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Issues in Statistical Modelling of Human Capital and Economic Growth Nexus: A Cross Country Analysis

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ABSTRACT

The human capital and growth relationship has been subject to a lot of debate in economic literature. The empirical growth models are beset with problems ranging from theoretical frameworks and statistical modelling to estimation procedures. Due to non-availability of precise human capital variable, theoretical knowledge fails when pitched against empirical data. This paper is an endeavour to answer four main questions that have prominently figured out in this debate: Is there a direct interplay between human capital and growth or not? Are parametric techniques incapable of capturing nonlinear aspects of human capital-growth relationship as compared to semi parametric techniques? Are estimates of human capital sensitive to proxy of human capital variables? Are estimates of human capital sensitive to estimation techniques? A data of 32 developing countries has been taken as sample for this study. Our findings reveal that human capital has a well established role in accelerating growth through both its 'level effects' and 'rate effects'. The results are not sensitive to definition of education variable but are rather technique dependent. The semi parametric model provides sufficient evidence for non linearity in human capital-growth relationship contrary to parametric models.

JEL Classification: C14, C23, O47

Keywords: Human Capital, Economic Growth, Total Factor Productivity, Semi Parametric

I. INTRODUCTION

The impact of human capital on economic growth has been a moot point in economic literature. Theoretical literature and empirical evidences have divergent opinion on impact of human capital on economic growth. Theoretically, the impact of human capital on economic growth has been explained in two distinctive ways. The first is the 'level effect' which reveals a direct relationship between economic growth and human capital [Mankiw, *et al*. (1992); Islam (1995); Barro (2001); Bassanini and Scarpetta (2001); Freire-Seren (2001); Agiomirgianakis, *et al*. (2002)]. The second approach is 'rate effect' which believes that human capital influences the technological progress thereby indirectly facilitating economic growth through adoption and generation of new technologies [Lucas (1988); Romer (1990); Black and Lynch (1996); Edwards (1997); Maudas, *et al*. (1999); Loof and Anderson (2008)].

The theoretical growth models when incorporated in empirical studies are beset with problems ranging from statistical modelling to estimation procedures. In statistical growth models a linear human capital-economic growth relationship is assumed which is increasingly questioned by the upcoming growth literature. Due to nonlinear aspect of human capital, the linear growth models are incapable of capturing the human capital-growth association [Liu and Stengos (1999); Krueger and Lindahl (2001); Kalaitzidakis, *et al*. (2001); Kourtellos (2002); Mamuneas, *et al.* (2006)].

The estimation of these statistical growth models gives rise to another set of complications. In most of research literature, education has been considered as the sole determinant of human capital variable. The importance of education notwithstanding, a healthier workforce is better able to learn, invent and implement new technologies. Consequently, the health status, which stands out as a crucial component of human capital, has usually been overlooked in the growth studies. Moreover, the proxy employed for the human capital further exacerbates the conundrum. The commonly used proxies like literacy rate, enrollment ratios and the educational attainment have their inherent limitations which lead to imprecise estimates. The choice of the suitable estimation technique is also critical as the relative strengths and weaknesses of the estimation technique employed

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also effects the resultant human capital coefficients. Resultantly, empirical growth models frequently present inaccurate and inappropriate estimates that are often inconsistent with the prior expectations from theoretical frameworks.

In the light of above discussion, following questions stand out in the context of human capital-growth relationship:

(a) Is there a direct interplay between human capital and growth or not?
(b) Are parametric techniques incapable of capturing nonlinear aspects of human capital- growth relationship as compared to semi parametric techniques?
(c) Are estimates of human capital sensitive to proxy of human capital variables?
(d) Are estimates of human capital sensitive to estimation techniques?

The objective of this article is to resolve the dilemma of incongruity between theoretical and empirical evidence on human capital-growth relationship. The paper specifically aims at dealing with statistical modelling of growth frameworks. The article also intends to suggest suitable estimation techniques for such models and appropriate proxy for human capital. In order to provide a comprehensive analysis, human capital has been decomposed into education and health variables. The research is based on sample of 32 developing countries.

This article has a significant contribution in the enrichment of human capital and economic growth debate. Human capital is a fundamental element in the economic growth models. Empirical issues in the human capital not only yield imprecise human capital estimates but also put a mark on the reliability of other estimates included in the growth model. This article highlights the limitations of existing approaches. It also identifies the estimation technique related issues that need to be specifically addressed while dealing with empirical growth models. The article is organised as follows: Section 2 presents the empirical methodology used in the paper. Results are reported and analysed in Section 3. Finally Section 4 concludes the paper.

II. MODEL SPECIFICATION

The empirical model employed in the study to investigate the impact of human capital on growth is a modification of the model presented by Mamuneas, *et al.* (2006).

Mamuneas, *et al.* (2006) takes a general production function describing the state of technology of a country i at time t:

$$Y = f(K, E, H, t) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where Y = Total Output, K = Physical Capital, E = Effective (or human capital augmented) Labour, H = Human Capital and t = Technology Index measured by time trend.

Total differentiation of Equation 1 with respect to time yields:

$$\frac{dY}{dt}=\left(\frac{\partial f}{\partial K}\right)\cdot\left(\frac{dK}{dt}\right)+\left(\frac{\partial f}{\partial E}\right)\cdot\left(\frac{dE}{dt}\right)+\left(\frac{\partial f}{\partial H}\right)\cdot\left(\frac{dH}{dt}\right)+\frac{\partial f}{\partial t} \quad \ldots \quad (2)$$

$$\Rightarrow \quad \dot{Y}=\frac{\partial f}{\partial K}\dot{K}+\frac{\partial f}{\partial E}\dot{E}+\frac{\partial f}{\partial H}\dot{H}+\frac{\partial f}{\partial t} \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

Division of Equation 3 by Y implies:

$$\frac{\dot{Y}}{Y}=\frac{\partial f}{\partial K}\cdot\frac{\dot{K}}{Y}+\frac{\partial f}{\partial E}\cdot\frac{\dot{E}}{Y}+\frac{\partial f}{\partial H}\cdot\frac{\dot{H}}{Y}+\frac{\partial f}{\partial t}\cdot\frac{1}{Y} \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

As $\frac{\partial \ln Y}{\partial Y}=\frac{1}{Y}$, Equation 4 becomes:

$$\hat{Y}=\hat{A}+\frac{\partial \ln Y}{\partial K}\cdot\dot{K}+\frac{\partial \ln Y}{\partial E}\cdot\dot{E}+\frac{\partial \ln Y}{\partial H}\cdot\dot{H} \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

Also $\frac{\partial \ln Y}{\partial Y}=\frac{1}{Y}$ implies that $\partial Y=\partial \ln Y\cdot Y$ and hence Equation 5 turns to be:

$$\hat{Y}=\hat{A}+\frac{\partial \ln Y}{\partial \ln K}\cdot\frac{\dot{K}}{K}+\frac{\partial \ln Y}{\partial \ln E}\cdot\frac{\dot{E}}{E}+\frac{\partial \ln Y}{\partial \ln H}\cdot\frac{\dot{H}}{H} \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

$$\Rightarrow \quad \hat{Y}=\hat{A}+\varepsilon_K\hat{K}+\varepsilon_E\hat{E}+\varepsilon_H\hat{H} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

where "∧" denote growth rates and $\varepsilon_X=\frac{\partial \ln Y}{\partial \ln X}$ $(X=K,E,H)$ denotes output elasticity. In an assumed competitive economy, the observed income shares of labour, S_{YL}, and capital S_{YK} should correspond to the output elasticities of effective labour and capital. Since growth rate of effective labour is not observable, Equation 7 can not be used for estimation purposes.

The effective labour input is then assumed to be a function of the labour force and human capital, i.e.

$$E=g(L,H) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

$\hat{E}$ also can be decomposed as:

$$\hat{E}=\eta_L\hat{L}+\eta_H\hat{H} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

Where η_L and η_H are effective labour elasticities with respect to labour and human capital respectively. Substituting Equation 9 in Equation 7 yields:

$$\hat{Y} = \hat{A} + \varepsilon_K \hat{K} + \varepsilon_E\left(\eta_L \hat{L} + \eta_H \hat{H}\right) + \varepsilon_H \hat{H} \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

$$\Rightarrow \quad \hat{Y} = \hat{A} + \varepsilon_K \hat{K} + \varepsilon_E \eta_L \hat{L} + \left(\varepsilon_E \eta_H + \varepsilon_H\right)\hat{H} \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

Further assuming that human capital is a function of education and health status. i.e.

$$H = h(Ed, Hs) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (12)$$

$\hat{H}$ can also be decomposed as:

$$\hat{H} = e_{Ed}\, \hat{Ed} + e_{Hs}\, \hat{Hs} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (13)$$

Where e_{ED} and e_{HS} are the elasticities of the human capital with respect to education and health status. Substituting Equation 13 in Equation 11 gives:

$$\hat{Y} = \hat{A} + \varepsilon_K \hat{K} + \varepsilon_E \eta_L \hat{L} + \left(\varepsilon_E \eta_H + \varepsilon_H\right)\left[e_{Ed}\, \hat{Ed} + e_{Hs}\, \hat{Hs}\right] \quad \ldots \quad (14)$$

$$\Rightarrow \hat{Y} = \hat{A} + \varepsilon_K \hat{K} + \varepsilon_E \eta_L \hat{L} + \left(\varepsilon_E \eta_H e_{Ed} + \varepsilon_H e_{Ed}\right)\hat{Ed} + \left(\varepsilon_E \eta_H e_{Hs} + \varepsilon_H e_{Hs}\right)\hat{Hs} \quad (15)$$

Impact of Human Capital on Output Growth

Equation 15 which is normally referred as the growth accounting methodology investigates the impact of human capital components; education and health on the output growth. The output elasticity of raw labour is $\varepsilon_E \eta_L$ which is equal to the output elasticity of labour. The coefficients of the human capital components also represent their respective output elasticity.[1] Equation 15 thus can be written as:

$$\hat{Y} = \hat{A} + \varepsilon_K \hat{K} + \varepsilon_L \hat{L} + \varepsilon_{Ed}\, \hat{Ed} + \varepsilon_{Hs}\, \hat{Hs} \quad \ldots \quad \ldots \quad \ldots \quad (16)$$

Impact of Human Capital on TFP Growth

The problem of parameter homogeneity normally exists in the models like Equation 16 as the estimated parameters signify the mean contribution of factor inputs, where as the contribution of inputs is assumed to be the same across time and countries.

To deal with this issue of parameter homogeneity, an index of Total Factor Productivity (TFP) growth is constructed for the panel that contains only the traditional inputs so the parameters of factor inputs are allowed to vary not only

[1]Proof is given in results section.

across countries but also across time. An index of TFP growth for country i in year t is as follows:

$$\hat{TFP}_{it} = \hat{Y}_{it} - s_{Eit}\hat{L}_{it} - s_{Kit}\hat{K}_{it} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (17)$$

Where S_{Eit} and S_{Kit} are the weighted averages of the cost shares of the labour and physical capital. This measure of TFP explains that element of output growth which is left inexplicable by the growth of labour and capital factors and is effected by the variations in $\hat{H}$.

To estimate the impact of human capital on total factor productivity growth, we opt for the following methodology. Subscripting Equation 16 by country and year (it), and adding Equation 17 to it yields:

$$\hat{TFP}_{it} = \hat{A}_{it} + [(\varepsilon_{Kit} - s_{Kit})\hat{K}_{it} + (\varepsilon_{Eit}\eta_L - s_{Eit})]\hat{L}_{it} + \varepsilon_{Edit}\hat{Ed}_{it} + \varepsilon_{Hsit}\hat{Hs}_{it} \quad (18)$$

where $\left(\hat{A}_{it}\right)$ is the exogenous rate of technological change. The first order conditions of standard cost minimisation with respect to physical capital and labour yield:

$$\varepsilon_{jit} = \rho\, s_{jit}, \quad j = K, E \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (19)$$

Using the condition described in Equation 19, Equation 18 can be written as:

$$\hat{TFP}_{it} = \hat{A}_{it} + \alpha\hat{M}_{it} + \varepsilon_{Ed}\hat{Ed}_{it} + \varepsilon_{Hs}\hat{Hs}_{it} \quad \ldots \quad \ldots \quad \ldots \quad (20)$$

where $\alpha = (\rho - 1)$ and $\hat{M}_{it} = s_{Kit}\hat{K}_{it} + s_{Eit}\hat{L}_{it}$.

Two control variables, Trade openness and Democracy are also introduced in the empirical model considering their relative importance in the economic uplift of a country.

Control Variables

Openness. Trade policies that make a country more open towards international trade along with stimulating human capital accumulation foster greater economic growth. As pointed out by Miller and Upadhyay (2002) greater outward orientation enhances efficiency in the use of resources and following the principles of comparative advantage, promotes production specialisation in certain industries. The increase in exports relaxes the foreign exchange constraint and a large inflow of important inputs in the production is facilitated through imports. The countries with increased trade openness as a result experience faster economic growth.

Democracy. The role of democratic institutions in a country's economic growth is considerably emphasised in the recent growth literature. Democracy facilitates better building of economic, social and legal institutions which have a vital role in a country's progress. Besides the direct role of democracy in the growth process, studies like Baun and Lake (2003) have also explained the indirect impact of democracy on economic growth via secondary education and life expectancy.

Equations 16 and 20 have been estimated through a variety of techniques to examine the impact of human capital components on the output growth as well as TFP growth and the extent to which the results are sensitive to the application of the different estimation techniques. These equations are first estimated through panel data models [Common Effects (CE), Fixed Effects (FE) and Random Effects (RE)] and then after detecting exogeniety are re-estimated through Two Stage Least Squares (2SLS) and Generalised Methods of Moments (GMM). Finally Partially Linear semi-parametric estimation technique is applied.

III. RESULTS

As already discussed in methodology section, the coefficients of the components of human capital actually represent their respective output elasticities. This can be shown as below:

$$\begin{aligned}
\varepsilon_E \eta_H e_{Ed} + \varepsilon_H e_{Ed} &= \frac{\partial \ln Y}{\partial \ln E} \cdot \frac{\partial \ln E}{\partial \ln H} \cdot \frac{\partial \ln H}{\partial \ln Ed} + \frac{\partial \ln Y}{\partial \ln H} \cdot \frac{\partial \ln H}{\partial \ln Ed} \\
&= \frac{\partial Y}{\partial E}\frac{E}{Y} \cdot \frac{\partial E}{\partial H}\frac{H}{E} \cdot \frac{\partial H}{\partial Ed}\frac{Ed}{H} + \frac{\partial Y}{\partial H}\frac{H}{Y} \cdot \frac{\partial H}{\partial Ed}\frac{Ed}{H} \\
&= \left(\frac{\partial Y}{\partial E} \cdot \frac{\partial E}{\partial H} \cdot \frac{\partial H}{\partial Ed} + \frac{\partial Y}{\partial H} \cdot \frac{\partial H}{\partial Ed} \right) \frac{Ed}{Y} \\
&= \frac{\partial f}{\partial Ed} \cdot \frac{Ed}{Y} = \varepsilon_{Y,Ed}
\end{aligned}$$

Table 1 shows an enhancing role of education in output growth as education leads to skill development and increased productivity of the labour force which contributes affirmatively to the growth process. Literacy rates have been opted as a proxy for education in Table 1 as the smoothest data for all countries in our sample was available for this indicator among all other possible educational indicators. Literacy rate, however, is considered as a poor proxy for education since it incorporates only the very first part of investment in education and neglects the larger part of it, which is above the attainment of the basic literacy. So analysis is repeated using the most commonly used proxy for education i.e. the mean years of schooling and results are reported in Table 2.

Table 1

Comparison of Output Growth Model with Different Estimation Techniques

Dependent Variable	CE (Output Growth)	FE (Output Growth)	RE (Output Growth)	2SLS (Output Growth)	GMM (Output Growth)
Constant	–0.00 1953	0.01132	0.0179535	–0.0057337	–0.011465
	(0.017087)	(0.046479)	(0.0219714)	(0.014183)	(0.013886)
Capital Growth	0.385149*	0.27582***	0.4451359*	0.3601799*	0.119265***
	(0.07479)	(0.162671)	(0.0802244)	(0.0528332)	(0.069464)
Labour Growth	0.204943	0.459233	0.2247373	0.090886	0.193315
	(0.192339)	(0.351415)	(0.2042151)	(0.190417)	(0.313364)
Education Growth (lit)	0.431256	0.486624	0.271633	0.4409085***	0.661969*
	(0.336731)	(0.898637)	(0.4925597)	(0.2661781)	(0.241684)
Growth in Health	0.0894	0.071268	0.0423024	0.1692617	0.287386**
	(0.123167)	(0.188014)	(0.092662)	(0.1577864)	(0.142818)
Openness	0.0000732	0.000382**	0.0000843	0.0000965***	0.000179*
	(0.0000707)	(0.000174)	(0.0000645)	(0.0000517)	(0.0000628)
Democracy Index	0.014509	0.012812	0.0086693	0.0199995	0.026289**
	(0.015974)	(0.05265)	(0.0171498)	(0.0125023)	(0.010968)
R square	0.116293	0.1524	0.1615	0.1306	0.123625
No. of Observations	960	960	960	896	838

Notes: The results are robust to White Heteroscedasticity.
Values in parenthesis are SE.
*,**,*** Denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Table 2

Output Growth Models

Dependent Variable	CE (Output Growth)	FE (Output Growth)	RE (Output Growth)	2SLS (Output Growth)	GMM (Output Growth)
Constant	0.003103	0.023893	0.0227907***	0.0023874	0.00765
	(0.009903)	(0.020772)	(0.0131073)	(0.009223)	(0.011543)
Capital Growth	0.381844*	0.28239**	0.4407882*	0.3689001*	0.197082**
	(0.068985)	(0.140581)	(0.0784934)	(0.0576747)	(0.082765)
Labour Growth	0.20921	0.395341	0.218725	0.1442877	0.251657
	(0.20279)	(0.330909)	(0.21025)	(0.1992715)	(0.300793)
Education Growth	0.166458	0.105322	0.1321265	0.0104301	0.196411***
(Sch)	(0.158431)	(0.229484)	(0.1679666)	(0.1232943)	(0.118687)
Growth in Health	0.097597	0.08768	0.0443824	0.2466025**	0.250049***
	(0.098408)	(0.21136)	(0.1052466)	(0.1203831)	(0.140984)
Openness	0.0000676	0.000375**	0.0000776	0.0000851***	0.000119***
	(0.0000674)	(0.000189)	(0.0000601)	(0.0000501)	(0.0000706)
Democracy Index	0.009304	0.014793	0.0054992	0.0121915	0.005275
	(0.008702)	(0.052555)	(0.0077814)	(0.0075566)	(0.008337)
R square	0.116021	0.1525	0.1617	0.1283	0.114129
No. of Observations	960	960	960	896	865

Notes: The results are robust to White Heteroscedasticity.
Values in parenthesis are SE.
*,**,*** Denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Though remaining insignificant most of the times, the magnitude of the educational growth parameter reduces considerably with average years of schooling indicator. It may be for the reason that this measure is beset with a substantial noise arising from various inconsistencies of primary data used in its construction and is likely to bring in a downward bias in the estimated coefficient.

It can be shown that like the educational component of human capital, the coefficient of the health status corresponds to the respective output elasticity. Like the educational component of human capital, the health component also has a substantial positive contribution in growth although lesser in magnitude as compared to the education. The health effect is very important in case of developing countries where a sufficiently large number of labour force is employed in the manual labour and thus better health status ensures less absenteeism from work. Better health in terms of higher life expectancy tends to encourage the growth process by providing incentives for investing in other forms of human capital. The household savings are likely to increase in view of greater life expectancy which also supplements the domestic and foreign investment; thereby accelerating the growth process.

Results from both Tables 1 and 2 reveal that though remaining positive, the significance of the human capital coefficients is sensitive to the use of estimation technique. In panel data models, both education and health coefficients are insignificant primarily because of the existence of endogeneity, which when is treated in 2SLS turns one of the human capital coefficient significant. The more technically advanced technique GMM turns both of the human capital coefficients significant.

Tables 3 and 4 depict an affirmative relationship between education and TFP growth. It is because education develops skills among the labour force; thereby increasing their productivity. Also, an educated labour force is better trained to innovate, use and adapt new technologies. The estimated parameter of the mean years of schooling education variable is again lower in magnitude as compared to the literacy rate educational indicator and is insignificant in all panel data regressions.

Health also has positive association with the TFP growth but under the panel models this effect is insignificant.

In 2SLS technique, as shown in Table 3 with the literacy rate educational variable, when we account for the endogeneity of health variable, the coefficient of education turns out to be positive and significant. On the other hand when mean years of schooling is used as the educational indicator in Table 4, dealing with health endogeneity turns the positive health variable significant as well. These results indicate that while accounting for the endogeneity in human capital components, either of these human capital components is likely to have a significant positive impact on growth and the result is sensitive to the definition of the educational measure used in the regression.

Table 3

Comparison of TFP Growth Model with Different Estimation Techniques

Dependent Variable	CE (TFP Growth)	FE (TFP Growth)	RE (TFP Growth)	2SLS (TFP Growth)	GMM (TFP Growth)
Constant	–0.002005	0.025764	0.0166822	–0.0074441	–0.0084
	(0.015654)	(0.041451)	(0.0210725)	(0.0131538)	(0.010665)
Additive Term of Labour and Capital: (skK + slL)	–0.334982**	–0.424094	0.2489515***	–0.4136965*	–0.769932*
	(0.145698)	(0.271367)	(0.1417596)	(0.0806418)	(0.125491)
Education Growth (lit)	0.420248	0.248093	0.2574645	0.4237604	0.659898*
	(0.342875)	(0.886595)	(0.4936478)	(0.2676516)	(0.220658)
Growth in Health	0.133918	0.09977	0.1112044	0.220124	0.318187**
	(0.123368)	(0.201898)	(0.0949984)	(0.154663)	(0.144222)
Openness	0.00006	0.000345**	0.000068	0.0000837	0.000173*
	(0.0000738)	(0.000171)	(0.0000665)	(0.0000521)	(0.0000623)
Democracy Index	0.01349	0.01455	0.0080183	0.0193461	0.025738**
	(0.016285)	(0.053846)	(0.0172985)	(0.012609)	(0.010267)
R square	0.104561	0.1487	0.1467	0.1133	0.109767
No. of Observations	960	960	960	896	832

Notes: The results are robust to White Heteroscedasticity.
Values in parenthesis are SE.
*,**,*** Denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Table 4

TFP Growth Model

Dependent Variable	CE (TFP Growth)	FE (TFP Growth)	RE (TFP Growth)	2SLS (TFP Growth)	GMM (TFP Growth)
Constant	0.00361	0.030188***	0.0215694***	0.0018505	0.013621**
	(0.006878)	(0.01735)	(0.0117594)	(0.0065424)	(0.006382)
Additive Term of Labour and Capital: (skK + slL)	–0.342023*	–0.425506***	–0.2573585***	–0.3937059*	–0.58069*
	(0.125747)	(0.229081)	(0.1316689)	(0.087435)	(0.104419)
Education Growth (lit)	0.146158	0.093385	0.1133303	–0.0065759	0.151848***
	(0.15226)	(0.225234)	(0.1641487)	(0.1223719)	(0.086675)
Growth in Health	0.147268	0.103872	0.1135621	0.309495*	0.345319**
	(0.1002)	(0.220872)	(0.1099672)	(0.1182353)	(0.15962)
Openness	0.0000549	0.00034***	0.000062	0.0000734	0.0000312
	(0.0000704)	(0.000186)	(0.0000619)	(0.0000503)	(0.0000501)
Democracy Index	0.008147	0.01561	0.0048594	0.0116085	0.007216
	(0.008933)	(0.053347)	(0.0079754)	(0.007645)	(0.007457)
R-square	0.104083	0.1489	0.1467	0.1111	0.101735
No. of Observations	960	960	960	896	896

Notes: The results are robust to White Heteroscedasticity.
Values in parenthesis are SE.
*,**,*** Denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Also as compared to the 2SLS technique which accounts for only the significantly positive impact of education, the GMM approach states that both components of human capital exert a significant impact on growth. With both proxies of education variable, the regression estimates give evidence of the strong determinate impact of education and health status on the TFP growth.

The impact of human capital on economic growth can also be non-linear in style. To account for the possible nonlinearities in the human capital-output growth and human capital-TFP growth relationships, we employed the square, cubic and quartic terms of the human capital components; education and health in the various specifications of the equations 16 and 20. The results are reported in Appendix 3, Sections I and II. The interaction terms relating human capital components to democracy and trade openness is also in cooperated in the alternative specifications to explore the indirect impact of human capital components on the growth of output as well as TFP via democratic institutions and outward orientation in the economy. The interaction terms of human capital components and the power variables do not reflect any non linear trend in human capital- output growth and human capital-TFP growth relationships.

Semi-parametric Approach

The parametric model may lead to specification bias in case the functional form of the variables is not correctly modeled. An appropriate approach, in this case, would be to use a semi parametric formulation in which the human capital components are estimated in a data driven non parametric way. A partially linear semi parametric model is used for estimation where capital growth, labour growth, democracy and openness variables constitute the linear parametric part while human capital is essentially employed as the non parametric element in the model.

We first discuss the cases when human capital variable comprises of only one component. Appendix 3, Sections III and IV, specifications 3 and 11 report the results of the parametric components when literacy rate and health status are used as an indicator of human capital respectively. The second order Gaussian kernel is used as the multivariate kernel estimator and cross validation method is used for the band width selection. When literacy rate is employed as the only indicator of human capital, the corresponding graph depicts a slightly downward sloping curve which indicates that the studies that consider only the educational component of human capital are likely to attain the negative coefficients of human capital variable. On the other hand, the health component when employed as the single indicator of human capital reveals a non linear relationship with growth.

We then modelled both the education and health variables together as the non parametric components and the results are reported in Appendix 3, Section III specifications 4-6, and Section IV specifications 4-6. The corresponding graphs indicate that when both education and health components of human capital are included in the estimation model, the education component which initially

suggested a negative and some what linear relationship with growth, exhibit non linear trends along with the health component. The coefficients of the parametric variables do not change their signs or significance in this case.[2]

The interaction terms of the human capital components with democracy and openness are used in the semi parametric formulations which allow for the impact of human capital components on growth to be nonlinear. The corresponding graphs clearly depict that the human capital components affect output growth and TFP growth in a non linear way. However, the exact nature of the non linear relationship is not evident.

IV. CONCLUSION

Since the last few decades, researchers have contributed tremendously to the field of economic growth. There has been a continuous inflow of research papers right from the theoretical models of growth to their implications for the real world data. Among the different variables that gained the researchers' attention towards their impact on growth, human capital is undeniably the most significant one.

The empirical growth literature has yet to decide on the human capital-growth linkages in accordance with the theoretical growth models that assign a fundamental role to the human capital investments. This study has been conducted to resolve the dilemma of incongruity between theoretical and empirical evidence on human capital-growth relationship. Firstly it is focused whether human capital in terms of education and health indicators has a direct impact on output growth or indirect effect through total factor productivity growth. The study attempts to explore the sensitivity of the human capital estimates to different econometric estimation techniques and proxy for education. It is also investigated whether human capital-growth linkages are linear or nonlinear in nature using a sample of selected developing countries. Keeping in view the importance of health status in the context of developing countries, the human capital is decomposed in to education and health measures.

Our findings reveal that the human capital has a well established role in accelerating growth through both its 'level effects' and 'rate effects'. All the estimation techniques used in our analysis confirm the positive impact of human capital components on growth. However, the significance of the coefficients of human capital components varies with the estimation technique. In the panel data models, the coefficients of both components of human capital are insignificant. The 2SLS technique was applied in response to the endogeneity detected in the health variable, which turned the coefficient of one of the human capital

[2] A model specification test has been conducted as proposed by Li and Wang (1998). The general linear model is tested against the semi parametric formulation. The value of this test is insignificant in all cases implying that the null hypothesis of linear parametric model can not be rejected.

components significant, depending upon the indicator of the educational variable. The application of the GMM technique turned the coefficients of both human capital components significant. Thus the estimates of human capital components become accurate and sound with the incorporation of more theoretically sound estimation techniques that could deal with the more complex empirical growth issues.

Regarding the linear and non-linear connections of human capital with growth; our findings reveal that the parametric models perform well in case of linear relationship between human capital and growth. Parametric models considered in our study are unable to reveal the non linearities in the human capital-growth associations. The semi-parametric model, on the other hand, does indicate the existence of non linear linkages between human capital and growth, though it does not depict the true non linear functional form. In the nutshell we can claim that human capital coefficients in the growth models are technique dependent. Furthermore the choice of human capital proxies create little differences in the estimation results.

APPENDIX 1

Data and Variable Construction

The study is based on a balanced panel data set over the time period 1970-2000 for 32 developing countries i.e. thirty observations for each country in the sample adding up to a total of 960 observations. The selection of countries is on the basis of data availability. Among the selected 32 countries, 4 belong to South Asia, 4 to Middle East and North Africa, 9 to Sub Saharan Africa, 11 to Latin America and 4 to East Asia and Pacific Region. List of countries included in the sample along with the summary statistics of key variables are given in the Appendix 2.

Data and Variable Construction

Variable	Denoted by	Construction	Source
Output (in constant 2000 domestic prices)	Y_C		World Development Indicators
Price of Output	q_Y	GDP Deflator	World Development Indicators
Base Year PPP for Output	PPP^0_Y		Penn World Tables
Output (in constant 2000 US dollars)	Y	Y_C/PPP^0_Y	
Output Price Index	P_Y	$q_Y*PPP^0_Y$	
Output Share of Labour	s_{YL}	compensation of employees paid by resident producers (as`% of GDP) adjusted for no. of self employed in each country/no. of employees	National Accounts Statistics of UN ILO Database
Total Labour Compensation	L_{cpn}	$s_{YL}*q_Y Y_c$	
No. of Workers	N		World Development Indicators
Price index of Labour (2000 base)	q_L	L_{cpn}/N	
Labour Quantity (in constant 2000 domestic prices)	L_C	L_{cpn}/q_L	
Base Year PPP for Labour	PPP^0_L	$(q^0_L L^0_C/N^0)^I / (q^0_L L^0_C/N^0)^{US}$	
Labour (in constant 2000 US dollars)	L	L_C/PPP^0_L	
Labour Price Index	P_L	$q_L*PPP^0_L$	
Physical Capital (in constant 2000 domestic prices)	K_C	build from investment series via perpetual inventory method	World Development Indicators
Acquition Price of Investment	q_I	Investment Deflator	World Development Indicators
Rental Price of Capital	q_K	$(q_Y Y_C - q_L L_C)/K_C$	
Base Year PPP for Capital	PPP^0_I		Penn World Tables
Physical Capital (in constant 2000 US dollars)	K	K_C/PPP^0_I	
Capital Price Index	P_K	$q_K*PPP^0_I$	
Total Cost	C	$P_K K+P_L L$	
Cost Share of Capital	S_K	$P_K K/C$	
Cost Share of Labour	S_L	$P_L L/C$	
Adult Literacy Rates	ALR	Percentage of people aged 15 & above	World Development Indicators
Average Years of Schooling	AYS		Lee and Barro (1998)
Democracy	DEM	[14-(PR+CL)]/12	
Political Rights	PR		Freedom House
Civil Liberties	CL		Freedom House
Ratio of Exports + Imports to GDP	OPEN	Percentage of GDP	World Development Indicators
life expectancy at birth			World Population Prospects http://esa.un.org/unpp/index.asp

APPENDIX 2

Summary Statistics of Key Variables in Developing Countries over 1971-2000

Country		Growth Rates (in percentage) Output	Capital	Labour	Education (lit)	Education (sch)	Health	TFP
Algeria	Mean	3.40	4.36	3.63	3.77	4.12	0.96	-0.67
	St.Dev	5.69	3.22	0.43	1.30	1.37	0.33	5.44
Benin	Mean	3.32	2.22	2.34	4.10	5.42	0.69	1.05
	St.Dev	3.49	2.70	0.47	0.71	2.85	0.25	4.05
Botswana	Mean	9.79	10.01	3.12	1.72	3.89	-1.11	2.16
	St.Dev	5.37	3.17	0.39	0.46	2.49	3.63	5.52
Cameroon	Mean	3.64	4.66	2.39	2.90	2.00	0.39	-0.28
	St.Dev	6.62	4.39	0.40	0.71	0.51	1.09	6.42
Chile	Mean	4.27	3.78	2.46	0.29	0.96	0.68	0.97
	St.Dev	5.78	3.04	0.25	0.10	0.86	0.34	5.93
Colombia	Mean	3.78	3.97	3.28	0.54	1.82	0.57	0.07
	St.Dev	2.41	1.15	0.53	0.17	2.39	0.26	2.59
Costa Rica	Mean	4.31	4.67	3.54	0.26	1.42	0.49	0.15
	St.Dev	3.53	1.75	0.53	0.09	1.78	0.37	3.63
Dominican Republic	Mean	4.98	5.70	2.93	0.73	1.23	0.52	1.32
	St.Dev	3.60	1.91	0.39	0.19	0.36	0.22	3.54
Ecuador	Mean	4.11	3.59	3.06	0.69	1.98	0.66	0.77
	St.Dev	60.07	2.30	0.36	0.23	2.58	0.24	59.81
El Salvador	Mean	2.11	3.68	2.71	1.01	2.10	0.52	-0.76
	St.Dev	4.84	2.64	0.67	0.21	0.72	0.67	4.49
Fiji	Mean	2.72	2.57	2.47	0.85	1.37	0.52	0.23
	St.Dev	4.90	2.28	0.52	0.43	0.78	0.22	4.91
Honduras	Mean	3.61	3.99	3.44	1.30	2.57	0.79	-0.15
	St.Dev	3.28	1.77	0.22	0.31	2.40	0.48	3.53
India	Mean	4.64	4.79	2.06	1.82	2.39	0.85	0.93
	St.Dev	3.01	0.92	0.16	0.28	2.62	0.10	2.92
Indonesia	Mean	5.96	8.65	2.66	1.45	1.84	1.12	2.37
	St.Dev	4.32	2.17	0.22	0.52	1.33	0.28	4.24
Iran	Mean	3.09	4.61	2.98	2.65	3.97	0.91	-1.01
	St.Dev	7.59	4.62	0.70	0.84	1.31	0.16	8.01
Jordan	Mean	4.71	6.53	4.41	1.62	2.51	0.47	-1.21
	St.Dev	7.24	3.86	2.65	0.58	0.88	0.60	6.74
Kenya	Mean	4.45	2.35	3.41	2.35	2.20	0.06	2.08
	St.Dev	4.41	1.26	0.21	0.74	3.17	1.15	3.91
Mauritius	Mean	5.57	5.39	2.41	0.76	1.18	0.46	1.53
	St.Dev	3.91	2.84	0.57	0.24	1.43	0.21	3.90
Myanmar	Mean	4.24	4.83	2.11	0.64	3.08	0.52	0.55
	St.Dev	4.59	2.93	0.13	0.13	5.02	0.21	4.21
Pakistan	Mean	4.84	4.17	2.72	2.37	2.67	0.83	1.89
	St.Dev	2.22	0.81	0.26	0.47	0.72	0.24	2.25
Panama	Mean	3.45	3.30	2.88	0.49	1.93	0.45	0.30
	St.Dev	4.68	2.66	0.26	0.16	1.86	0.18	5.03
Paraguay	Mean	4.39	6.46	2.94	0.52	1.93	0.24	-0.89
	St.Dev	4.10	3.69	0.36	0.18	1.86	0.07	4.00
Philippines	Mean	3.47	4.78	2.82	0.41	1.81	0.64	-0.68
	St.Dev	3.70	2.37	0.14	0.51	1.33	0.04	4.18
South Africa	Mean	2.14	2.49	2.74	0.67	0.94	-0.45	-0.44
	St.Dev	3.58	1.52	0.32	0.17	3.18	2.36	3.65
Sri Lanka	Mean	4.49	6.18	2.06	0.43	1.26	0.39	0.15
	St.Dev	1.68	2.77	0.18	0.11	0.97	0.07	2.03
Tanzania	Mean	3.04	3.50	2.87	2.48	-0.13	-0.13	-0.37
	St.Dev	2.12	1.23	0.28	0.63	0.94	1.61	2.58
Thailand	Mean	6.18	6.32	2.37	0.48	1.54	0.43	0.88
	St.Dev	4.32	2.92	0.91	0.65	1.02	0.64	4.44
Trinidad and Tobago	Mean	1.99	4.44	1.93	0.25	1.27	0.38	-1.26
	St.Dev	4.74	3.83	0.81	0.11	1.87	0.06	3.97
Tunisia	Mean	5.07	4.96	3.07	3.17	4.07	0.96	1.60
	St.Dev	3.53	2.04	0.52	1.41	2.27	0.54	3.50
Venezuela	Mean	1.82	1.97	3.78	0.64	2.42	0.41	-0.74
	St.Dev	4.30	2.13	0.79	0.24	3.74	0.12	4.76
Zambia	Mean	1.01	-1.42	2.63	1.65	2.19	-0.63	0.56
	St.Dev	4.05	2.20	0.47	0.31	2.06	2.06	4.18
Zimbabwe	Mean	2.98	3.08	2.89	1.43	3.29	-0.44	-0.06
	St.Dev	5.36	2.16	0.80	0.45	4.45	1.90	5.64
All Countries	Mean	3.99	4.39	2.85	1.39	2.23	0.41	0.34
	St.Dev	11.43	3.30	0.85	1.18	2.45	1.13	11.33

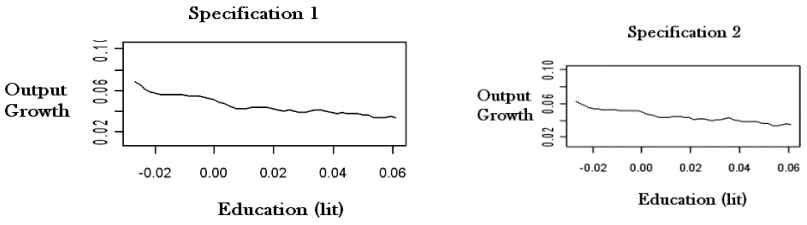
Appendix 3

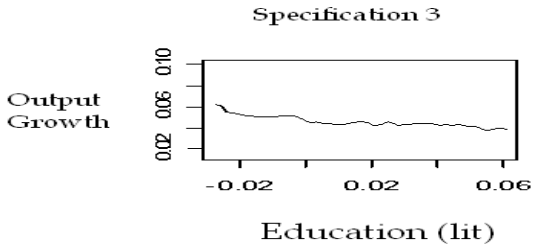
Appendix 3

Appendix 3

Appendix 3

Graphs Related to Section III





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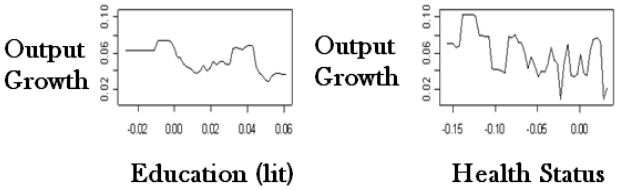

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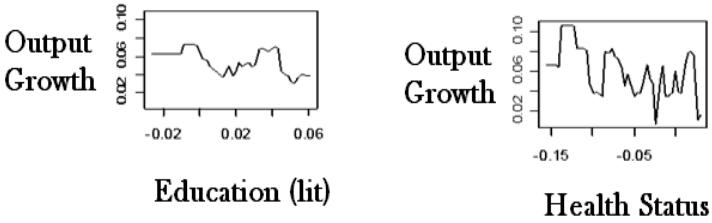

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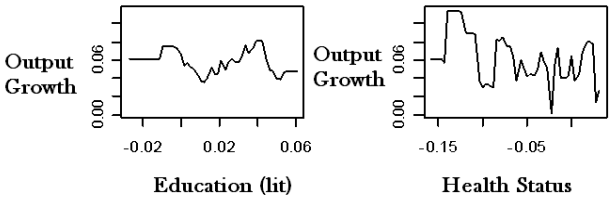

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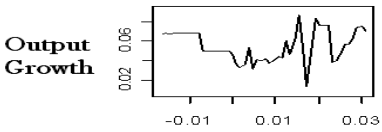

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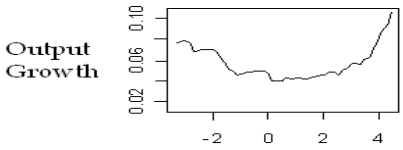

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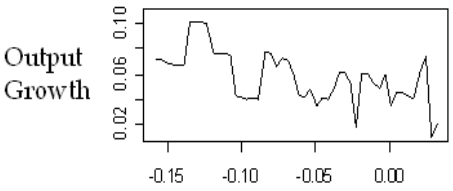
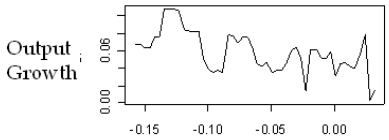


Health Status

Specification 10



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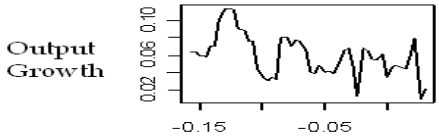

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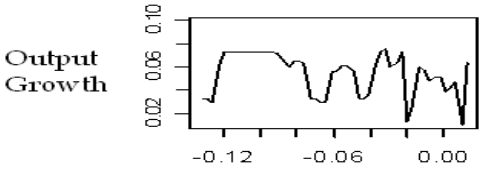

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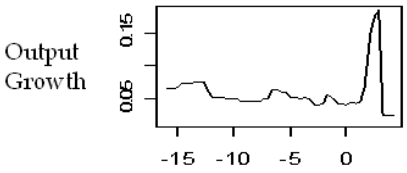

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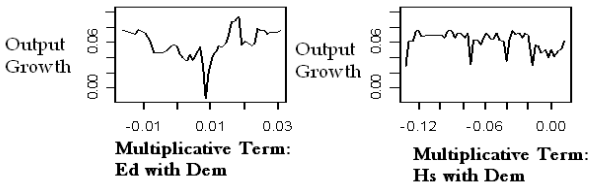
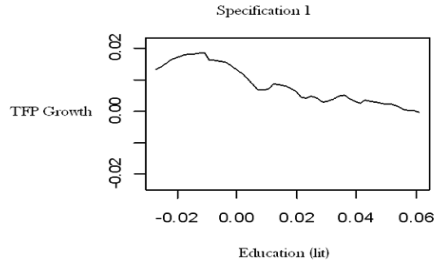
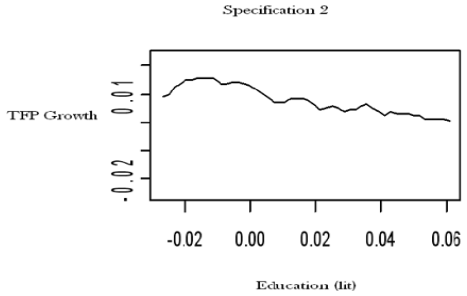
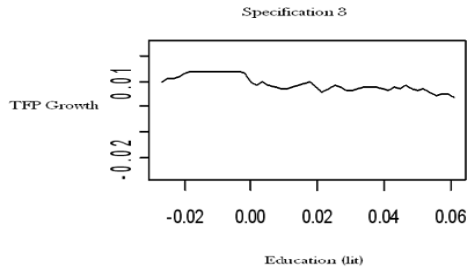
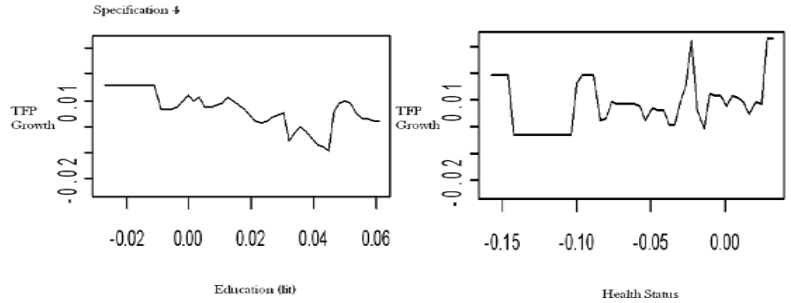


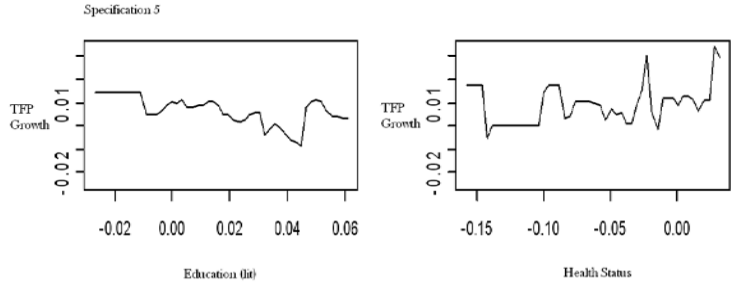
Graphs Related to Section IV

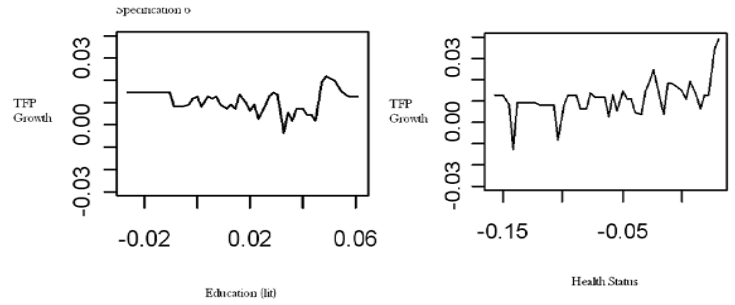












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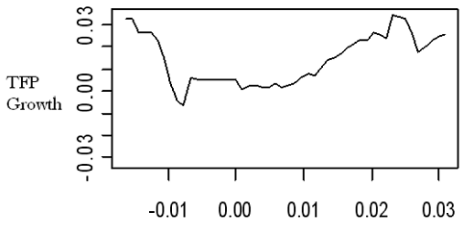

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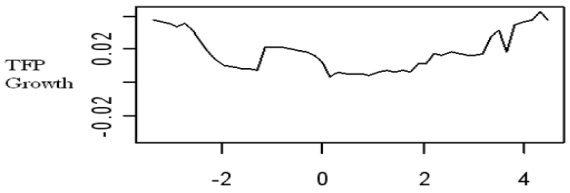

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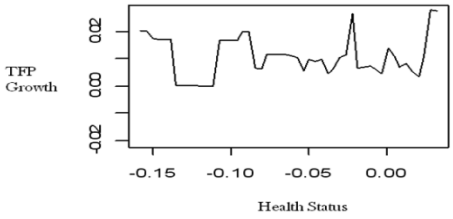

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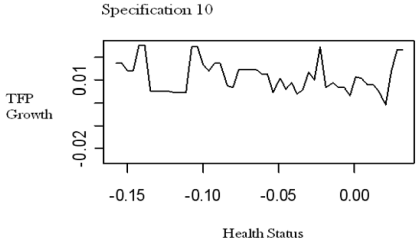

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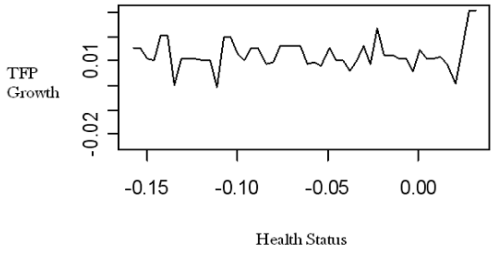

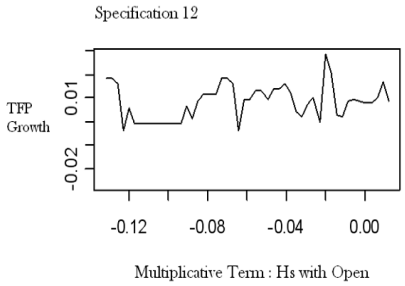

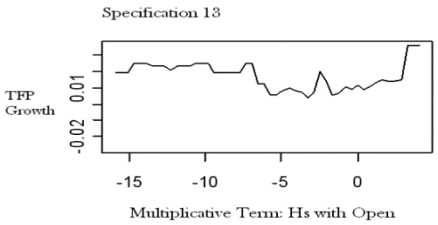

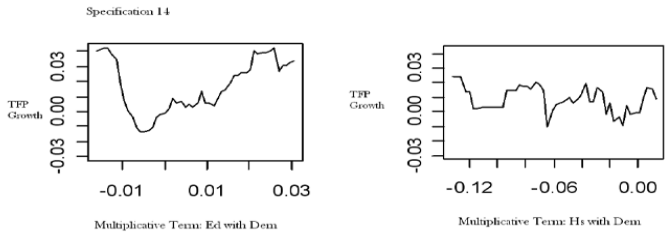

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APPENDIX 3

Section I

Parametric Estimation (GMM)

Dependent Variable: Output Growth	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Constant	0.021**	0.020**	0.022**	0.005	0.011	0.004	0.004	0.003	0.001	0.026	0.005	0.017	0.010	0.007
	(0.03)	(0.01)	(0.01)	(0.010)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.05)	(0.03)	(0.01)	(0.01)
Capital Growth	0.219*	0.232*	0.209*	0.144**	0.119***	0.235*	0.221*	0.230*	0.291*	0.243*	0.211**	0.233**	0.181**	0.165*
	(0.0004)	(0.06)	(0.06)	(0.066)	(0.07)	(0.06)	(0.06)	(0.06)	(0.08)	(0.06)	(0.09)	(0.09)	(0.08)	(0.06)
Labour Growth	0.243	0.195	0.256	0.221	0.193	0.120	0.022	0.081	0.10 1	0.082	0.193	0.302	0.137	0.099
	(0.44)	(0.33)	(0.32)	(0.31)	(0.31)	(0.32)	(0.32)	(0.33)	(0.34)	(0.36)	(0.33)	(0.39)	(0.32)	(0.31)
Education Growth : Ed	0.275***	0.139		0.297***	0.661*	1.640*	1.684*	2.066***	0.347	3.658	0.688	2.459	0.494**	0.411**
	(0.09)	(0.13)		(0.15)	(0.24)	(0.55)	(0.58)	(1.19)	(2.42)	(3.22)	(5.04)	(2.34)	(0.21)	(0.18)
Growth in Health: Hs		0.297**	0.363**	0.303**	0.287**	0.169**	0.461***	0.184**	0.103	0.155	0.122	0.161	0.627**	0.872**
		(0.13)	(0.16)	(0.14)	(0.14)	(0.08)	(0.24)	(0.09)	(0.12)	(0.09)	(0.09)	(0.12)	(0.31)	(0.41)
Open				0.0001*	0.00017*	0.00013*	0.00011**	0.00014*	0.00013**	0.00017*	0.000004	0.0002	0.0002***	0.0002**
				(0.00006)	(0.00006)	(0.00005)	(0.00004)	(0.00005)	(0.00006)	(0.00006)	(0.0002)	(0.0003)	(0.0001)	(0.00008)
Democracy Index					0.026**	0.014**	0.007	0.012***	0.013	0.034	0.011	0.014	0.025*	0.024*
					(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.04)	(0.01)	(0.01)	(0.01)
Ed^2						–28.762**	–33.462**	-61.623	–44.972	–-63.986	–75.324	–36.512***		
						(12.64)	(13.80)	(68.42)	(98.00)	(59.98)	(25.94)	(18.78)		
Ed^3								531.184	4297.962					
								(1025.94)	(6396.06)					
Ed^4									-71176.63					
									(101775.8)					
Hs^2							4.341						7.226***	11.029
							(3.11)						(4.21)	(17.53)
Hs^3														1.748
														(113.83)
Hs^4														
Dem * Ed										–1.423	0.241			
										(2.22)	(3.02)			
Open * Ed											0.011	-0.009		
											(0.01)	(0.03)		
R-square	0.112	0.117	0.111	0.119	0.123	0.123	0.118	0.12	0.111	0.113	0.123	0.119	0.12	0.118
No of Obs.	895	867	865	832	838	838	867	838	838	867	867	867	867	896
Chi-square value for J Test	7.72	12.261	10.023	6.576	5.653	11.5	11.163	13.573	9.664	16.3863	14.034	13.872	11.997	9.509
Critical value of chi-square	9.48	12.59	11.07	14.06	15.5073	22.3621	19.6751	22.3621	22.3621	22.3621	22.3621	19.6751	18.307	18.307

Notes: (1) The results are robust to White Heteroscedasticity.

(2) Values in parenthesis are SE.

(3) *,**,*** denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Section II

Parametric Estimation (GMM)

Dependent Variable: TFP Growth

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Constant	0.019* (0.01)	0.012** (0.01)	0.021* (0.01)	0.009 (0.01)	-0.008 (0.01)	-0.008 (0.01)	-0.019** (0.01)	-0.021** (0.01)	-0.008 (0.02)	0.029** (0.01)	0.030 (0.02)	-0.017 (0.01)	-0.017 (0.01)	-0.012 (0.01)
M :(skK + slL)	-0.659* (0.12)	-0.399* (0.15)	-0.597* (0.16)	-0.736* (0.12)	-0.769* (0.13)	-0.663* (0.12)	-0.737* (0.12)	-0.723* (0.12)	-0.345* (0.09)	-0.797* (0.16)	-0.799* (0.13)	-0.744* (0.14)	-0.749* (0.12)	-0.705* (0.13)
Education Growth : Ed	0.261*** (0.13)	0.350** (0.16)		0.309** (0.14)	0.659* (0.22)	1.89* (0.61)	1.922* (0.59)	2.996*** (1.61)	0.603 (2.07)	-0.874 (1.12)	-2.945*** (1.73)	1.629*** (0.89)	0.842* (0.29)	0.987** (0.41)
Growth in Health: Hs		0.311** (0.15)	0.369** (0.16)	0.339** (0.15)	0.318** (0.14)	0.279** (0.13)	0.713*** (0.43)	0.174*** (0.09)	0.119 (0.11)	0.009 (0.08)	0.130 (0.08)	0.171*** (0.09)	0.313 (0.48)	0.013 (0.86)
Open				0.00017* (0.00006)	0.00017* (0.00006)	0.00011** (0.00005)	0.00017* (0.00005)	0.00018* (0.00005)	0.000081 (0.00005)	0.000023 (0.00006)	0.000043 (0.00009)	0.00013 (0.0001)	0.00015** (0.00006)	0.00014** (0.00006)
Democracy Index					0.026** (0.01)	0.016** (0.01)	0.025* (0.01)	0.025* (0.01)	0.015 (0.01)	-0.008 (0.01)	-0.012 (0.02)	0.030* (0.01)	0.035* (0.01)	0.031* (0.01)
Ed^2						-33.652** (14.68)	-32.694** (14.26)	-102.076 (89.96)	-28.086 (81.29)	17.569 (18.25)	42.586*** (25.03)	-29.117** (13.96)		
Ed^3								1121.027 (1310.37)	2732.89 (6100.39)					
Ed^4									-49095.41 (95386.02)					
Hs^2							11.159 (9.05)						3.691 (10.01)	-43.721 (84.76)
Hs^3														-573.459 (936.76)
Hs^4														
Dem * Ed										1.339 (1.16)	3.063* (1.13)			
Open * Ed											0.012 (0.01)	0.005 (0.01)		
R square	0.104	0.104	0.103	0.105	0.109	0.103	0.107	0.101	0.102	0.102	0.106	0.109	0.11	0.106
No of Obs	838	838	867	838	832	867	867	838	867	838	867	867	867	838
Chi-square value for J Test	6.704	13.408	9.45	6.443	5.544	7.311	4.371	11.648	17.34	20.112	16.473	6.774	13.005	20.112
Critical value of chi-square	9.487	14.067	11.07	12.591	15.507	15.507	18.307	19.675	22.362	23.684	22.362	18.307	16.919	21.026

Notes: 1) The results are robust to White Heteroscedasticity

2) Values in parenthesis are SE.

3) *,**,*** denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Section III

Semiparametric Model

Dependent Variable: Output Growth

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Capital Growth	0.414**	0.398**	0.394**	0.435**	0.429**	0.419**	0.388**	0.373**	0.419**	0.399**	0.389**	0.391**	0.391**	0.409**
	(0.11)	(0.11)	(0.11)	(0.17)	(0.16)	(0.17)	(0.12)	(0.12)	(0.13)	(0.13)	(0.13)	(0.12)	(0.12)	(0.17)
Labour Growth	0.243	0.193	0.152	0.072	0.035	0.006	0.127**	0.177	0.215	0.148	0.127	0.142	0.163	0.064
	(0.45)	(0.45)	(0.46)	(0.65)	(0.66)	(0.66)	(0.46)	(0.45)	(0.43)	(0.44)	(0.44)	(0.45)	(0.46)	(0.65)
Open		0.0001	0.0001		0.0001	0.0001	0.0001	0.00001		0.0001	0.0001	0.0001	0.00002	0.0002
		(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.001)
Democracy Index			0.012			0.021	0.009	0.014			0.014	0.004	0.007	0.009
			(0.02)			(0.02)	(0.02)	(0.02)			(0.02)	(0.02)	(0.02)	(0.001)
Country Dummies	included	included	included	included	included	included	included	included	included	included	included	included	included	included
Time Dummies	included	included	included	included	included	included	included	included	included	included	included	included	included	included
Non-Parametric Estimators														
Education Growth (lit): Ed	included	included	included	included	included	included								
Growth in Health: Hs				included	included	included			included	included	included			
Dem * Ed							included							included
Open * Ed								included						
Dem * Hs												included		included
Open * Hs													included	
Model Specification Test	-0.926	-0.926	-0.926	-0.944	-0.937	-0.941	1.249	-0.962	-0.938	-0.931	-0.937	-0.875	-0.973	-0.949
p-value	0.479	0.476	0.476	0.426	0.424	0.431	0.015	0.288	0.449	0.436	0.454	0.714	0.519	0.276
R square	0.119	0.120	0.120	0.112	0.112	0.113	0.141	0.123	0.118	0.120	0.120	0.116	0.125	0.114
No. of observations	960	960	960	960	960	960	960	960	960	960	960	960	960	960

Notes: 1) Values in parenthesis are SE.

2) *,**,*** denote significance at 1 percent, 5 percent and 10 percent levels respectively.

Section IV

Semiparametric Model

Dependent Variable: TFP Growth

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
M :(skK + slL)	-0.286	-0.314***	-0.324***	-0.312	-0.321	-0.336	-0.321***	-0.371***	-0.274	-0.312	-0.330	-0.323	-0.329	-0.316
	(0.18)	(0.18)	(0.19)	(0.28)	(0.28)	(0.28)	(0.19)	(0.20)	(0.21)	(0.21)	(0.21)	(0.21)	(0.20)	(0.28)
Open		0.0001	0.0001		0.0001	0.0001	0.0001	-0.00001		0.0001	0.0001	0.0001	-0.00001	0.0001
		(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	(0.0001)		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Democracy Index			0.011			0.019	0.006	0.014			0.013	-0.008	0.007	-0.013
			(0.02)			(0.02)	(0.02)	(0.02)			(0.02)	(0.02)	(0.02)	(0.03)
Country Dummies	included	included	included	included	included	included	included	included	included	included	included	included	included	included
Time Dummies	included	included	included	included	Included	included	included	included	included	included	included	included	included	included
Non-Parametric Estimators														
Education Growth: Ed	included	included	included	included	Included	included								
Growth in Health: Hs				included	Included	included			included	included	included			
Dem * Ed							included							included
Open * Ed								included						
Dem * Hs												included		included
Open * Hs													included	
Model Specification Test	-0.874	-0.875	-0.875	-0.874	-0.875	-0.875	-0.956	-0.951	-0.874	-0.875	-0.875	-0.875	-0.875	-0.985
p-value	0.714	0.714	0.714	0.714	0.714	0.714	0.328	0.371	0.714	0.714	0.714	0.714	0.714	0.323
R square	0.103	0.104	0.104	0.102	0.102	0.103	0.106	0.107	0.103	0.104	0.104	0.104	0.104	0.106
No. of observations	960	960	960	960	960	960	960	960	960	960	960	960	960	960

Notes: 1) Values in parenthesis are SE.

2) *,**,*** denote significance at 1 percent, 5 percent and 10 percent levels respectively.