Revised Macro-Mincer Model for Human Capital Investment in Economic Growth

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Abstract: Theoretical verdict of the economic growth evolved extensively over last decades in the growth literature. Despite the numerous explanations of growth empiric, macro economic perspectives to understand the role of human capital in economic growth needs to be thoroughly understood to make prudent economic policies for investment. The paper intends to identify the empirical specification and estimation for effect of human capital on economic growth. The rationale for the research is to provide pragmatic evidences that lead economic growth under the human capital investment policies. Empirical approach is applied to (i) construct revised-Macro-Mincer model (ii) estimate revised Macro-Mincer model with instrumental variable 2SLS approach to reveal the effect of human capital growth on economic growth using macroeconomic data from ASEAN and South Asian region from 1960 to 2014. The revised Macro-Mincer model provides theoretical specification and empirical validation of the human capital in economic growth derived from Solow growth model. Then, it is used for finding the signaling effect of the Investment, dependency, industry-services and rural-urban population changes of the Macro-Mincer model. Further, the revised version is applied for the Lucasian growth model to confirm the effects of human capital in economic growth progress. The revised Macro-Mincer model, across estimation methods and specifications, predicts a strong relationship between human capital and economic growth, and estimates the coefficients robustly than recent models in the literature. The results of the model exposes that, in addition to the growth of the previous year and its difference, human capital also paly a significant role on the growth rate of the economy. Further, life expectancy and trade openness included in new version of the model are significant predictors of growth rate of GDP per capita. Insignificance of the binary for regional variation implies that spatial disparities are not a driver of economic growth. The implications of the study are to deliberate on the investment in human capital to promote economic growth in the economies. Finally, the paper guides policymakers to reform human capital, in terms of educational reforms in human development policies to achieve advancement in economic growth.

Keywords: Human Capital, Economic Growth, Signaling, Revised Macro-Mincer Model, IV 2SLS estimation

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1. Introduction

Most of the growth literature supported the fact that economic growth is driven by the human capital, as one of the major determinants for many economies, while its investment in growth of human capital is an important source for ASEAN and South Asian regions. Theoretical underpinning of substructures for economic growth is studied in many seminal studies in the empirical literature. The role of human capital for the economic growth has been studied emphasizing the neoclassical or endogenous growth theories including the investment in human capital. Today, the growth empiric provides insight of the explanations of the economic growth under the diverse indicators of the human capital embedded into the basic economic growth models. However, the role of human capital growth in stimulating economic growth is capable of making drastic structural changes to the economies of ASEAN and South Asia. The idea of investment of human capital for economic growth is highly interrelated among many developed and developing countries to facilitate the economic growth in terms of macroeconomic perspectives. This study analyzes the new approach for modeling the interconnection between the human capital and economic growth for the ASEAN and Japan, China and Korea and South Asia. In human development, policy analysis has been devoted to explain these relationships in economic growth. Nevertheless, the literature shows a gap in these economies to provide empirical evidences to foster the economic growth.

Literature provides wide range of relationships between the human capital investment and economic growth. Those discuss about the theoretical and empirical approaches for realizing the role of human capital in the progression of economic growth. However, prominent and seminal studies on human capital theory and investment are developed for the rigorous analysis at macroeconomic level by many researchers. They have concluded mixed results that how increase of human capital affect the economic growth in individual and group of countries as well as the globe. Many Asian governments remain severely involved in the provision of human capital development in terms of education and training for labour force to foster rapid economic growth. ASEAN and South Asia are two regions share the same human development motives with different level of capacities to improve the educational quantity and quality with accelerated economic policies. But underline facts inhibit the human development with lack of studies governing factors in the human capital investment for the region. According to the Mincer hypotheses, the relationship between human capital measured by years of schooling and economic growth: various indicators of education tend to predict unrevealing evidences for modern economic growth. Finding a set of appropriate growth promoting policies is a complicated for the human development since different countries face different challenges and constraints.

In terms of methodology, serious theoretical specifications and econometric issues are raised in parameter estimation of results with the use of panel data in the Macro-Mincer model. In terms of theoretical specification, omission of key variable called experience in the macro model, and physical capital, other possible explanatory variables are prominent limitations in the prevailing models. In terms of empirical estimation, the endogeneity issue center around the likely non-random nature of the distribution of the residuals obtained from time series estimation, robustness of the estimates, simultaneous problems, over estimation of the results due to inclusion of the key macro variables in the model are obvious errors. Therefore, it needs a number of steps for specifications and estimation of new version of Macro-Mincer model to test and estimate the accurate coefficients while detecting and revising these problems. This paper, fill the gaps in the literature, construct the revised Macro-Mincer model based on the Solow growth hypothesis and then augmented it for the human capital obtaining robust estimations emphasizing the law of motion of physical capital and human capital. Lastly, Macro-Mincer hypothesis was tested to build empirical evidences for human capital investment policies for ASEAN and South Asia regions for economic

growth.

Base on the above justification, the objective of this paper is to examine the extent to which human capital investment influence on economic growth explained in the revised Macro-Mincer model for ASEAN and South Asian countries. It examines the role of human capital in signaling for the investment, demographic changes, sectoral changes and population changes in rural and urban setting. To support the growth literature, this paper builds the revised version of the model using the instruments for innovation, financial development and urbanization rate extensively used as the best available proxies in economic analyses. Findings of the study will support the group of countries to take macroeconomics policy alternatives to invest in human capital for economic growth.

The outline of the remainder of this paper is as follows. Section 2 provides an explanation of literature review. Section 3 presents the Data and Empirical Method, in particular, the estimation model, econometric approach, and section 4 gives the estimation of results and discussion. Section 5 and 6 present conclusion and policy recommendations respectively.

2. Literature Review

2.1 Macroeconomic Perspective of Human Capital and Economic Growth

The growth empiric provides Ramsey (1928) started works in neo-classical growth theory. But Solow (1956) and Swan (1957) have made important contributions in the neoclassical after Ramsey's initiative. Besides, the Solow-Swan growth model is the neoclassical form of production function, a specification that assumes constant returns to scale, diminishing returns to each input, and some positive and smooth elasticity of substitution between the inputs. The important prediction of the neoclassical growth model is that the economic growth in the long run, depends on the exogenous variables, namely technological progress and population growth. The macroeconomic perspective of role of human capital to economic growth has two means: neo-classical stand of human capital and endogenous growth.

a. Neo-classical approach to human capital accumulation

In 1950, the Solow-Swan exogenous growth theory that was developed considering the immediate predecessor of the new growth theories. Initially, it only included labour, L, physical capital, K and technology, A; the latter exogenous variables are also included in the long-run growth. However, in human capital revolution, human capital was augmented to this model. But, no real difference happened in the structure of the theory because of the assumption of diminishing returns of human capital.

Two ways to augment human capital to the Solow-Swan model implemented, in first, capturing the heterogeneity by adjusting the quantity of labour by the human capital index, and the second treating human capital as another input in the production function. The first strand considered the heterogeneity of labour force and augments human capital under this phenomenon. In here, human capital is treated as a weight to capture the quality of labour – named the labour quality adjusted model or three factor inputs model (Mankiw – Romer – Weil Model). In the second strand, human capital is treated as a factor input like physical capital and labour. The standard Solow-Swan model (Solow 1956; 1957, Swan 1956), augmented with human capital and starting with a Cobb-Douglas production function are the given capital intensities of physical, human capital and labour which have decreasing rate of returns.

b. Endogenous Growth and Human Capital

Later, the endogenous growth theory describes economic growth generated by factor within the production process. In the theory, the growth rate depends on one variable i.e. the rate of return on capital. It further argued that the rate of returns on all form of capital must be equal in the balanced - growth equilibrium. The rise of human capital theory (Schulz, 1961; Becker, 1964) led the inclusion of human capital; still long run growth was completely driven by unobserved component of reduced Total Factor Productivity (TFP). Hence, it led to the introduction of the new growth theories in which human capital was modeled as a factor of long run growth.
The two strands of new growth theories emerged use of the new additional 'capital' to relax the diminishing returns in the neo-classical model and thus create endogenous growth; human capital in a various forms. In the Lucas (1988) model, human capital was inserted as a factor of production with the Solow model augmenting human capital. However, in contrast, he argued that the formation of human capital was subject to constant, or increasing, marginal returns in human capital accumulation. Next, a logical consequence of the Solow growth model was build with human capital positively influenced the growth of GDP. The third, inclusion of human capital as a factor of production implying the skills embodied in a worker (Barro and Sala-i-Martin 2004). In the latter Romer (1990) model, the neo-classical growth model is followed in the sense that technological change causes long-run growth. This effect of technological growth on GDP growth through its level of human capital, either because human capital produces new technologies directly or because it is used as an input in R&D related activities (Sianesi and Van Reenen 2003). This has two consequences. First, it is the level of human capital that has an effect on GDP growth. Second, whereas in the theory of Lucas human capital is seen as skills embodied in a worker, in the theory of Romer it is seen as knowledge and ideas.

2.2 Investment in Human Capital

Shultz (1961) classified skills and knowledge that people acquire as a form of human capital, and revived interest in the notion of human capital. Recently, however, the concept of human capital has been extended to incorporate non-market activities, and a broader definition of human capital is 'the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being' (OECD, 2001, p18).

In theory of human capital investment, Becker (1975), Mincer (1974) and Schultz (1961) make a significant contribution to the literature for understanding the investment in human capital. These literatures established a strong foundation for investments in physical capital and in human capital. They suggest theoretical foundation indicating that the agents are assumed to choose their schooling attainment level in order to maximise their expected present value of the stream of future incomes, up to their retirement age. Thus, the optimum level of schooling, s, is obtained by equating marginal benefits and marginal costs, as below:

$$\sum_{t=1}^{T-s} \frac{w_s - w_{s-1}}{(1+r_s)^t} = w_{s-1} + c_s$$

Where T is the retirement date, c_s are costs of education, w_s are wages to be obtained with s years of schooling, and r_s is the internal rate of return.

Following the above framework and micro approach of Mincer equation, recently many studies attempt to build a relationship in macroeconomic perspectives of Mincer model. Even though, the basic model suffers from numerous deficiencies in terms of specification and estimation, it provides an avenue to revise the model into a new version overcoming drawbacks.

2.3 Macro-Mincer Model and Macro Returns to Education

Based on the theoretical arguments, it is evidence that the microeconometric approach to an increase in individual's income in line with education investment. In macroeconomic approach, it is the avoidance of experience from the Mincer equation to build log-linear functions for the individuals that can be aggregated into a "Macro-Mincer" wage equation (Heckman and Kleenow, 1997).

The equation becomes:

$$ln(Y) = \alpha + \beta S + \varepsilon$$

Where Y is the geometric mean of wages and S is the average education.

In literature, it shows that the macro and micro estimates yield similar effects of education on income comparing the coefficient on education from cross-country log GDP equations to the coefficient on education (Heckman and Kleenow, 1997) revealing that no human capital externalities exist. However, in Krueger and Lindahl (1998 and 2000) study finds the macro literature suggested that the effect of changes in educational attainment on income growth in cross country data is at least as great as microeconometric estimates of returns to years of schooling. De la Fuente and Domenech (2000) found no influence of education on growth are due to deficiencies of human-capital data used in empirical studies. They remove deficiencies from the data for a set of OECD countries and then, the results suggest that human capital is a crucial productive input in economic growth. Cohen and Soto (2001) used new data on human capital and employed neo-classical production function as in Mankiw et. al. (1992) and a macro-Mincerian approach to human capital. However, they interestingly found that the problem of endogeneity of education, and instrumented schooling with the 1900 school enrolment level. The instrumental variable (IV) results are slightly higher than the OLS estimates. The study regressed the growth rate of the income per capita on the increase in the number of years of schooling to test the robustness of the results.

2.4 Review of Empirical Studies

A number of attempts to empirically investigate the relationship between human capital and economic growth have been made in the literature with variety of approaches such as cross sectional regression or time series in modeling. This section provides evidences for the cross-countries approach in panel data models.

Mankiw, Romer and Weil (1992) modelled human capital as an factor input to do the growth accounting exercise for 98 countries in 1985. They found strong support for the contribution of human capital to economic growth. Further, Boswoth, Collins and Chen (1995), Hall and Jones (1999), Klenow and Rodiquez (1997) found smaller results of human capital to economic growth. In another study, the growth accounting for growth in output per worker in cross country differences found that the contribution of human capital to economic growth during 1960-1992 (Bosworth et. al., 1995). Additionally, Hall and Jones (1999) found a high contribution of human capital whereas Klenow and Rodriquez (1997) found surprisingly low contribution of human capital on economic growth. The results of modern the studies show a higher effect of TFP on growth per labour but the role of human capital declined in TFP. The original studies also focused on variables such as literacy and enrolment rate since the effect of TFP growth seems to increase over time and use different human capital variables.

An enormous empirical literature on the relationship between education and economic growth has developed as macro studies using different proxies of education indices for

the estimation of the effect of human capital on economic growth. The main proxies of the education quantity are measured by: a. schooling enrolment ratios (Barro, 1991; M.R.W, 1992; Levine and Renelt, et. al., 1992), b. the average years of Schooling (Hanushek and Woessmann, 2007; Krueger and Lindhal, et. al., 2001), c. adult literacy rate (Romer, 1990; Durlauf and Johnson, et. al., 1995), d. education spending (Baldacci, 2008, et al; et al). The bulk of studies conclude that there is a strong positive relationship between education quantities or in broader term human capital and economic growth (Krueger and Lindahl, 2001; Temple, 1999, 2000; Topel 1999; De la Fuente and Domenech, et. al., 2006). The overall conclusion from the macro-empirical literature suggests the existence of a bi-directional or a unidirectional causal relationship between education quantity and economic growth. More specifically, Krueger and Lindahl (2001) in their survey on education and economic growth found that "education is statistically significantly and positively associated with subsequent growth only for the countries with the lowest level of education".

Nevertheless, recent studies show that the variables shifted toward 'average years of schooling'. But, literacy and enrolment rates are obvious proxies for the level and growth of human capital respectively. But 'average years of schooling' are generally used as a proxy of the level of human capital. Evidently, this reduces the effect of human capital on growth considerably. This is one of the misspecification in the recent literature. The cross sectional regression discussed it as a limitation because panel regressions suffer of parameter heterogeneity. Even today, the vast majority of empirical growth studies assume that the parameters that describe growth are identical across countries, which is not factual according to the theory. Still, cross-countries approach refers to the 'average effect' of a variable across countries are also shortcoming particularly severe when testing the causality as the possibility of differences in causality pattern.

3. Data and Empirical Methodology

This approach first follows previous empirical studies to build the macro-mincer model and then it is augmented with the motion of physical capital with several econometric specifications. Second, starting from new Macro-Mincer model, the variations are captured using exogenous variables with macroeconomic data. Key instrumental variables with testing for robustness of IV-2SLS estimation method is applied to control for endogeneity, omitted variable bias, simultaneity, and measurement error.

3.1 Data

The dataset includes South Asia and ASEAN countries and Japan, China, and South Korea over the period 1960-2014. Based on the availability of data for the ASEAN and South Asian regions, macroeconomic data on government consumption, inflation, total population growth, old dependency ratio, young dependency ratio, foreign direct investment, trade openness, human capital, patents, population density are generated from various years of the World Development Indicators of the World Bank and PWT 9; all nominal values are converted to constant 2015 U.S. dollars using the CPI. Table A.1 (see Annex) represents the countries of the study. The key variables are constructed as below.

GDP per capita (GDP): real GDP per capita is calculated. If the estimated coefficient is positive and significant, it is concluded that countries with high GDP per capita catch up countries with low GDP per capita.

Human capital (hc): Proxy for the human capital accumulation by the percentage of labour force was obtained from the Human capital index, based on years of schooling and returns

to education were obtained from the PWT 9. Further it focuses on human capital investment measuring in the form of education and keeping aside investment in health and training.

Population growth rate ($\boldsymbol{n+g+\delta}$): According to endogenous growth theory, an investment rate leads to high physical capital stock at regular state and increases human capital during transitional dynamics. They conclude that population growth is responsible for the increase in human capital. The population growth rate was obtained from PWT 9 and adjusted with the depreciation rate and technical progress.

3.2 Estimation of Macro-Mincer Model

The basic Solow model (Solow, 1956) assumes a neoclassical production at time t:

$$Y_t = F(K_t, A_t L_t) \quad \text{(1)}$$

Where y_t is output, $K_t$is physical capital, L_t is labour and $A_t$is technology. $A_t L_t$ is referred to as effective labour, taking into account labour L_t and technology A_t. The neo-classical production function has three important assumptions (Barro and Sala-i-Martin, 2004; Romer, 2006). First it has constant returns to scale in its capital and labour input:

$$F(aK_t, aA_t L_t) = a * F(K_t, A_t L_t) \; for \; all \; a \geq 0 \quad \text{(2)}$$

Under the above assumption, setting $a = \frac{1}{A_t L_t}$yields the intensive form of the production function,

$$\frac{Y_t}{A_t L_t} = F(\frac{K_t}{A_t L_t}, 1) = \frac{1}{A_t L_t} F(K_t, A_t L_t) \quad \text{(3)}$$

Define,

$$y_t \equiv \frac{Y_t}{A_t L_t}, k_t \equiv \frac{K_t}{A_t L_t} and \; F(k_t) \equiv F(k_t, 1) \quad \text{(4)}$$

Where $y_t \equiv \frac{Y_t}{A_t L_t}$ referred to as output per effective worker and $k_t \equiv \frac{K_t}{A_t L_t}$refers to capital per effective worker.

The equation then becomes,

$$y_t = f(k_t) \quad \text{(5)}$$

The second assumption for the production function is the rule of diminishing returns in capital and labour. This assumption implies that, holding labour and the level of technology constant, the marginal product of capital is positive but it reduces if capital increases. In similar pattern, under the assumption of diminishing returns to labour, the marginal product of labour is positive but it decreases if labour increases, holding capital and the level of technology constant.

Where βL is labor augmenting technological progress that grows at a constant exponential rate gB. The population grows at rate n and the K capital stock grows according to:

$$K = sY - \delta K \quad \text{(6)}$$

The model written in intensive form is,

$k = sy - (\delta + n + gB)^k$ ……..……..…..*(7)*

To see this, consider the following law of motion for human capital:

$\frac{\dot{h}}{h} = gH + \alpha\frac{\dot{k}}{k}$……..……..……..*(8)*

and the law of motion of physical capital,

$\frac{\dot{k}}{k} = sk^{\alpha-1}(1-\theta) - (\delta + n + gB)$ ……..……..…..*(9)*

3.3 Estimating the equation

The estimating equation is derived differentiating a per capita version with respect to time.

$\frac{\dot{h}^c}{h} = -gA + \frac{\dot{y^c}}{y}$……..……..……..…..*(10)*

An amended version of above (5) equation with the other developments in baseline model is

$ln(y_{it}) = \beta_0 + kt_i + \beta_1\, ln(y_{it-1}) + \beta_3 edu_{it-1} + \mu_{i,t}$……..……..……..…..*(11)*

Substituting out income per capita with motion across the time, the estimating equation becomes:

$\Delta \ln(y_{it}) = \beta_0 + kt_i + \beta_1 \ln(y_{it-1}) + \beta_2\, \Delta\ln(y_{it-1}) + \beta_3 edu_{it-1} + \beta_4 \Delta edu_{it-1} + \mu_{i,t}$…..……..*(12)*

Where y_{it} is per capita real GDP, edu_{it} is 'average years of education' in year t, t_i is the trend, and $\mu_{i,t}$ is the error term. GDP per capita as independent variable is used with one time lag to avoid simultaneity. Eq. 12 includes average years of education in the regression without logarithm, as a result of the underlying assumptions this is equal to inserting a monetary variable such as newly estimated human capital stock with a logarithm.

3.4 Augmentation for Macro-Mincer Specification

At this point, the above Macro-Mincer model suffers from series of inefficiencies in the estimation including omitted variable bias, simultaneity bias, and even robustness. A key consideration of the macro-Mincer equation is that it excludes physical capital. But in a dynamic growth model, inclusion of physical capital course surplus effect on growth while exclusion may cause a rise in the effect of human capital on economic growth. However, the theory suggests that it is not necessary to include but also could relate with foregone wages - - meaning that omitting it may also bias the results. However, previous researches do not provide strong evidences for the biasness. This model (Eq.12) was built on avoiding error of omitting the physical capital into the model using a law of motion of physical capital as average population growth (n) adjusted by the depreciation rate and rate of technical progress into the Eq. 13.

$\Delta\, ln(y_{it}) = \beta_0 + kt_i + \beta_1\, ln(y_{it-1}) + \beta_2\, \Delta ln(y_{it-1}) + \beta_3 edu_{it-1} + \beta_4 \Delta edu_{it-1} + \beta_5\, ln(n_i + g + \delta) + \mu_{i,t}$……..……..*(13)*

As explained under the human capital theory, many literatures use the years of education as a measure to the human capital. But, the motion of human capital cannot be measured only by the years of education but more accurately it can be measured with combination of years of education and returns to education as human capital index at macroeconomic level.

Therefore, the Eq. 15 included the human capital instead of years of education to avoid misspecification.

$$\Delta\, ln(y_{it}) = \beta_0 + kt_i + \beta_1\, ln(y_{it-1}) + \beta_2\, \Delta ln(y_{it-1}) + \beta_3 hc_{it-1} + \beta_4 \Delta hc_{it-1} + \beta_5\, ln(n_i + g + \delta) + \mu_{i,t} \qquad (15)$$

Further, the baseline model was augmented and specified in population growth to avoid the omitted variable bias in micro-model defined as 'experience'. It is argued that variables as life expectancy are almost certainly related to the standard of living. As a consequence, inserting average experience, which is related with life expectancy is paramount. This model is further extended using exogenous variables Z_{it} for openness to external trade, fertility rate, government consumption and inflation.

$$\Delta \ln(GDPpc_{it}) = \beta_0 + \beta_1 \ln(GDPpc_{it-1}) + \beta_2\, \Delta\ln(GDPpc_{it-1}) + \beta_3 hc_{it-1} + \beta_4 \Delta hc_{it-1} + \beta_5 \ln(n_i + g + \delta) + \beta_6\, t_i + \beta_7 Z_{it} + \mu_{i,t} \qquad (22)$$

Where i and t refer to the $i - th$ country and the year respectively. The dependent variable $\Delta \ln(GDPpc_{it})$ is the growth rate of logarithm of real GDP per capita; in here, hc_t is the human capital (generated using the years of schooling and return to education), t is the time trend and Z_{it} indicates other control variables with potentially explanatory power in the economies.

Further, this estimation considered the alternative approach such as bi-directional effect of human capital influence on growth, but growth influence on human capital as well. Hence, in order to correct this, the model simply use a proxy variable under the assumption that (1) the independent variable is intertemporal correlated and (2) both the first lag of the independent variable and the error term of the regression of the explanatory variable on its first lag are uncorrelated with the error term of the estimation.

3.5 Lucasian Growth model

$$\Delta \ln(y_{it}) = \beta_0 + kt_i + \beta_2\, \Delta^2 \ln(h_{it}) + \mu_{i,t} \qquad (16)$$

Assuming no break points;

$$\ln(y_{it}) = \beta_0 + kt_i + \beta_2\, \Delta\ln(h_{it}) + \mu_{i,t} \qquad (17)$$

Thus, a permanent increase in the growth of human capital causes only a one-time increase in the level of human capital. This means that for consistent economic growth, the growth of human capital must continuously accelerate. To test this effect, the two approaches for with and without break points under the Lucasian growth is applied.

3.6 Econometric Approach of the Estimations

The empirical model is estimated with the Instrumental variables two-stage least squares in panel-data model. The advantage of the econometric estimation is that it provides robust estimations while minimizing the biasness. The model was applied as below.

Consider the equation of the form:

$$y_{it} = Y_{it}\gamma + X_{1it}\beta + \mu_i + v_{it} = Z_{it}\delta + \mu_i + v_{it} \qquad (18)$$

y_{it} = Dependent variable – GDP per capita
Y_{it} = is an $1 \times g_2$vector of observation on g_2 endogenous variables included as covariates,

and these variables are allowed to be correlated with the v_{it} .
X_{1it} is an $1 \times k_2$ vector of observations on the exogenous variables included as covariates;
$Z_{it} = [Y_{it}\ X_{1it}]$;
γ is a $g_2 \times 1$ vector of coefficients;
β is a $k_1 \times 1$ vector of coefficients; and
δ is a $K \times 1$ vector of coefficients, where $K = g_2 + k_1$
Assume that there is a $1 \times k_2$ vector of observations on the k_2 instruments in X_{2it}. The order condition is satisfied if $k_2 \geq g_2$

Although the estimates allow for different assumptions about the μ_i, all the estimators assume that the idiosyncratic error term v_{it} has zero mean and is uncorrelated with the variables in X_{it}. Just as when there are no endogenous covariates, there are various perspectives on what assumptions should be placed on the μ_i. If they assumed to be fixed, the μ_i may be correlated with the variables in X_{it}., and the within estimator is efficient within a class of limited information estimators. If μ_i are assumed to be uncorrelated with the variables in X_{it}, the GLS random effects estimators are more efficient than within estimator (Mundlak, 1978; Hsiao, 2003). The GLS estimator of random effect model are efficient when GLS instruments are endogenous and instrumental variables contained in $X_{it} = [X_{1it}\ X_{2it}]$. For more robustness of the model estimation, G2SLS random-effects estimator is applied.

3.7 Robustness Checks

Several tests are carried out to check the robustness of the results.

IV 2SLS Estimation: IV 2SLS estimation is used to correct for any potential endogeneity bias associated with the model. The instruments for the technique are chosen on the basis of Shea's (1996) partial R^2. The estimated coefficients are consistent with the estimates derived under the OLS method. The p values for the Wald test suggest the absence of any statistically significant difference between the OLS and IV-2SLS estimates and the model is correctly specified and that the instruments are valid.

Robust Regression: According to Temple (1998), outliers that arise from measurement error and omitted variables can bias the results of growth models. Therefore, to address the issue of omitted variables and influential outliers, the equations are also estimated using the robust regression technique, which gives minimum weight to outlying observations. The estimates are consistent with the OLS estimates suggesting that influential outliers do not influence the estimates.

Dummy Variables: The models were re-estimated with regional dummy variables in order to account for any regional disparities in ASEAN and South Asia. Selecting ASEAN as the benchmark group, regional dummies were defined for South Asia.

Time trend: time trend variable also included in the model to check for the trend of growth patterns in the specifications.

4. Results and Discussion

The following table (1) provides the summary statistics of the explanatory variables in the Macro-Mincer model estimation. It shows the mean values, and standard deviation of the macroeconomic variables.

Table 1: Summary statistics of variables in the estimation

Variable	Mean	Std. Dev.	Min	Max	Obs.

GDP per Capita (GDPpc)	4271.32	9297.57	46.24	56336.1	941
Human Capital (HC)	1.90	0.60	1.01	3.59	993
Patent	39025.85	106926.6	1	928177	607
Population density	434.12	1058.50	4.9	7714.7	1080
Financial Structure	45.68	45.54	0.96	221.29	865
Fertility rate	4.05	1.81	1.08	7.24	1100
Life expectancy	62.35	11.21	19.27	83.59	1100
Trade openness	78.15	80.00	0.17	439.66	917
Govt. consumption	0.17	0.07	0.02	0.37	1038
Inflation	9.73	41.66	-23.82	1136.25	867
FDI	2.47	3.73	-6.01	26.52	695
Domestic Investment	183865.9	620743.4	9.06	7859457	1038
Age Dependency Ratio	70.76	17.67	34.49	102.54	1100
Age Dependency Ratio – Old	7.61	3.87	3.61	41.9	1100
Age Dependency Ratio - Young	63.12	19.62	19.6	96.4	1100
Industry Share	31.49	12.72	6.06	90.51	837
Service Share	45.66	13.50	8.15	100	842
Rural Population	64.80	24.86	0	96.52	1100
Urban Population	35.20	24.86	3.48	100	1100

4.1 Estimation of Revised Macro-Mincer Model

Based on the augmented Macro-Mincer model, the estimation of instrumental variables with 2SLS Panel data approach is conducted for fixed effect (FE) estimation, between effect (BE) estimation, random effect (RE) estimation and first difference (FD) estimation. Then, Hausman test were performed to select the best suitable model in estimation of the robust estimates for the prediction. The results are presented in Table 2.

Table 2: IV Estimation Results of Macro Mincer Model

Dependent Variable:	**Instrumental Variable 2SLS Panel Model**			
$\Delta \ln(GDPpc_{it})$	**(FE)**	**(BE)**	**(RE)**	**(FD)**
$\ln(GDPpc_{it-1})$	0.57***	1.02***	0.49***	-8.09**
	(3.65)	(6.54)	(4.73)	(-1.02)
$\Delta\ln(GDPpc_{it-1})$	-0.38	23.88	-0.29***	0.42
	(-0.84)	(0.83)	(4.56)	(0.36)
$\ln(n_{it} + g + \delta)$	0.73**	0.36***	0.42***	0.61**
	(2.32)	(4.31)	(3.22)	(2.72)
hc_{it-1}	0.53	0.33	0.69**	-1.22
	(0.86)	(-0.34)	(1.37)	(-0.20)
Δhc_{it-1}	-4.10	-18.99***	-0.46**	3.91
	(-1.01)	(3.48)	(2.93)	(0.30)
t_i	0.02	-0.01***	-0.04	-
	(0.25)	(-4.08)	(-1.31)	
Life expectancy	0.18**	0.36**	0.41**	0.38**
	(1.19)	(1.87)	(2.18)	(2.42)
Gov. consumption	0.08	-11.12	8.09	35.46
	(0.02)	(-0.51)	(0.11)	(0.51)
Fertility rate	-0.16	0.22	-0.39	-9.00
	(-0.03)	(0.36)	(0.56)	(-1.79)
Inflation	0.13**	-0.06	-0.03**	-0.06
	(2.14)	(-0.31)	(-0.32)	(-0.31)
Trade openness	0.28**	0.33**	0.48**	0.39**

	(1.82)	(1.56)	(2.01)	(1.93)
Dummy for regions	-0.71	0.64	0.30	0.45
	(-5.16)	(0.40)	(0.72)	(0.72)
Constant	-27.53	10.41	26.50	0.36
	(-0.26)	(0.13)	(0.57)	(0.37)
N	400	400	400	320
Wald chi^2	922.79	201.76	2283.27	-
p-value	0.000	0.000	0.000	
R square	0.60	0.19	0.66	0.45
sigma_u	0.47	0.56	0	8.89
sigma_e	1.01	-	6.67	7.05
rho	0.17	-	0	0.61

Note: the dependent variable is D.lnGDPpc = average growth rate of log real GDP per capita; hc= human capital; (n+g+d) = average population growth adjusted by the depreciation rate and rate of technical progress. The data for the 20 countries are prepared from 1960 to 2014, balanced panel data. Cluster robust standard errors in parenthesis. a * denotes statistical significance at the 10 percent level and a ** denotes statistical significance at the 5 percent level and a *** denotes statistical significance at the 1 percent level. Robust estimation of the coefficients. Instrumental variables: patent, population density, financial structure and lag variables of the explanatory variables. Binary: D = 1 if countries are ASEAN, and 0 = South Asia

Table (2) shows the results of estimated Macro-Mincer model with fixed effect, between effect, random effect and first difference models to obtain robust estimations. These four models were estimated based on the augmented Macro-Mincer equation incorporating the exogenous variables that influence the growth rate. As described in the empirical model section, this augmented version is mainly driven by the rate of change of the growth and human capital under the law of motion to measure the growth of the GDP against growth of human capital. Hausman specification test were performed to evaluate the efficacy of the models and the random effect model was selected for further estimation of the relationships since at all level of statistical significance, chi-squared critical value is significant at 1% level. The Hausman tests give identical information indicating that Chi-square form, which is equal to 8.97; while the Wu version is a t-statistic, t = 3.62, which is the square root of 13.10 in p-value of 0.002, indicating rejection of the consistency of OLS, providing support for using G2SLS. The over identification test has a p-value of 0.002, which is significant at 1%. So at the 1% level we would reject the hypothesis that the instrumental variables patent, population density and finance are exogenous.

Based on the random effect estimation (RE), lag GDP per capita, growth of labour force (adjusted by the rate of technological progress and the rate of depreciation), and lag human capital are positively significant. Whereas, the growth rate of lag GDP per capita, and growth rate of lag human capital is negatively significant. Besides, life expectancy, and trade openness are also positively significant at 5% level, but inflation. Regional binary variable and time trend are not significant indicate the increase of robustness since no regional difference is observed. As in the literature, life expectancy a proxy for the experience, in micro Mincer model, is significant at the revised Macro-Mincer model. In this estimation, since logarithmic values of the variables are used for the GDP and rate of growth of GDP, it directly gives elasticities of the model as how rate of growth of GDP is affected by the lag GDP and lag GDP growth.

Three distinguishable variables are used for the instruments in the analysis considering their direct influence to the growth rate changes and indirect induce of the human capital at macroeconomic level includes number of patents as a proxy for innovation, credit to the financial sector as a proxy for financial structure, and population density as a proxy for urbanization rate. The estimation predicts that these variables are better instruments for the model showing no significant variation in the Hausman test results. Further, even in

literature, the arguments are built on the preference towards the random effect estimation because of high precision and independent from association with the error terms. In comparison to the all four model estimations, logarithm of lag GDP per capita, population growth rate, life expectancy and trade openness are significant predictors of the growth of GDP per capita in the Macro-Mincer Model. Further, it shows that the region does not affect the growth of GDP per capita in the sample. The regional dummies were insignificant suggesting that regional disparities are not the main driver of economic growth.

In a nutshell, the revised Macro-Mincer model predicts the relationship between human capital and economic growth, and estimates the coefficients robustly than recent models in the literature. Further, the model shows the importance of inclusion of omitted variables such as life expectancy and trade openness to enhance its capability of accurate specification and estimation.

4.2 Analysis of Signaling Effect of Human Capital Growth

Table 3: IV Estimation Results of Growth Model for Signaling Effect

Dependent Variable:	**Instrumental Variable 2SLS Panel Model**			
$\Delta \ln(GDPpc_{it})$	**(1)**	**(2)**	**(3)**	**(4)**
$\ln(GDPpc_{it-1})$	0.99***	0.92***	0.89***	0.79***
	(3.51)	(15.41)	(10.45)	(3.37)
$\Delta\ln(GDPpc_{it-1})$	0.16	-0.31	-0.19	-0.17
	(0.74)	(-0.60)	(-0.42)	(-0.36)
$\ln(n_{it}+g+\delta)$	0.73**	0.81**	0.44**	0.51***
	(1.25)	(2.11)	(1.11)	(3.72)
hc_{it-1}	0.26***	0.13**	0.21***	0.29***
	(2.46)	(1.94)	(1.78)	(1.85)
Δhc_{it-1}	-1.76***	0.28	-1.38***	-3.26**
	(2.73)	(0.10)	(1.83)	(-1.09)
t_i	-0.01	-0.01	-0.01	-0.05
	(-1.60)	(-1.42)	(-1.89)	(-0.45)
Dummy for regions	0.45	0.47	0.40	0.67
	(0.32)	(-5.43)	(-1.72)	(0.55)
FDI	-0.93**	-	-	-
	(1.52)			
Domestic Investment	-3.65	-	-	-
	(-0.64)			
Dependency Ratio	-	-160.76***	-	-
		(2.24)		
Old Dependency Ratio	-	160.78***	-	-
		(2.24)		
Young Dependency Ratio	-	160.76***	-	-
		(2.24)		
Industry Share	-	-	0.02***	-
			(2.19)	
Service Share	-	-	0.01	-
			(0.82)	
Urban Population	-	-	-	0.06
				(0.31)
Rural Population	-	-	-	0.06
				(0.30)
Constant	16.64	13.88	10.29	-
	(1.37)	(1.15)	(1.44)	

N	360	400	373	334
Wald chi^2	4322.97	543.01	2152.20	221048.05
p-value	0.000	0.000	0.000	0.000
R square	0.72	0.57	0.76	0.73
sigma_u	0	0	0	0
sigma_e	0.89	0.92	0.85	1.43
rho	0	0	0	0

Cluster robust standard errors in parenthesis. a * denotes statistical significance at the 10 percent level and a ** denotes statistical significance at the 5 percent level and a *** denotes statistical significance at the 1 percent level. Both time and year fixed effects are used. Instrumental variables: patents, finance, and population density and lag variables of the explanatory variables. Binary: D = 1 if countries are ASEAN, and 0 = otherwise ; Eq. 1=Investment; Eq. 2= dependency; Eq. 3 = industry-service growth; Eq. 4 = rural-urban variation

Table 2 gives results of the Macro-Mincer model in particularly, baseline model with the comparative variables such as investment, demographics, market share, and population differences. This contrasting comparison embedded in the baseline model predicts the responsiveness of the variables against the growth rate of the economy in the absence of other exogenous variables. The idea behind this analysis is to identify the information asymmetries behind the growth promoting factors. Since many literatures provide the facts that based on the difference in investments, variations in demographic factors, movement in sector shares from industry to service, and population differences in urban and rural setting under the mincer model is ambiguous. Under this point of view, human capital with high foreign direct investment signals the ability of human capital growth to increase growth rate of GDP per capita. In terms of demographics dependency ratio, old dependency ratio, and young dependency ratio are significant predicting that the human capital growth is signaling the demographic variation in the regions. Further, industry share shows significant influence to the rate of growth implies that the human capital movement is signaled by the change of industrial share.

Signalling

Signalling involves comparing the human capital and comparable variables. The intuition behind these results is to identify the impacts from human capital as a signal for the other variables such as investment, demography, sectoral growth and population and have no informational asymmetries problems.

Table 4: Human Capital, Domestic Investment and Foreign Direct Investment

	Domestic Investment	Foreign Direct Investment
Human Capital	-3.65	-0.93**

The results presented in Table 4 suggests that human capital for the domestic investment are at least as high as those for foreign direct investment and significant, therefore there is no sign of signalling.

Table 5: Human Capital, and Dependency Ratios

	Dependency Ratio	Old Dependency Ratio	Young Dependency Ratio
Human Capital	-160.76***	-160.78***	-160.76***

The results of the Table 5 cannot be explained due to its high value of coefficients and more or less similar estimates.

Table 6: Human Capital, Industry and Service Shares

	Industry Share	Service Share

Human Capital	0.02***	0.01

The results of the Table 6 predicts a significant influence of the industry share in comparison to the service share, and this is a signalling form the motion of human capital from service sector to the industrial sector considering all countries together.

Table 7: Human Capital, Urban and Rural Population

	Urban Population	Rural Population
Human Capital	0.06	0.06

Table 7 predict no difference in the population of urban and rural on the human capital. The regional dummies were insignificant suggesting that regional disparities are not the main driver of economic growth.

4.3 Lucasian Growth Model

Table 8: IV Estimation Results of Lucasian Growth Model

Dependent Variable: $\Delta \ln(GDPpc_{it})$	**Instrumental Variable 2SLS Panel Model**		
	(1)	**(2) No-break point**	**(3) with break point**
$\ln(GDPpc_{it-1})$	0.92***	-	-
	(8.14)		
$\Delta\ln(GDPpc_{it-1})$	0.01	-	-
	(0.88)		
$\ln(n_{it}+g+\delta)$	0.12**	-	-
	(4.32)		
hc_{it-1}	0.29***	-	-
	(2.42)		
Δhc_{it-1}	-0.61	-	-
	(-1.51)		
$\Delta\ln(hc_{it})$	-	0.61***	-
		(4.17)	
$\Delta^2\ln(hc_{it})$	-	-	0.12***
			(2.28)
t_i	0.54**	0.82***	0.10***
	(1.27)	(3.05)	(2.37)
Patent	-0.87**	-	-
	(2.18)		
PD	0.57**	-	-
	(1.42)		
Finance	0.30***	-	-
	(-3.03)		
Dummy for regions	0.34	-	-
	(2.55)		
Constant	23.24***	-2.74***	-195.02***
	(5.92)	(4.56)	(-2.40)
N	344	362	380
Wald chi^2	5550.44	438.80	125.52
p-value	0.000	0.000	0.000
R square	0.73	373	0.10
sigma_u	0	0	12.21

sigma_e	0.85	0.34	1.76
rho	0	0	0.98

Cluster robust standard errors in parenthesis. a * denotes statistical significance at the 10 percent level and a ** denotes statistical significance at the 5 percent level and a *** denotes statistical significance at the 1 percent level. Instrumental variables: patent, finance, population density and lag variables of the explanatory variables for Eq. 2&3. Binary: D = 1 if countries are ASEAN, and 0 = otherwise

The first equation provides the results for the estimation of Macro-Mincer model using the instrumental variables ignoring those as instruments. This provides the evidence that the three key instruments used for the Macro-Mincer model under IV-2SLS is efficient and effective in predicting the variability of the growth of GDP. After the establishment of Macro-Mincer model, the study further analyzes the effects of the Lucasian growth model (2 & 3) for identification of the influence of the human capital for the economic growth. The Table 8 provides the results for the prediction of the influence of human capital for GDP per capita growth. It indicates that the human capital under both with breakpoint and without breakpoint is significant in the Lucasian growth prediction.

Therefore, the Lucasian growth model is one such that could used to understand the relationships between the human capital and economic growth alternatively. The purpose of this estimation is to realize the direct relationship of the macroeconomic indicators for the policymaking and robustness check. The results show that the both coefficients in with break and without break of the human capital are positively significant implying that the increase of human capital continuous to accelerate the economic growth and also the rate of economic growth.

5. Conclusion

The empirical analysis of augmented-Macro-Mincer model was estimated, employing the econometric methods of IV-2SLS estimation, in human capital investment for economic growth in ASEAN and South Asian countries. Further, Lucasian growth model is also estimated to identify the impact of human capital for growth under with-break and without-break scenarios for pragmatic evidences on human capital development policy.

The advantage of the IV 2SLS estimation is that it counts for the many econometric issues like endogeneity and simultaneous bias. The results of IV approach revealed a strong correlation of human capital in economic growth. The random effect estimation revealed that the lag GDP per capita, growth of labour force (adjusted by the rate of technological progress and the rate of depreciation), and lag human capital are positively significant. The growth rate of lag GDP per capita and growth rate of lag human capital is negatively significant. Additionally, life expectancy and trade openness are also positively and inflation is negatively significant. Macro-Mincer model in particularly the baseline model is applied for analyzing the information asymmetry for the investment, demographics, market share, and population differences. This contrasting comparison predicts the responsiveness of the variables against the growth rate of the economy to the response of human capital. The study shows human capital with high foreign direct investment signals the ability of human capital growth to increase growth rate of GDP per capita, demographic variation, and the changes of industrial share in the regions. Lastly, the Lucasian growth model estimates the human capital and economic growth alternatively to the Macro Mincer. The results show that the both coefficients in with-break and without-break of the human capital are positively significant implying that the increase of human capital continuously accelerates the economic growth and also the rate of change of economic growth.

Therefore, combining results of the Macro Mincer model and Lucasian Growth model, one of the significant evidences of this study is that human capital is key for the accelerated and continuous economic growth of those two regions. Human capital also played a significant role in the signaling the inequalities of the variations in investment, population, demography and sectors. The significant exogenous predictors of the model are pillars of the human capital investment policymaking in these economies. Therefore, the research evidences suggest the policymakers to design the appropriate economic growth policies with the use of pragmatic findings for these countries.

6. Policy Recommendations

The findings from the study can be inferred to provide recommendations to the economic growth policies for policymakers in selected economies. The implications of the study are cautious on the determinants of the human capital investment to reform the education systems. Provided, it implies that increase of human capital can accelerate the economic growth rigorously, and improved education systems support to achieve this while leading towards sustainable growth. Therefore, it is evidence that policies need to focus on improving human development capacities with financial development, technology adoption to improve innovation, and growth promoting policies.

The following recommendations are inferred:

1. Human capital needs to be treated as a policy instrument for economic growth

The evidences show that the investment in human capital is key for the economic growth. Thus, the human capital is instrument of the economic growth policies. Therefore, these regions can induce the human development efforts to improve the human capital for reaching the goals of economic growth.

2. Link Education with the Economic Development.

Human Capital in this study is not only years of education, but also returns to the education. It gives a broader view for the link of education for economic development. Further, it suggests that the innovation, financial development and rate of urbanization have a significant influence in human capital investment indirectly. New knowledge, attitudes and skills be applied to satisfy basic learning needs, such as the skills and abilities to work, to take care of health in economy. Educational policy generates needs and demands stimulating the desire to learn and hope for personal and social development.

3. Industrial sector economy can be promoted.

The growth of the industrial economy will not only provide resources to absorb the human capital from educational system, but maintain and strengthen the perceived value of educated workforce. Therefore, this study suggests that the industrial economy is worth for improving the human capital for economic growth in those regions.

4. Demographic change has a significant influence

Three key indicators of the model is population growth rate, life expectancy and the dependency ratio. These indicators are highly influential for the human development and provide a way forward for the investment according to the evidences of the study. Thus, the human capital investment is vital for enhance the rate of growth while focusing on the demographic fluctuations that severely affect the capacity of human development.

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Annex

Table A.1: List of Countries in the Study

ASEAN plus China, Japan and Korea and South Asia
Bangladesh
Bhutan
Brunei Darussalam
Cambodia
China
India
Indonesia
Japan
Korea, Rep.
Lao PDR
Malaysia
Maldives
Myanmar
Nepal
Pakistan
Philippines
Singapore

Sri Lanka
Thailand
Vietnam