in their priorities" may not be relevant or applicable in the context of developing economies considered in our study. We should, however, emphasise that the authors' short-run findings on developed countries based on causality tests are consistent with our results which will be discussed below.

c) ***Causality:*** Since all our education variables are cointegrating with the GNPPC across the countries, we have conducted the causality test within the

Table 5

Long Run Cointegration Test Results Between GNPPC and Education Indicators

Countries	Likelihood Ratio							
	PRENRF	PRENRM	SEENRF	SEENRM	TPRP	TPRS	VEPC	HEPC
South Asia								
Bangladesh	22.74 **	16.69 *	18.99*	17.86 *	15.62 *	-	21.26 **	17.78 *
	(0.51)	(0.39)	(0.55)	(0.53)	(0.40)	-	(0.52)	(0.45)
India	19.04 *	19.69 *	35.21 **	16.60 *	17.91 *	18.14 *	19.03 *	20.01 *
	(0.46)	(0.45)	(0.77)	(0.47)	(0.46)	(0.46)	(0.48)	(0.51)
Pakistan	4.65 *	15.74 *	17.95 *	18.30 *	24.25 **	24.20 **	16.89 *	4.30 *
	(0.15)	(0.41)	(0.39)	(0.41)	(0.44)	(0.47)	(0.43)	(0.15)
Sri Lanka	4.68 *	4.59 *	4.07 *	24.84 **	20.81 **	-	-	18.09 *
	(0.16)	(0.16)	(0.14)	(0.51)	(0.45)	-	-	(0.49)
East Asia and Pacific								
China	16.76 *	19.04 *	21.21 **	17.01 *	21.37 **	15.91 *		
	(0.38)	(0.50)	(0.49)	(0.44)	(0.46)	(0.34)	-	
Fiji	31.88 **	24.22 **	19.16*	17.95 *	17.27 *	16.28 *	17.71 *	16.23 *
	(0.64)	(0.55)	(0.39)	(0.37)	(0.34)	(0.35)	(0.47)	(0.47)
Hong Kong	23.41 **	18.67 *	4.24 *	15.58 *	17.48 *	20.60 **	18.63 *	16.17 *
	(0.49)	(0.36)	(0.14)	(0.35)	(0.40)	(0.44)	(0.50)	(0.39)
Indonesia	16.41 *	24.43 **	18.41 *	27.68 **	18.86 *	16.19 *	18.59 *	16.98 *
	(0.43)	(0.55)	(0.45)	(0.61)	(0.51)	(0.45)	(0.49)	(0.47)
Malaysia	22.20 **	21.90 **	19.33 *	3.88 *	46.02 **	27.93 **	19.37 *	15.90 *
	(0.55)	(0.51)	(0.46)	(0.13)	(0.84)	(0.60)	(0.52)	(0.36)
Philippines	20.82 **	18.90 *	31.14 **	20.82**	25.73 **	15.81 *	-	17.85*
	(0.49)	(0.49)	(0.53)	(0.44)	(0.57)	(0.35)	-	(0.39)
Singapore	18.94 *	17.70 *	60.46 **	16.86 *	16.39 *	16.15 *	42.92 **	19.27 *
	(0.49)	(0.35)	(0.90)	(0.28)	(0.34)	(0.26)	(0.65)	(0.40)
South Korea	29.55 **	15.67 *	4.60 *	40.23 **	15.98 *	18.69 *	18.39 *	27.50 **
	(0.59)	(0.39)	(0.15)	(0.75)	(0.46)	(0.37)	(0.41)	(0.47)
Thailand	5.41 *	19.68 *	28.15 **	38.87 **	18.53 *	15.50 *	20.51 **	28.84 **
	(0.18)	(0.51)	(0.66)	(0.78)	(0.52)	(0.42)	(0.48)	(0.53)
Africa								
Benin	17.78 *	4.37 *	17.55 *	32.12 **	21.87 **	20.20 **	-	
	(0.41)	(0.15)	(0.45)	(0.62)	(0.57)	(0.55)	-	
Cameroon	26.51 **	20.21 **	6.24 *	34.45 **	20.14**	4.98*	-	-
	(0.50)	(0.42)	(0.19)	(0.75)	(0.47)	(0.17)		
Egypt	24.63 **	4.41 *	21.65 **	20.32 **	4.62 *	18.44 *	-	
	(0.40)	(0.14)	(0.53)	(0.54)	(0.15)	(0.38)	-	
Ghana	17.94 *	19.08 *	20.41 **	16.12 *	20.37 **	15.55 *	-	
	(0.42)	(0.45)	(0.48)	(0.36)	(0.36)	(0.36)		
Kenya	19.59 *	22.40 **	4.92 *	19.61 *	20.59 **	23.82 **	-	-
	(0.44)	(0.51)	(0.16)	(0.48)	(0.44)	(0.45)		
Rwanda	16.51 *	3.89 *	5.24 *	26.10 **	20.74 **	16.10 *	-	
	(0.38)	(0.13)	(0.17)	(0.51)	(0.42)	(0.32)		
Zimbabwe	16.97 *	3.91 *	20.97 **	27.87 **	15.47 *	16.77 *	-	-
	(0.47)	(0.13)	(0.50)	(0.57)	(0.45)	(0.36)	-	
Southern Europe								
Turkey	18.84 *	25.67 **	20.84 **	4.23 *	4.47 *	17.87 *	-	-
	(0.45)	(0.59)	(0.40)	(0.15)	(0.15)	(0.51)	-	-
Latin America								
Argentina	20.41 **	54.31 **	4.43 *	16.39 *	19.04 *	3.80 *	-	-
	(0.47)	(0.82)	(0.17)	(0.44)	(0.42)	(0.14)	-	-
Colombia	4.17 *	19.27 *	34.76 **	27.88 **	18.72 *	4.81 *	-	17.85 *
	(0.13)	(0.40)	(0.69)	(0.58)	(0.46)	(0.15)	-	(0.39)
Developed Economies								
America	5.97 *	21.77 **	26.35 **	28.16 **	18.30 *	18.38 *	-	-
	(0.19)	(0.38)	(0.49)	(0.57)	(0.43)	(0.31)	-	
France	22.13 **	5.56 *	17.36 *	16.53 *	21.21 **	18.86 *	-	-
	(0.60)	(0.19)	(0.40)	(0.45)	(0.47)	(0.47)	-	-

Note: 1) "(**) Indicate the rejection of null hypothesis that there exist no cointegration between GNPPC and the stated variable at 5%(1%) level of significance

2) Values in the parenthesis are eigen values

framework of an error-correction model proposed by Engle and Granger [1987] as discussed earlier. Table 6 reports the results of bivariate causality based on estimated F-test values. For each country, the first line presents results of causality test from educational variables to GNPPC while, in the second line, the causality goes from GNPPC to each education indicator.

Inspection of the results in Table 6 indicates that, while the causality between economic development and education is bi-directional, there are, however, more significant F-test values in favour of causality from education to GNPPC (125 out of 171) compared to that of GNPPC to education (91 out of 171). It is interesting to note that among the different regions considered in the study, the direction of causality in East Asia and the Pacific seems to be more frequently significant (59 out of 69) from education to GNPPC but the opposite holds true for the South Asia region where GNPPC leads education variables more frequently (16 out of 29).

Since, by and large, the causality goes from education to economic development, we will, therefore, focus our discussion on the significance of causality in this sequence. Furthermore, as the discussion on causality will be crucial and since there are too many numbers to interpret, we have, therefore, organized our discussion on the results of causality test across the countries as follows: We will first focus on the results of school education (primary and secondary) followed by vocational and technical and higher education and, finally, on the role of quality of education.

School Education: In general, the role of school education appears to be quite important in explaining the economic development across the countries considered in the study as shown in Table 6. What is even more crucial to note is the fact that

Table 6

Results of Bivariate Granger-Causality Based on F - test

Countries	Dependent Variable	Causaul Variable	F - Statistics PRENRF	PRENRM	SEENRF	SEENRM	TPRP	TPRS	VFPC	HFPC
South Asia										
Bangladesh	GNPPC	XI	7.95 (1)	1.19* (2)	1.95* (7)	1.05* (7)	2.1* (1)		7.68 (1)	2.86* (3)
	XI	GNPPC	0.42* (1)	4.99 (2)	1.85* (7)	2.84 (7)	24.01 (1)		1.13*(1)	2.6* (3)
India	GNPPC	XI	1.94* (1)	1.47* (4)	3.6 (7)	2.74 (4)	3.46* (1)	2.72* (1)	4.44 (2)	1.22* (3)
	XI	GNPPC	7.32 (1)	1.41* (4)	7.76 (7)	2.06* (4)	98.63 (1)	36.77 (1)	20.88 (2)	3.14 (3)
Pakistan	GNPPC	XI	7.42 (1)	3.65* (1)	6.98 (1)	4.01 (3)	3.16 (7)	1.35* (5)	2.65* (4)	2.82 (4)
	XI	GNPPC	3.29* (1)	12.42 (1)	1.13* (1)	2.08* (3)	1.7* (7)	1.98* (5)	4.91 (4)	10.98 (4)
Sri Lanka	GNPPC	XI	2.77* (3)	3.02* (3)	3.11 (3)	6.28 (2)	2.81* (3)			4.97 (3)
	XI	GNPPC	4.46 (3)	4.84 (3)	2.65* (3)	3.78* (2)	10.16 (3)			3.46 (3)
East Asia and Pacific										
China	GNPPC	XI	1.25* (3)	1.83* (3)	3.43 (4)	2.74* (3)	3.09* (1)	2.82 *(3)	-	
	XI	GNPPC	3.56 (3)	1.99* (3)	3.06 (4)	1.83* (3)	8.92 (1)	132.72 (3)	-	-
Fiji	GNPPC	XI	6.02 (4)	4 (4)	5.09* (1)	4.19* (1)	3.51* (2)	1.5* (2)	0.86* (3)	3.43 (5)
	XI	GNPPC	0.64* (4)	0.49* (4)	0.82* (1)	0.37* (1)	6.58 (2)	21.22 (2)	5.5 (3)	1.25* (5)
Hong Kong	GNPPC	XI	4.92 (4)	4.28 (3)	16.58 (1)	4.93 (5)	4.16 (4)	13.74 (2)	16.41 (3)	17.43 (1)
	XI	GNPPC	3.96 (4)	2.91* (3)	6.57 (1)	2.42* (5)	2.84 (4)	4.96 (2)	0.21* (3)	9.46 (1)
Indonesia	GNPPC	XI	17.62 (1)	21.11 (1)	14.03 (1)	13.21 (1)	7.91 (7)	5.71 (3)	63.21 (3)	12.34 (1)
	XI	GNPPC	12.7 (1)	5.98 (1)	9.29 (1)	8.17 (1)	4.43 (7)	3.72 (3)	17.54 (3)	7.83 (1)
Malaysia	GNPPC	XI	6.59 (2)	4.28 (3)	4.65 (4)	11.11 (1)	35.19 (5)	19.76 (4)	5.09 (4)	11.41 (1)
	XI	GNPPC	8.01 (2)	11.12 (3)	1.53* (4)	3.45* (1)	1.33* (5)	1.46* (4)	5.07 (4)	3.11* (1)
Philippine	GNPPC	XI	11.26 (1)	7.64 (4)	16.98 (7)	24.96 (1)	12.82 (4)	10.12 (1)	-	24.4 (1)
	XI	GNPPC	16.34 (1)	1.19* (4)	0.65* (7)	0.65* (1)	1.85* (4)	15.69 (1)	-	5.79 (1)
Singapore	GNPPC	XI	27 (2)	18.12 (1)	12.84 (4)	11.7 (2)	15.3 (1)	9.4 (2)	57.08 (1)	26.91 (1)
	XI	GNPPC	4.08 (2)	3.66* (1)	1.67* (4)	0.96* (2)	2.35* (1)	2.81* (2)	0.46* (1)	18.58 (1)
South Korea	GNPPC	XI	70.8 (1)	51.96 (2)	82.08 (2)	66.18 (2)	36.41 (5)	69.7 (1)	71.5 (1)	117.11(1)
	XI	GNPPC	16.65 (1)	6.15 (2)	3.48* (2)	20.81 (2)	0.65* (5)	19.19 (1)	8.31 (1)	13 (1)
Thailand	GNPPC	XI	18.78 (2)	12.83 (3)	12.82 (5)	17.55 (5)	9.42 (5)	9.42 (4)	21.41 (1)	30.74 (2)
	XI	GNPPC	1.56* (2)	6.22 (3)	1.52* (5)	2.93 (5)	0.32* (5)	1.36* (4)	7.93 (1)	3.28* (2)
Africa										
Benin	GNPPC	XI	4.26 (2)	1.78 *(4)	2.58 (5)	2.08* (4)	89.7 (4)	1.37* (7)		-
	XI	GNPPC	1.21* (2)	1.1* (4)	6.6 (5)	13.14 (4)	7.91 (4)	6.19 (7)		-
Cameroon	GNPPC	XI	7.49 (1)	7.72 (1)	10.33 (1)	11.57 (5)	7.76 (3)	4.99 (4)	-	-
	XI	GNPPC	9.24 (1)	6.73 (1)	0.78* (1)	2.42* (5)	10.66 (3)	0.46* (4)	-	-
Egypt	GNPPC	XI	6.22 (1)	12.04 (1)	3.42* (2)	3.24 (5)	7.51 (1)	4.91* (1)		-
	XI	GNPPC	5.45* (1)	2.23* (1)	5.61 (2)	3.9 (5)	3.66* (1)	9.76 (1)		-
Ghana	GNPPC	XI	0.67* (1)	0.6* (1)	4.44 (2)	3.17* (2)	1.27* (5)	1.46* (1)	-	-
	XI	GNPPC	12.65 (1)	10.6 (1)	0.61* (2)	0.51* (2)	3.27 (5)	12.99 (1)	-	-
Kenya	GNPPC	XI	7.9 (2)	6.96 (3)	4.97 (2)	3.37 (5)	4.64* (1)	7.98 (1)	-	-
	XI	GNPPC	2.71* (2)	0.74* (3)	2.02* (2)	1.67* (5)	16.15 (1)	5.12* (1)	-	-
Rwanda	GNPPC	XI	2* (5)	7.09 (1)	6.88 (1)	3.91 (2)	5.65* (1)	9.7 (1)	-	-
	XI	GNPPC	1.46* (5)	4.7* (1)	4.03* (1)	4.86 (2)	22.15 (1)	9.4 (1)		-
Zimbabwe	GNPPC	XI	13.16 (3)	8.91 (1)	9.38 (4)	13.22 (3)	8.78 (4)	12.43 (3)	-	-
	XI	GNPPC	6.59 (3)	0.17* (1)	15.19 (4)	10.8 (3)	3.13 (4)	0.45* (3)		-
Southern Europe										
Turkey	GNPPC	XI	9.43 (1)	4.49 (2)	17.23 (1)	3.73 (4)	3.95 (2)	2.22* (5)		-
	XI	GNPPC	10.9 (1)	8.31 (2)	1.87* (1)	1.43* (4)	7.37 (2)	5.17 (5)		-
Latin America										
Argentina	GNPPC	XI	1.69* (4)	0.9* (6)	1.44* (6)	1.38* (7)	1* (3)	0.72* (4)	-	-
	XI	GNPPC	1.4* (4)	7.32 (6)	2.83 (6)	1.95* (7)	10.07 (3)	1.74* (4)		-
Colombia	GNPPC	XI	10.11 (1)	10.88 (4)	42.19 (1)	34.84 (1)	24.08 (1)	14.27 (1)		24.4 (1)
	XI	GNPPC	13.95 (1)	0.57* (4)	4.88* (1)	5.07* (1)	0.47* (1)	1.03* (1)		5.79 (1)
Developed Economies										
America	GNPPC	XI	7.65 (2)	16.52(1)	21.57 (1)	24.39 (1)	16.14 (1)	14.32 (1)		-
	XI	GNPPC	2.77* (2)	0.8*(1)	10.2 (1)	4.03* (1)	13.12 (1)	7.02 (1)	-	-
France	GNPPC	XI	10.91 (7)	12.6 (3)	12.48 (3)	7.75 (5)	27.22 (1)	12.38 (1)	-	-
	XI	GNPPC	5.65 (7)	3.33 (3)	1.44* (3)	4.12 (5)	0.89* (1)	39.68 (1)	-	-

*Note: 1) * indicates the insignificant variables*

2) Numbers in the parenthesis indicate the size of the lag taken for causal variables

the occurrence of frequent significant F-test values for female education and more so at the secondary level in explaining the GNPPC seem to surpass that of other male school education in 22 out of 25 countries.

On a regional basis, our results in Table 6 suggest that more countries in East Asia and the Pacific (barring China) seem to have a significantly greater impact (measured by F-test) for all types of school education on economic development followed by the countries in the Africa region. As far as South Asia is concerned, the impact of secondary school (both male and female) seems to be significant in more countries (3 out of four) than primary male education. It is, however, interesting to note that the role of female primary education is more predominant in economic development in countries like Bangladesh and Pakistan in the South Asia region.

Vocational and Technical and Higher education: The contribution of vocational and technical (VEPC) and higher education (HEPC) appears to be even greater (measured by F-test) than those of school (primary and secondary) education for countries in the East Asia and Pacific regions in explaining the economic development as shown in Table 6. In fact, out of the two, VEPC seems to have the greatest impact (measured by F-test) on GNPPC, particularly in countries like Indonesia, Singapore and South Korea. Contrary to this, the results in Table 6 could not find significant support for VEPC as compared to HEPC in influencing GNPPC for Pakistan.

This result may not be surprising particularly when one considers the historical expenditure allocations on a per capita basis made to HEPC *vis-à-vis* VEPC. [8] There seems to be a bias towards higher education on a per capita basis as compared to VEPC or, for that matter, other types of education in Pakistan [e.g., Hasan and Hanif (1996) and Hasan and Rasheed (1996)]. While the importance of higher education (in terms of doctors, engineers, etc.) cannot be undermined, the results in Table 6 and the experiences from successful East Asia countries suggest that the investments in vocational and technical education as well as school education have significant long-run impact in the economic development of a nation.

Quality of Education: Quality of education in this study is proxied by the number of teachers assigned per student for a given level of education. This definition for the quality of education may be quite restrictive since variables such as better and modern curriculum, more hours devoted by the teachers, availability of books, etc. could be a more desirable proxy in this context. However, in the absence of availability of long time series data for these variables on a cross country basis, we feel that teacher per student ratio will at least reflect a broad quality aspect of education.

Once again in Table 6, the long-run impact of the quality of education at both primary and secondary levels on economic development is significant for more

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8 Total public expenditure (both development and recurring)allocated to vocational and technical education as a percentage of higher education in Pakistan were 7.7% in 1972-73 as opposed to only 4.7% in 1993-94. [Data Source: *Pakistan Statistical Year Book (1970-80 and 1992-94), Federal Annual Budget Statement (1973-74 and 1994-95), Provincial Annual Budget Statement (1973-74 and 1994-95)*]

countries (7 out of 9) in the East Asia and Pacific region followed by the countries in the Africa region (4 out of 7).

4. CONCLUSION

The objective of this paper was to empirically examine the long-run relationship (1960-90) between education variables and economic development of a nation for a number of developing and less developed countries using the Granger-causality technique within the framework of the recently proposed cointegration and error-correction econometric method.

Based on cointegration test, our results strongly support the hypothesis that there exists a long-run relationship between a variety of education indicators (represented by enrollment rates and quality of education) and economic development. Our results on Granger-causality test, in general, indicate that education variables lead to economic development in an overwhelming number of countries. In addition to this, our study not only finds the role of vocational and technical education to be significant in the process of economic development but, interestingly enough, the role of primary education in general and female education for East Asian economies in particular was worth mentioning.

The results of such broad cross country analysis are expected to provide policy makers, particularly in developing economies, with insight and information which will not only help them to understand the significance of education in the economic development of the country but will also enable them to make recommendations as to which type of education is required to foster the pace of economic development.

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Appendix

DATA COLLECTION

For the purpose of a cross-country regional analysis, we have lumped countries together for a given region on the basis of their similar economic and social stability conditions. Economic development in this study has been represented by per capita gross national product in U.S. dollar while the education efforts of a nation have been proxied by variables such as enrollment ratios at the primary and secondary levels by gender and number of per capita enrollments in vocational and technical and higher educational institutions. Quality aspect of education has been defined by taking teacher to pupil ratios at the primary and secondary school levels. Data on all variables are taken primarily from the "World Table" and "Statistical Year Book" for the years 1960 to 1990 on an annual basis.

Our data covers a period from 1960 to 1990. It should be noted that, for all countries, data for gross national product per capita is not available from 1960 to 1965 and then there are few missing years. All these missing data were estimated on the basis of growth rates. Data on vocational and college enrollment was available only for South Asia and Pacific countries from 1976 to 1990. Enrollment ratios for males at primary as well as secondary levels were not available, therefore, these ratios have been computed. We assume that total enrollment ratio is the mean of male and female enrollment ratios, i.e.,

$$PRENR_M = 2 * PRENR - PRENR_F$$

where;

$PRENR_M$	=	Primary enrollment ratio male
$PRENR_F$	=	Primary enrollment ratio female
PRENR	=	Total primary enrollment ratio