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CAN THE INCLUSION OF INDIA AND CHINA WITHIN THE 'OECD' GROUP BREAK THE GROWTH EFFECT TO TRANSITORITY?- AN EMPIRICAL ENQUIRY

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ABSTRACT

It has been observed that human capital is an important factor behind economic growth, especially corresponding to the developed countries or, of the Organization of Economic Cooperation and Development (OECD) countries over the past five decades. The theoretical models differ however regarding the extent of impact of human capital upon the economic growth. According to the Solow-Cass-Koopmans type of models, increase in human capital has only transitory effect upon economic growth in the sense that it only affects the level of steady state output with a growth effect only during the transition towards the new steady state growth path. However, according to the Lucas type AK models, human capital has permanent effect on economic growth in the sense that it affects both the level and the growth rate of the steady state growth path. Here, we are going to test the empirical validity of the Augmented Solow Model vis-à-vis Uzawa-Lucas Model in terms of the speed of convergence firstly for the 'Developed OECD Countries' to find out whether the impact of human capital on growth is transitory or permanent. Next, we are also going to enquire about the alteration in results, if any, when both India and China are included in the 'OECD' Country Group. Here we are using the Dynamic Fixed Effects (DFE) Approach of Panel Data and using the GMM estimators for this purpose.

Key Words: Dynamic Fixed Effect Framework, Panel Data, Arellano-Bond GMM Estimator, Economic Growth, Speed of Convergence.

JEL Classification: C22, C67, O11, O15, O41.

Introduction:

The last five decades have observed the fundamental role of human capital in acceleration of economic growth, especially in the context of the OECD countries. However, the theoretical models have debated a lot regarding the extent of impact of human capital upon the economic growth. Clearly stating, the question is: Is there the existence of a permanent impact of human capital upon the economic growth? According to the Solow-Cass-Koopmans type of models, increase in human capital has only transitory effect upon economic growth in the sense that it only affects the level of steady state output with a growth effect only during the transition towards the new steady state growth path. However, according to the Uzawa-Lucas type AK models, human capital has permanent effect on economic growth in the sense that it affects both the level and the growth rate of the steady state growth path.

'When a distinction between physical and human capital is made, the natural extensions of these models are, respectively, the augmented Solow model (Mankiew et al., 1992) and the two-sector AK (or Uzawa-Lucas) model (Uzawa,1965, Lucas, 1988)' (Arnold, Bassanini, Scarpetta (ABS) (2007)).

In an empirical paper, Jones (1995) has found no evidence of a permanent effect of the investment rate (and similarly of the human capital) on economic growth. This had led to the abandonment of one and two sector AK models in empirical literature of economic growth for quite sometimes then ((ABS) (2007)). However, in recent years, many studies have found the empirical evidence of permanent effect of investment rate (as well as of human capital) on the growth, thus rejecting the Solow model (Bassanini and Scarpetta (2001), Bernanke and Gurkaynak (2001), Li (2002), Bond et al. (2004), ABS (2007)).

ABS (2007) have exploited one advantage of Uzawa-Lucas model over the normal AK models, viz., Uzawa-Lucas model admits a well-defined transitional dynamics even in its' deterministic version. As a result, they have used the different non-linear restrictions on factor shares and speed of convergence implied by the Solow model with augmented human capital and Uzawa-Lucas model to discriminate between them. For that, they have used the Pooled Mean Group (PMG) estimator on a sample of 21 OECD countries over 1971-2004 periods. On the other hand, Islam (1995) has followed a panel data approach and thereafter used Least Squares Dummy Variables (LSDV) estimator to discriminate between the two archetypes through testing the speed of convergence.

In the present paper, we have broadly followed the approach of ABS (2007) and our work is to investigate about the empirical validity of the two archetypes in terms of the different non-linear restrictions on factor shares and speed of convergence implied by the Solow model with Augmented Human Capital Solow Model and Uzawa-Lucas model to discriminate between them, but in the framework of Dynamic Fixed Effect Approach with the use of Arellano-Bond GMM estimators. If the restrictions or conditions on factor shares and speed of convergence of our empirical study are consistent with the Human Capital Augmented Solow Model, then we conclude that human capital has transitory effect upon economic growth. On the other hand, if the restrictions or conditions on factor shares and speed of convergence of our empirical study are consistent with the Uzawa-Lucas Model then we conclude that human capital has permanent effect upon economic growth.

In Section-I, we will discuss the Solow model (with augmented human capital) and Uzawa-Lucas Model in nutshell. In Section-II, the empirical results get presented and analyzed corresponding to 27 OECD Countries. In Section-III, we are going to do the same, but incorporating India and China with OECD Group, to examine whether any alteration could have occurred in the results. The conclusion of our study is in Section-IV. We will discuss our econometric procedure of Dynamic Fixed Effect Panel Data approach and corresponding GMM estimators in brief in the Appendix.

<u>Section-I: Brief Discussions on Human Capital Augmented Solow Model & Uzawa-Lucas Model:</u>

<u>Model-1: Human Capital Augmented Solow Model:</u>

The human capital augmented Solow model with the following Cobb-Douglas production function is-

$$Y_t = [(K_t)^{\alpha}(H_t)^{\eta}\{A_t L_t\}^{(1-\alpha-\eta)}]\ldots\ldots\ldots\ldots\ldots(1)$$

Where, Y→ output, K → physical capital; H→ human capital; L→ labour; A→ level of labour augmenting technology; α→ partial elasticity of output w.r.t. physical capital and η→ partial elasticity of output w.r.t. human capital.

In the reduced form, we have the above equation (1) as –

$$\tilde{y} = \tilde{k}^{\alpha}\tilde{h}^{\eta}\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

The time paths of the relevant variables are –

$$\dot{\tilde{k}} = s_{\tilde{k}}\tilde{y} - (n + x + \delta)\tilde{k}\ldots\ldots\ldots\ldots(3)$$

$$\dot{\tilde{h}} = s_{\tilde{h}}\tilde{y} - (n + x + \delta)\tilde{h} \ldots\ldots\ldots\ldots(4)$$

$$\dot{A} = xA \ldots\ldots\ldots\ldots(5)$$

$$\dot{L} = nL \ldots\ldots\ldots\ldots(6)$$

The notations are used as it is given in Barro and Sala-i-martin (2007). Here, 's_k' and 's_h' denote the investment rate in physical and human capital respectively, whereas, 'n', 'x' and 'δ' imply the population growth rate, rate of technological progress and the common depreciation rate respectively. Further, $\tilde{y}$, $\tilde{k}$ and $\tilde{h}$ imply output per unit of effective labour, physical capital per unit of effective labour and human capital per unit of effective labour respectively.

The steady state conditions derived from equations (3) and (4) can be used to get –

$$\frac{\dot{\tilde{y}}}{\tilde{y}} = \frac{d \ln \tilde{y}(t)}{dt} = -\beta[\ln \tilde{y}(t) - \ln \tilde{y}^*] \ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

where $\beta = (1-\alpha-\eta).(n+x+\delta)$ and $\tilde{y}^*$ is the steady-state of output.

Now, the general solution shows that w.r.t. the condition that $(\alpha+\eta)\langle 1$, output converges to it's steady state and therefore, the time path of output is –

$$\ln \tilde{y}(t) - \ln \tilde{y}(t-s) = (-)\phi(\beta)[\ln \tilde{y}(t-s) - \ln \tilde{y}^*] \ldots\ldots\ldots\ldots(8)$$

Where 's' is an arbitrary lag and $\phi(\beta) = [1 - e^{-\beta s}]$.

Further, at steady state,

$$\ln \tilde{y}^* = \alpha \ln \tilde{k}^* + \eta \ln \tilde{h}^* \ldots\ldots\ldots\ldots\ldots\ldots(9)$$

Again we know that at steady state –

$$s_{\tilde{k}}.\tilde{k}^{*(\alpha-1)}\tilde{h}^{*\eta} = (n+x+\delta) \ldots\ldots\ldots\ldots\ldots(10)$$

From equations (9) and (10) we get –

$$\ln \tilde{y}^* = \frac{\alpha}{(1-\alpha)}\ln s_{\tilde{k}} + \frac{\eta}{(1-\alpha)}\ln \tilde{h}^* - \frac{\alpha}{(1-\alpha)}\ln(n+x+\delta) \ldots\ldots\ldots\ldots(11)$$

Now, following ABS (2007), we have approximated '$\ln \tilde{h}^*$' with $\ln \tilde{h}(t) + \psi\Delta \ln \tilde{h}(t)$ with ψ being a function of the non-specified parameters of the model. Hence, from the specifications of $\ln \tilde{y}^*$ and $\ln \tilde{h}^*$, we get the following equation:

$$\Delta \ln y(t) = -\phi(\beta)\left[\ln \tilde{y}(t-s) - \frac{\alpha}{(1-\alpha)}\ln s_{\tilde{k}} - \frac{\eta}{(1-\alpha)}\ln \tilde{h}(t) - \frac{\eta\psi}{(1-\alpha)}\Delta \ln \tilde{h}(t) + \frac{\alpha}{(1-\alpha)}\ln(n+x+\delta)\right] \ldots\ldots(12)$$

Owing to the possibility of loss of information for the loss of time periods, we have taken 's=1' and correspondingly we write the equation (12) in the following general error correction form:

$$\Delta \ln \tilde{y}(t) = -\phi(\beta)\left[\ln \tilde{y}(t-1) + \theta_1 \ln s_{\tilde{k}} + \theta_2 \ln \tilde{h}(t) - \theta_3 \ln(n(t) + x(t) + \delta(t))\right]$$
$$+ v_1 \Delta \ln s_{\tilde{k}}(t) + v_2 \Delta \ln \tilde{h}(t) + v_3 \Delta \ln(n(t) + x(t) + \delta(t)) + \varepsilon(t) \ldots\ldots(13)$$

Finally, we substitute 'n' for $\ln(n(t) + x(t) + \delta(t))$ (as 'x' and 'δ' are not observable), and we allow for trend (linear or non-linear) to get to the following equation:

$$\Delta \ln \tilde{y}(t) = a_0 - \phi\left[\ln \tilde{y}(t-1) + \theta_1 \ln s_{\tilde{k}} + \theta_2 \ln \tilde{h}(t) - \theta_3 n(t))\right] + \gamma t$$
$$+ v_1 \Delta \ln s_{\tilde{k}}(t) + v_2 \Delta \ln \tilde{h}(t) + v_3 \Delta n(t) + \varepsilon(t) \ldots\ldots(14)$$

Where, $\theta_1 = \left(-\frac{\alpha}{1-\alpha}\right); \theta_2 = \left(-\frac{\eta}{1-\alpha}\right)$.

Model-2: Uzawa-Lucas Model:

In the Uzawa-Lucas model, the production of human capital happens in a different sector than the goods sector. It is called 'Education Sector'. Here it is assumed that the production of human capital involves no physical capital, but production of goods requires both physical capital as well as human capital. Thus, in this setting, education sector is relatively intensive in human capital, i.e., $\psi \leq \alpha$. Here it has been assumed that $\psi = 0 \leq \alpha$ and $0 \langle \alpha \langle 1$.

We can write the general structure of our two sector growth model as provided by Rebelo (1991) as –

$$Y = C + \dot{K} + \delta K = A(\upsilon K)^{\alpha}(uH)^{(1-\alpha)} \ldots\ldots(15)$$

$$\dot{H} + \delta H = B[(1-\upsilon)K]^{\psi}[(1-u)H]^{(1-\psi)} \ldots\ldots(16)$$

Since 'K' is not at all productive in the education sector, by assumption, therefore, $\psi = 0$ and $\upsilon = 1$ applies in case of the Uzawa-Lucas model.

So, the Uzawa-Lucas entails the two sector growth model as –

$$Y = C + \dot{K} + \delta K = AK^{\alpha}(uH)^{(1-\alpha)} \ldots\ldots(17)$$

$$\dot{H} + \delta H = B[(1-u)H] \ldots\ldots(18)$$

Now, in system of equations (17) and (18), we divide outputs of the two sectors by 'AL' which implies effective labor.

Then we get equations (17) and (18) in the intensive form as –

$$\tilde{y}(t) = (\tilde{k}(t))^{\alpha}(u(t)h(t))^{(1-\alpha)} \ldots\ldots(19)$$

$$\dot{\tilde{h}} = B(1-u)\tilde{h} \ldots\ldots(20)$$

We also obtain the following equations –

$$\dot{A} = xA \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (21)$$

$$\dot{L} = nL \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (22)$$

Now, in the present set up of Uzawa-Lucas model, the objective of the household is to maximize the intertemporal dynastic utility function –

$$\begin{bmatrix} Maximise \\ U = \int_0^{\infty} \left(\dfrac{\tilde{c}^{(1-\theta)} - 1}{1-\theta} \right) e^{-\rho t} dt \\ s.t. \\ \dot{\tilde{k}} = k^{\alpha} (u\tilde{h})^{(1-\alpha)} - \tilde{c} - (n+x+\delta)\tilde{k} \\ \dot{\tilde{h}} = B(1-u)\tilde{h} \\ \tilde{k}(0) = \tilde{k}_0 (given) \\ \tilde{h}(0) = \tilde{h}_0 (given) \\ \tilde{k}, \tilde{h}, \tilde{c} \rangle 0 \forall t \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (23)$$

The Hamiltonian of this problem is –

$$J = \left[\frac{\tilde{c}^{(1-\theta)}}{1-\theta} \right] e^{-\rho t} + \lambda \left[\tilde{k}^{\alpha} (u\tilde{h})^{(1-\alpha)} - \tilde{c} - (n+x+\delta)\tilde{k} \right] + \mu \left[B(1-u)\tilde{h} \right] \ldots\ldots\ldots\ldots (24)$$

The solution requires the solutions of the following conditions –

$$\begin{bmatrix} (J_{\tilde{c}} = 0) \\ (J_u = 0) \\ \left(J_{\tilde{k}} + \dot{\lambda} = 0 \right) \\ \left(J_{\tilde{h}} + \dot{\mu} = 0 \right) \\ \left(J_{\lambda} = \dot{\tilde{k}} = \tilde{k}^{\alpha} (u\tilde{h})^{(1-\alpha)} - \tilde{c} - (n+x+\delta)\tilde{k} \right) \\ \left(J_{\mu} = \dot{\tilde{h}} = B(1-u)\tilde{h} \right) \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots (25)$$

With the Transversality Condition –

$$Lt_{t \to \infty} \left(\lambda \tilde{k} + \mu \tilde{h} \right) e^{-\rho t} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (26)$$

The Balanced Growth Path (BGP) solution is given by –

$$\frac{\dot{\tilde{c}}}{\tilde{c}} = \frac{\dot{\tilde{k}}}{\tilde{k}} = \frac{\dot{\tilde{h}}}{\tilde{h}} = \frac{\dot{\tilde{y}}}{\tilde{y}} = \frac{(B-\rho)}{\theta} \quad \ldots\ldots(27)$$

Now, the dynamics of the system is represented as –

$$\frac{d \ln \tilde{\tilde{y}}}{dt} = -\beta\left(\ln \tilde{\tilde{y}}(t) - \ln \tilde{\tilde{y}}^*\right) \quad \ldots\ldots(28)$$

Where, $\tilde{\tilde{y}} = \frac{\tilde{y}}{u\tilde{h}}$; $\tilde{\tilde{y}}^* = \frac{\tilde{y}^*}{u^*\tilde{h}^*}$, with the steady state, $\tilde{\tilde{y}}^*$ being saddle-point stable, and the system converges to it from any initial value $\tilde{\tilde{y}}(0)$. Here, $\beta = \frac{(1-\alpha)}{\alpha}(B+n+x+\delta)$, which implies:

$$\ln \tilde{\tilde{y}}(t) - \ln \tilde{\tilde{y}}(t-s) = -\phi(\beta)(\ln \tilde{\tilde{y}}(t-s) - \ln \tilde{\tilde{y}}^*) \quad \ldots\ldots(29)$$

Here, we get the relevant solution as –

$$\ln \tilde{\tilde{y}}^* = \left(\frac{\alpha}{1-\alpha}\right)\ln s^*_{\tilde{k}} - \left(\frac{\alpha}{1-\alpha}\right)\ln\left(B(1-u^*) + n + x + \delta\right) \quad \ldots\ldots(30)$$

Now, substituting $\ln s^*_{\tilde{k}}$ by $(\ln s_{\tilde{k}}(t) + \eta\Delta \ln s_{\tilde{k}}(t))$, we get –

$$\ln \tilde{\tilde{y}}^* = \left(\frac{\alpha}{1-\alpha}\right)\ln s_{\tilde{k}}(t) + \left(\frac{\eta\alpha}{1-\alpha}\right)\Delta \ln s_{\tilde{k}}(t) - \left(\frac{\alpha}{1-\alpha}\right)\ln\left(B(1-u^*) + n + x + \delta\right) \quad \ldots\ldots(31)$$

Hence, from equations (29) and (31), we have –

$$\ln \tilde{\tilde{y}}(t) - \ln \tilde{\tilde{y}}(t-s)$$
$$= -\phi(\beta)\left[\ln \tilde{\tilde{y}}(t-s) - \left(\frac{\alpha}{1-\alpha}\right)\ln s_{\tilde{k}}(t) - \left(\frac{\eta\alpha}{1-\alpha}\right)\Delta \ln s_{\tilde{k}}(t) + \left(\frac{\alpha}{1-\alpha}\right)\ln\left(B(1-u^*) + n + x + \delta\right)\right] \quad \ldots\ldots(32)$$

So, taking a maximum 'one period lag', we get the 'ECM' model where $\ln \tilde{\tilde{y}}$ indicates GDP per capita divided by average years of education of the age group 25-64.

$$\Delta \ln \tilde{\tilde{y}}(t) = a_0 - \phi\left[\ln \tilde{\tilde{y}}(t-1) + \theta_1 \ln s_{\tilde{k}}(t) - \theta_3 n(t)\right] + \gamma t + v_1 \Delta \ln s_{\tilde{k}}(t) + v_3 \Delta \ln n(t) + \varepsilon(t) \quad \ldots\ldots(33)$$

Now, as we know that $\ln \tilde{\tilde{y}} = (\ln \tilde{y} - \ln(u\tilde{h}))$, hence, shifting the human capital part to the RHS of equation (33), we get –

$$\Delta \ln \tilde{y}(t) = a_0 - \phi\left[\ln \tilde{y}(t-1) + \theta_1 \ln s_{\tilde{k}}(t) + \theta_2 \ln \tilde{h}(t) - \theta_3 n(t)\right]$$
$$+ \gamma t + v_1 \Delta \ln s_{\tilde{k}}(t) + v_2 \Delta \ln \tilde{h}(t) + v_3 \Delta \ln n(t) + \varepsilon(t) \quad \ldots\ldots(34)$$

with the restriction that $\theta_2 = 1$.

For our work, we have followed the approaches of Barro and Sala-i-Martin (2007), Arnold et. al. (2007) Moro (2002), Ortigueira and Santos (1996).

Now, it has become quite clear that equations (14) and (34) are similar. So, practically, two different models are explained through one equation. Therefore the issue of 'model-restrictions' becomes the most important factor to discriminate between the 'Human Capital Augmented Solow Model' and 'Uzawa Lucas Model'. We are interested to know the validity of the two models in the present analysis. Therefore, econometric testing of these model restrictions is going to determine the validity of the two models. Hence, let's first discuss about the model restrictions.

The first test should check whether '$\theta_2 = 1$' in equation (34). If '$\theta_2 = 1$' then Uzawa-Lucas Model has to be accepted. However, if '$\theta_2 \neq 1$' and 'θ_2' is significantly different from '1' (one), the Uzawa-Lucas Model has to be rejected. However, this test of the hypothesis '$\theta_2 = 1$' is less reliable.

So, the second test should check whether the estimated speed of convergence is commensurate with it's predicted value implied by the Augmented Solow Model. As we denote the long run estimated coefficient of the logarithm of investment share with $\hat{\theta}_1$ and that of average years of schooling with $\hat{\theta}_2$, the derived estimate of $\hat{\alpha}$ is then equal to '$\left(\frac{\hat{\theta}_1}{1+\hat{\theta}_1}\right)$ while that of $\hat{\eta}$ is equal to $\left(\frac{\hat{\theta}_2}{1+\hat{\theta}_1}\right)$. Further, an estimate of the speed of convergence λ is given as $\left(-\ln\left[\frac{1-\hat{\phi}}{s}\right]\right)$, where $\hat{\phi}$ is the estimated average convergence coefficient. Therefore, the following restriction is supposed to test the acceptance or rejection of the Augmented Solow Model.

$$\left(-\ln\left[1-\hat{\phi}\right]\right) = s\left(\frac{1-\hat{\theta}_2}{1+\hat{\theta}_1}\right).(n+x+\delta)\ldots\ldots\ldots\ldots\ldots\ldots(35)$$

The third test for the null hypothesis that the Uzawa-Lucas Model is valid can be developed in a similar fashion –

$$\left(-\ln\left[1-\hat{\phi}\right]\right) = s\left(\frac{1}{\hat{\theta}_1}\right).(B+n+x+\delta)\ldots\ldots\ldots\ldots\ldots\ldots(36)$$

Here, Lucas (1988) calibrates B to be equal to 0.05 on the basis of Denison's (1961) estimates for the U.S. economy and the relations implied by the model. Alternatively, the value of 'u' could be set at $u = 2/3$ and B could be derived as $B = \left(\frac{\dot{\tilde{h}}}{\tilde{h}}\right)\left(\frac{1}{1-u}\right)$.

The fourth test is an exact one-tail test:

$$\left(-\ln\left[1-\hat{\phi}\right]\right) \rangle s\left(\frac{1}{\hat{\theta}_1}\right).(n+x+\delta)\ldots\ldots\ldots\ldots\ldots\ldots(37)$$

These tests are very useful for discrimination between the Solow Model and the Uzawa-Lucas Model and also to test the empirical validity of the two models too.

Section-II: The Empirical Results:

The growth equation (14) corresponding to a pooled cross country series is as follows –

$$\Delta \ln \tilde{y}_{i,t} = a_{0,i} - \phi_i \ln \tilde{y}_{i,(t-1)} + a_{1,i} \ln s_{\tilde{k}} + a_{2,i} \ln \tilde{h}(t) - a_{3,i} n(t) + a_{4,i} t$$
$$+ v_{1,i} \Delta \ln s_{\tilde{k}}(t) + v_{2,i} \Delta \ln \tilde{h}(t) + v_{3,i} \Delta n(t) + \varepsilon_{i,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(38)$$

Here we are going to estimate the validity of the above test conditions for the growth equation (14) (or, equation (34), as the construction of the two equations are similar) for 27 OECD countries[3] over the period 1960-2014. The following variables are used by us for the estimation of the aforementioned growth equation.

Dependent Variable [Δlog(RPCGDP1564)]: Growth in Real GDP per head of population aged 15-64 years, expressed in chained PPPs (2011US$).

Investment (Physical Capital Stock Accumulation) [log (SHINV)]: The propensity to accumulate physical capital is proxied here by the the logarithm of the ratio of gross capital formation to Real GDP.

Stock of Human Capital [log(AVSCH2564)]: Here the stock of human capital is proxied by the logarithm of the average years of total schooling of the population aged between 25 and 64 years.

Population [log (POP1564)]: Logarithm of working age population (15-64 years) in percentage points.

The data on GDP, Population and gross fixed capital formation are from the Penn World Table, Version 9.0. The data on working age population (in the age group 15-64) are obtained from Barro-Lee Data on Education Statistics, World Bank Databank.

Now, we are representing the Dynamic Fixed Effect GMM estimation in the following Table-1.

TABLE 1: Dynamic Fixed Effect GMM Estimation Results	
Dynamic Fixed Effect GMM Estimation Results (Without Linear Trend)	
Dependent Variable: DLNRPCGDP (Growth of Log of Per Capita GDP)	
LNRPCGDP1564(-1)	-0.215308***
	-0.047377
LNSHINV	0.096188***
	-0.026774
LNAVSCH2564	1.036285***
	-0.073997
LNPOP1564	-1.124972***
	-0.226336
DLNSHINV	0.084124***
	-0.014569
DLNAVSCH2564	-0.557625
	0.616252
DLNPOP1564	-4.149878***
	-0.9722
No. of Countries	27
Total panel (balanced) observations	1431
Standard Errors are in the parentheses. '***', '**' and '*' imply the significance at 10%, 5% and 1% levels respectively.	

Now, the above regressions are clearly stating that the coefficients corresponding to lagged log(per capita GDP in terms of working age population within the age group 15-64) (lag of one period), log(share of Investment to GDP, i.e., a proxy to physical capital),

[3] The 27 OECD countries are – Australia, Austria, Belgium, Canada, Chile, Denmark, Finland, France, Germany (incl. West Germany only before 1989 and incl. both East and West Germany post 1989), Greece, Iceland, Ireland, Israel, Italy, Japan, Korea south, Mexico, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

log(average years of total schooling in the age group 25-64, i.e., a proxy to human capital), log(working age population in the age group 15-64) and first difference of log(share of Investment to GDP, i.e., a proxy to physical capital), first difference of log(average years of total schooling in the age group 25-64, i.e., a proxy to human capital) and first difference of log(working age population in the age group 15-64) are significant at 1 percent level, be it with trend or without trend. Rather, the impact of linear trend is itself insignificant.

As the coefficient corresponding to lagged log(per capita GDP in terms of working age population within the age group 15-64) (lag of one period) in each of the above two equations implies actually the convergence coefficient, therefore, as it is negative and significant, hence it indicates that a long run relationship exists.

TABLE 2: DERIVED PARAMETERS AND SPEED OF CONVERGENCE TESTS

Derived Parameters	Without trend
'α'	0.09
'η'	0.75
'Constant Returns to Scale: (α+η)=1'	35.25847
p-value	0
Average 'λ'	0.242
Solow: Theoretical 'λ'	0.01
Uzawa Lucas: Theoretical 'λ', u=2/3	0.223
Uzawa Lucas: Theoretical 'λ', B=0.05	0.315
Speed of Convergence Test	Without trend
Speed of Convergence Test: Solow Model (Eq. 35) [χ2(1)]	40.16222
p-value	0
Speed of Convergence Test: Uzawa-Lucas Model (Eq. 36; u=2/3) [χ2(1)]	1.336346
p-value	0.2477
Speed of Convergence Test: Uzawa-Lucas Model (Eq. 36, B=0.05) [χ2(1)]	0.021152
p-value	0.8844
No. of Countries	27
Total panel (balanced) observations	1431

The Wald Test results are shown above in Table-2. From Table-2, first of all, the null hypothesis of 'Constant Returns to Scale' is never rejected at the 1% level of significance, be it 'without trend' model or be it 'with trend' model. Hence, our first test cannot effectively rule out the possibility of the empirical validity of the 'Uzawa-Lucas Model.

Secondly, the estimated convergence parameters of the models are very high relative to the theoretical values of the Augmented Solow Model, making the Solow Model inconsistent with our empirical studies. The estimated point estimators of 'λ' are more than twenty times greater than what the Solow Model would imply, given the estimates of the other parameters.

Through the Wald Test statistics, we observe that the Solow Model gets rejected (through the Wald test of equation (35)) and Uzawa-Lucas Model gets accepted and never gets rejected (through the Wald test of equations (36) and (37)) always. Therefore, it is evident that the one-tailed test of equation (37) can never reject the Uzawa-Lucas Model.

Thus we can conclude that according to the estimates, the growth experience of the OECD countries is not inconsistent with the Uzawa-Lucas Model with Constant Returns to Scale.

Now, in the Uzawa-Lucas Model with constant returns to scale, the coefficient of human capital is exactly equal to unity (1) and we cannot reject this hypothesis on the basis of our estimates of Table-2 above. Thus we may restrict the coefficient on human capital to be one (1) " in order to gain efficiency on the remaining parameter estimates and perform our test on the speed of convergence without any risk of a bias from the possible endogeneity of human capital" (ABS 2007). Hence, we have to estimate the following regression –

$$\Delta \ln \tilde{\tilde{y}}_{i,t} = a_{0,i} - \phi_i \ln \tilde{\tilde{y}}_{i,(t-1)} + a_{1,i} \ln s_{\tilde{k}} + a_{2,i} \ln \tilde{h}(t) - a_{3,i} n(t) + a_{4,i} t$$
$$+ v_{1,i} \Delta \ln s_{\tilde{k}}(t) + v_{2,i} \Delta \ln \tilde{h}(t) + v_{3,i} \Delta n(t) + \varepsilon_{i,t} \ldots\ldots\ldots\ldots\ldots\ldots (39)$$

The following Table-3 represents the estimates of the above equation. Here also, through the Wald Tests of different test conditions, we can observe that the Solow Model gets rejected and Uzawa-Lucas Model with constant returns to scale (CRS) cannot be rejected by the data at conventional statistical level.

TABLE 3: ESTIMATION RESULTS OF THE CONSTRAINED REGRESSION	
Dependent Variable: Growth of log GDP per capita divided by total years of Education (DLNRPCGDPAVS)	
LNRPCGDPAVS(-1)	-0.18966***
	-0.027668
LNSHINV	0.056563***
	-0.013021
LNAVSCH2564	0.644147***
	-0.067736
LNPOP1564	-0.83746***
	-0.136953
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DLNSHINV	0.064241***
	-0.00962
DLNAVSCH2564	-1.12626***
	-0.2621
DLNPOP1564	-4.72647***
	-0.577535
No. of Countries	27
Total panel (balanced) observations	1431
Speed of Convergence Test	Without trend
Speed of Convergence Test: Solow Model (Eq. 35) [χ2(1)]	121.5369
p-value	0
Speed of Convergence Test: Uzawa-Lucas Model (Eq. 36; u=2/3) [χ2(1)]	0.828257
p-value	0.3628
Speed of Convergence Test: Uzawa-Lucas Model (Eq. 36, B=0.05) [χ2(1)]	3.683671
p-value	0.0549
Standard Errors are in the parentheses. '***', '**' and '*' imply the significance at 10%, 5% and 1% levels respectively.	

Section-III: The Inclusion of INDIA and CHINA in the OECD Group:

The objective of this paper was initially to examine whether the present empirical study of 27 OECD countries over the period 1960-2014 corresponding to the impact of human capital on economic growth is consistent with the Uzawa-Lucas Model and inconsistent with the Augmented Human Capital Solow Model or the other way round. Our results specify a positive and significant impact of human capital accumulation to per capita output growth, observed by the share of human capital in the production function very close to unity (1), signifying constant returns to the human capital. So, as a result, growth effect is permanent. Our results also qualify the different test conditions to specify a long run permanent impact of human capital upon economic growth. We have also observed a significant growth effect from the accumulation of physical capital and our estimated speed of convergence appears to be too high to be consistent with the human capital augmented version of Solow Model and rather it supports the Uzawa-Lucas Model.

Now, we experiment with our obtained results with 27 OECD Countries with the inclusion of India and China within the OECD group. That makes the cross section identifires (Countries) to be (27+2=29), i.e., we are now going to deal additionally with the World's most populous two (2) states (India and China) by including them within the OECD Group to see the impact upon the permanence of the growth effect in the presence of massive amount of both population as well as effective population (pop1564) with significant growth rate of population as well as effective population, low average years of schooling (avsch2564) and paltry per capita income as well as per capita effective income (rpcgdp1564). In a way, here, already we have stated that these two countries, viz., India and China, are significant nonhomogeneous nations when compared to any of the 27 'OECD' Group member country, especially in terms of measly per capita effective income (rpcgdp1564), low average years of schooling (avsch2564) and huge population as well as effective population (pop1564) and significant growth rate of population as well as effective population growth (dlnpop1564).

Now, when we have done the same above exercise with 29 countries, then only due to the presence of India and China, significant change in the growth effect is observed. Our results specify a positive but less significant impact in terms of diminishing returns of human capital, observed by the share of human capital in the production function very small (0.04 (from our study (much lesser than 0.5), signifying diminishing returns to the human capital. So, as a result, growth effect is permanent.We, in turn obtain only transitory impact of human capital upon the economic growth (in the sense that it only affects the level of steady state output with a growth effect only during the transition towards the new steady state growth path) with moderate or low speed of convergence, consistent with the human capital augmented version of Solow Model and too low corresponding to the speed of convergence of the Uzawa-Lucas Model. Actually, in terms of the 'Speed of Convergence', the Solow Model with augmented human capital (null hypothesis condition) has not been rejected at 5 percent level; but rather, the Uzawa Lucas Framework (null hypothesis condition) has been rejected at 1 percent level. Thus, the results shown in the following Tables 4, 5 and 6 establishes the empirical validity of the human capital augmented version of Solow Model, thereby signifying the transitory impact of human capital accumulation upon the growth rate, probably owing to the fact that although in India and China, the investment rate (investment/ GDP Ratio) is in line with the rest 27 OECD Countries, but low avsch2564, paltry rpcgdp1564 and massive pop1564 and dlnpop1564 of India and China obviously has created the difference between the set of Tables (1,2,3) and set of Tables (4,5,6). The results are showing that only incorporation of India and China has made the share of the human capital paltry in the production function even in case of the developed OECD Countries; such huge/massive is the impact of 'poverty (rankings are 103/119 and 25/119 in terms of global hunger index (2019) and the rankings are 139/187 and 79/187 in terms of per capita GDP)', 'illiteracy' (literacy rate rankings are 168/234 and 54/234 respectively (2019), 'low human capital accumulation (rankings are 115/152 and 71/152 respectively (2016)) and 'population (rankings are 2/238 and 1/238 (2019)) [Source: https://www.wikipedia.org] of these two countries upon the 'affluent', 'literate' and 'low population dense' OECD Countries so that physical capital is the prime factor to provide 'big push' to have all these countries in the balanced growth path in the face of the diminishing returns to capital (both physical and human (if judged from the perspective of inclusion of the two 'developing' outliers in the homogeneous OECD Group). Let's see the results.

TABLE 4: Dynamic Fixed Effect GMM Estimation Results	
Dynamic Fixed Effect GMM Estimation Results (Without Linear Trend)	
Dependent Variable: DLNRPCGDP (Growth of Log of Per Capita GDP)	
LNRPCGDP1564(-1)	(-0.050788)***
	0.011578
LNSHINV	0.029111***
	0.011909
LNAVSCH2564	0.04113*
	0.022092
DLNSHINV	0.145512***
	0.004564
DLNAVSCH2564	0.099749***
	0.046135
DLNPOP1564	(-1.405503)***
	0.233719
DLNAVSCH2564(-1)	(-0.140576)
	0.128804
No. of Countries (OECD & INDIA & CHINA)	29
Total panel (balanced) observations	1508
Standard Errors are in the parentheses. '***', '**' and '*' imply the significance at 10%, 5% and 1% levels respectively.	

TABLE 2: DERIVED PARAMETERS AND SPEED OF CONVERGENCE TESTS	
Derived Parameters	Without trend
'α'	0.03
'η'	0.04
'Constant Returns to Scale: (α+η)=1'	-0.281074
p-value	0.596
Average 'λ'	0.035
Solow: Theoretical 'λ'	0.01
Uzawa Lucas: Theoretical 'λ', u=2/3	0.223
Uzawa Lucas: Theoretical 'λ', B=0.05	0.315
Speed of Convergence Test	Without trend
Speed of Convergence Test: Solow Model (Eq. 35) [χ2(1)] (U-L Model Rejected at 5% Level)	3.711548
p-value	0.06
Speed of Convergence Test: Uzawa-Lucas Model (Eq. 36; u=2/3) [χ2(1)](U-L Model Rejected at 1% Level)	8.791109
p-value	0.003
Speed of Convergence Test: Uzawa-Lucas Model (Eq. 36, B=0.05) [χ2(1)](U-L Model Rejected at 1% Level)	8.785182
p-value	0.003
No. of Countries	29
Total panel (balanced) observations	1508

TABLE 6: ESTIMATION RESULTS OF THE CONSTRAINED REGRESSION	
Dependent Variable: Growth of log GDP per capita divided by total years of Education (DLNRPCGDPAVS)	
LNRPCGDPAVS(-1)	(-0.04701)***
	-0.008239
LNSHINV	0.030088***
	-0.009421
LNAVSCH2564	(-0.0247)
	-0.0032754
DLNSHINV	(0.147343)***
	0.00495
DLNAVSCH2564	(-0.87989)***
	0.066693
DLNPOP1564	(-1.21373)***
	0.229332
DLNAVSCH2564(-1)	0.012739
	0.128967
No. of Countries (OECD & INDIA & CHINA)	29
Total panel (balanced) observations	1508
Speed of Convergence Test	Without trend
Speed of Convergence Test: Solow Model (Eq. 35) [χ2(1)] (Solow Model is accepted and not rejected)	0.674927
p-value	0.4113
Speed of Convergence Test: Uzawa-Lucas Model (Eq. 36; u=2/3) [χ2(1)] (U-L Model Rejected at 1% Level)	12.74433
p-value	0.0004
Speed of Convergence Test: Uzawa-Lucas Model (Eq. 36, B=0.05) [χ2(1)] (U-L Model Rejected at 1% Level)	12.73475
p-value	0.0004
Standard Errors are in the parentheses. '***', '**' and '*' imply the significance at 10%, 5% and 1% levels respectively.	

Section-IV: Conclusion:

(1)Thus it seems reasonable that the growth experience of the OECD countries over the past five and half decades is more consistent with an endogenous process in which the accumulation of human capital has a importunate effect upon the economic growth.

(2)However, incorporation of India and China within the OECD Group has dampened the effect of human capital accumulation upon the economic growth through breaking the long term permanent growth effect to transitority.

(3) Hence, 'Massive population and population growth',' serious poverty' and 'mass illiteracy' of India and China are to be addressed by the OECDs to have a relatively more homogenized and strong economic power group in terms of human capital accumulation and permanent economic growth as, according to both International Monetary Fund (IMF) and World Bank, both these countries are at present are among the fastest growing economies, having their high position among the countries in terms of growth rate (In 2018, in terms of real GDP growth, India ranks higher than China) with third largest GDP at Purchaching Power Parity for India and largest GDP at Purchasing Power Parity for China (2019). India is the 17th largest export economy in the world with China ranks the first (1st) in terms of exports in the world (2017). According to the statement made by IMF (5/10/2019), India and China both rank as the World's fastest growing major economy, with a projected growth rate of 6.1 percent. So, it is in the interest of the globe, as has been pointed by IMF that the problems of thes two countries should be addressed by the developed world (OECDs) to have permanent growth effect.

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