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CAUSALITY TEST BETWEEN HUMAN CAPITAL AND PHYSICAL CAPITAL FOR JAPAN, INDIA AND INDONESIA BETWEEN THE PERIOD OF 1890 AND 2000

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ÖZET

Fiziksel sermaye ile beşeri sermaye arasındaki tamamlayıcı bir ilişkinin olduğunu gösterir güçlü nedenler vardır ve bunun veriler tarafından da desteklenip desteklenmeyeceğine odaklanmaya çalışmaktayız. Bu nedenle de 1890-2000 yılları arası veriler için Hindistan, Endonezya ve Japonya için fiziksel sermaye ve beşeri sermaye yatırımları arasında nedensellik ilişkisi varmıyı test etmeyi amaçladık. Bu üç ülke hem beşeri sermaye bakımından hem de teknolojik etkilenme bakımından dışsal etkilere daha yatkın olduklarından şeçilmişlerdir. Ölçümlememiz sonunda zayıfta olsa bir nedensellikten sözedilebileceği sonucuna vardık. Nedensellik Japonya için biraz daha net ifade edilebilir. Bu belki de Japonyanın daha planlı bir ekonomi olmasındandır. Ancak diğer iki ülke için nedensellik net değildir.

ABSTRACT

There are very strong reasons to believe that there is a complementary interaction between physical and human capital, and whether this can be supported by data is tested. Thus, the aim of our study is to test for causality between investment in physical and human capital for India, Indonesia and Japan between the period of 1890 to 2000. These three countries were subordinate to exogenous influences both in technology and human capital development. Very weak causality has been found. It may be said that it is little clearer for Japan. This may be because of the fact that Japan is much better organized and planed economy than the others. However, for the rest it is not so clear at all.

Keywords: Unit root; Economic growth; Physical capital, Human capital, complementarities between physical and human capital and Granger causality, error correction mechanism.

I. INTRODUCTION

Some economies are richer than others. To identify why it is a fundamental question for economists to answer, therefore, knowing what causes economic growth would make an enormous contribution to people wellbeing. The mid-1950s' the theoretical work proposes that an exogenous technological alteration is the main driving

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force of economic growth. However, in the extensive exogenous growth literature discussions, the emergence of human capital did not collect the awareness it deserved in the neoclassical growth theory until 1980s while human capital has now become the most important focus of awareness with endogenous growth discussion, which deals with the technology issue.

Since human capital is considered one of the main determinants of economic growth besides raw labor, physical capital and technological progress, any increases in human capital have straight and meandering influences on physical capital and technological progress. Consequently, economies with the higher initial stocks of human capital are anticipated to grow faster. In view of the fact that there is a very strong relationship between human capital and economic growth (Kalyoncu, 2008, s. 46; Kar ve Ağır, 2009, s. 1; Barro and Sala-i-Martin, 1995, s. 431; Bulutay, 1995, s. 9, Tansel and Güngör, 1997, s.1). Most economies face many diverse resource difficulties and infrastructural constraints that limit their economic growth potential.

There is also a general agreement that the process of economic growth and investment in physical to human capital ratio is closely interlinked (Kalyoncu and Kalyoncu, 2009, s. 119). Since the investment in physical to human capital ratio is the input to increase the income growth, the growth models should focus on investment in physical to human capital ratio as the models focuses on the capital. In the general literature, economists have emphasized the importance of investment but not the investment in physical to human capital ratio. In terms of investment, many of empirical work have investigated on the role of investment in economic growth and it is found that investments play crucial role in Solow type of economic growth (Barro and Sala-i-Martin, 1995, s. 16). While in Solow type of growth model investment is the main contributor to economic growth; in endogenous growth models their interaction is cyclical (Aron, 2000, s. 101). Maybe it is related with the issue of decreasing return to physical capital (Bulutay, 1995, s. 7) Barro and Sala-i-Martin (1995, s. 433) refer that economic growth causes the investment rather than vice versa.

After giving brief information, it is believed that there is a complementary interaction between physical and human capital. Ramcharan (2004) and Lee (2007) emphasis the complementarities between human capital and physical capital because of the nature of the production process since machines have need of trained workers to operate them and trained mechanics to repair them. Lee (2007) also points out that it is multifaceted to introduce improved methods of production, new ways of doing things and more complex and sophisticated products if buyers, workers and consumers have unsatisfactory training and education to enable them to understand the technology. Ramcharan (2004) and Lee (2007) conclude from the more formal econometric evidence that important complementarities do exist between various types of human capital. Lucas (1990) also spells out that one of the central causes for physical capital not to flood from richer to poor countries is the lack of human capital and its external benefits to physical capital. Therefore, it will be focused on whether this can be supported by data. Thus, the aim of our study is to test for causality between investment in physical and human capital for India, Indonesia and Japan between the period of 1890 to 2000.

These countries have been chosen since the endogenous growth theories are considered as state of the art tools in explaining economic growth. Therefore, two branches have developed pioneered by Romer (1990) and Lucas (1988). The Romer's views economic growth as being driven by technological growth, facilitated by human capital as an input in the R&D sector, where Lucas's views sees human capital as a factor of production. Even though there are hypothetical differences, it remains difficult to distinguish empirically between these two theories. Using Bas van Leeuwen's alternative human capital estimates, we try to estimate whether there is a differences in terms of complementary intereaction for these two types of countries since Bas van Leeuwen runs two tests to distinguish between these theories in India, Indonesia and Japan where he found that, although the Indian and Indonesian economies where characterised by Lucasian growth, in Japan Lucasian growth was in the midtwentieth century replaced by Romerian growth.

In the next section, the methodology is discussed. In the third section, the data is described. The physical and human capital complementarities is discussed in the forth section. The estimated results are evaluated in the fifth section. The general finding is summed up at the last section.

II. METHODOLOGY

According to the Granger causality test approach, a variable Y is caused by X if Y can be predicted better from past values of Y and X than from past values of Y alone or vice versa. Therefore, the following regressions are employed:

$$Y_t = b_0 + \sum_{i=0}^{m} b_i Y_{t-i} + \sum_{i=1}^{m} a_j X_{t-j} + u_t$$

$$X_t = c_0 + \sum_{i=0}^{m} c_i X_{t-i} + \sum_{i=1}^{m} d_j Y_{t-j} + v_t$$

Where u_t and v_t are mutually uncorrelated white noise series. Testing a_j=d_j=0 for all j (j=0,1,...m) against $a_j \neq d_j \neq 0$ for at least some js will determine the direction of the relationship between Y and X. Prior to perform the causality test, we need to make sure that variables are stationary individually and cointegrated together. A series which is I(0) is held to be stationary. In order to test whether the series is stationary, the Augmented Dickey Fuller test (ADF) is employed. The estimation of the following regression are used:

$$\Delta X_t = \alpha_0 + \alpha_1 t + \alpha_2 X_{t-1} + \sum_{i=1}^{k} \alpha_3 \Delta X_{t-i} + e_t$$

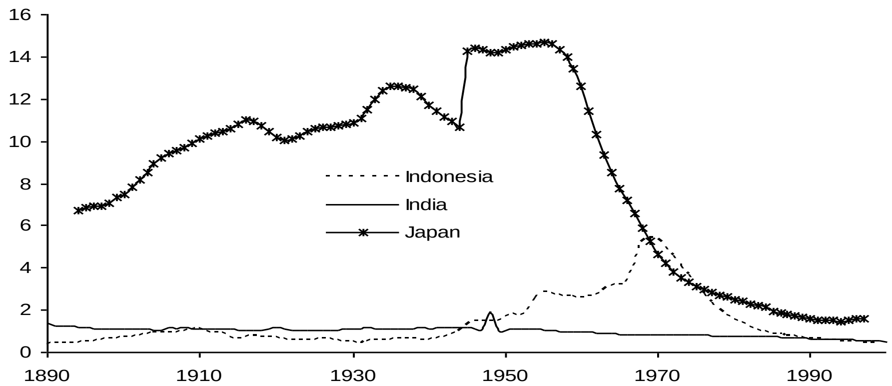
Where Δ presents the first difference operator, t is the linear time trend and e_t is a normally distributed error term. In the third equation, H_0: α_2=0 against the alternative $H_{0:}\ \alpha_2 \neq 0$ is tested. If the absolute value of calculated t-ratio is greater than the critical value, then the null hypothesis of a unit root is rejected which means that the series is I(0).

III. THE DATA

Bas van Leeuwen data called human capital and economic growth in Asia 1890–2000 are used in this study[1]. The general patterns of the data are summarized in figures 1 and 2. According to Leeuwen, Figure 1 shows the human capital to physical capital ratio and figure 2 shows the human capital to output ratio. While the human to physical capital ratio is more or less constant in India and Indonesia, in Japan it increases slightly up to 1950 and decreases afterwards.

These three countries were subject to exogenous influences both in technology and human capital development. But, whereas Japan is an example of a successful developer, India and Indonesia lagged behind.

Figure 1: Human Capital:Gross Fixed Non-Residential Physical Capital Stock Ratio (Based On Constant 1990Iinternational USD, Converted at PPP)



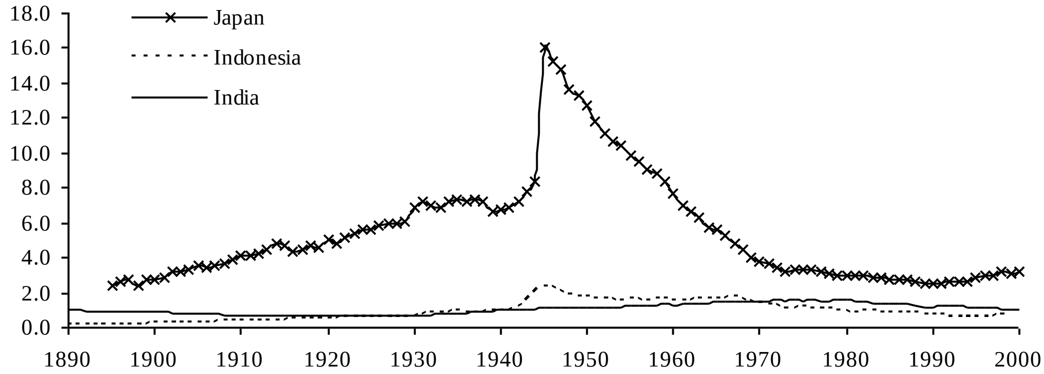
Source: Van Leeuwen (2009)

In Indonesia around 1970, the increase in the ratio was caused by a decline in physical capital investments, which was independent of GDP. It can be seen in figure 2, where there is even a decline in the human capital to output ratio. Likewise, the peak in the human capital to output ratio in Japan was caused by a fall in GDP caused by World War II. The human capital to output ratio shows about the same pattern. This suggests that the growth rates of per capita GDP and physical and human capital are

[1] Bas van Leeuwen (2007) "Human Capital and Economic Growth in India, Indonesia, and Japan: A quantitative analysis, 1890-2000" Printed in the Netherlands, ISBN: 978 90 8891 003 6

more or less in association. The exception is Japan in the second half of the century. The growth of human capital was considerably lower in Japan.

Figure 2: Human capital: output ratio (based on constant 1990 international USD, converted at PPP)



Source: Van Leeuwen (2009).

IV. PHYSICAL AND HUMAN CAPITAL INTERACTION

Some studies designate that the fundamental relations between physical and human capital is not substitution but complementarities as if there is no physical capital then there will be no human capital in action or use of technology (Bulutay, 1995, s. 17; Kalyoncu, 2008 s. 45). If there is not an adequate amount of human capital then having more physical capital is futile. In the frequently accepted production function, the level of physical capital (K) and human capital (H) in the production function entail that even the tiny unit of either physical or human capital is enough to continue for production:

$$Y_t = F_t\left[A_t, K_t, H_t, L_t\right] = F_t\left[A_t, c, H_t, L_t\right] = c_t^{\alpha} H_t^{\beta}\left(A_t L_t\right)^{1-\alpha-\beta} \text{ or}$$

$$Y_t = F_t\left[A_t, K_t, H_t, L_t\right] = F_t\left[A_t, K_t, c, L_t\right] = K_t^{\alpha} c_t^{\beta}\left(A_t L_t\right)^{1-\alpha-\beta} \text{ where}$$

Y stands for GDP level, L for raw labor and A for technology parameters.

Nevertheless, it is not matter-of-fact to set such interaction since any type of machines requires skilled labor to operate. Otherwise, it will not function as expected. The human capital and physical capital complementarities are established as the nature of the production process, for the reason that machines require trained workers to activate them and to repair them[2]. Therefore, it is believed that the production function should be as follows.[3]

$$Y_t = F_t\left[A_t, \frac{K_t}{H_t}, L_t\right]$$

Thus, it will be investigated whether this complementarities assumption is supported by causality test for Indonesia, India and Japan.

V. ESTIMATION

We briefly present the causal relations physical and human capital in order to see whether the set up for physical to human capital ratio is supported by the data. Any increase in income present incentive for more savings which means, in turns, more physical and human capital investment. Briefly, physical capital causes to human capital investment or vice versa- with any increase in per-capita GDP. Therefore, governments would be able to expend more on infrastructure and schooling. By these investments, government would increase the marginal productivity of physical and human capital ratio and labor in private sector, encouraging more physical and human capital investment. Alternatively, more physical (or human capital) investment presents more human (or physical capital) competence, more opportunities for jobs and higher wages resulting in higher income so physical and human capital investment.

There are two alternatives to conclude physical and human capital interaction. Firstly, in cooperation of physical and human capital investment is interdependent and could lead each other simultaneously and secondly, there could be no causality among them but they might move together under the influence of other factors. Before regression is run, the data is ploted for each sample. The data shows that there is a trend tendency to for each variable.

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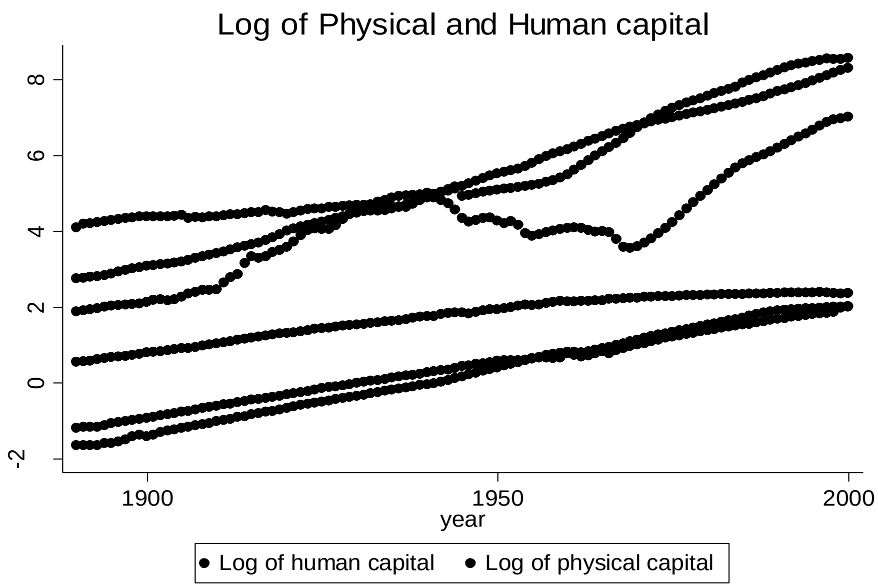
[2] For more detail about the complementarities interaction and how they interact by describing the excludability degree for different types of capital, please refer to Kalyoncu (2008).

[3] Rogers and Dowrick (1997, s. 17) report that human capital term has a negative coefficients, which is contrary to the models prediction. Islam (1995, s. 1153) also reports a negative coefficient on human capital in a panel estimation. Therefore, their finding may have supported our view since $Log\left[K/H\right] = Log\left[K\right] - Log\left[H\right]$



Firstly it is checked whether the series are stationary. Most of the series are non stationary at 10%. Only for human capital for India and Indonesia with lag-7 and lag-8 barely is rejected. Therefore, it is moved on the second step for the non-stationary series to check the direction of the causality. Then the equation 1 and 2 are run to confirm the causality direction. The results are shown in table 1.

Table 1: Causality result

Lag	India		Indonesia		Japan	
	R-BAR^2	R-BAR^2	R-BAR^2	R-BAR^2	R-BAR^2	R-BAR^2
	Log(H)	**log(H) and log(K)**	**Log(H)**	**log(H) and log(K)**	**Log(H)**	**log(H) and log(K)**
10	0.9995	0.9995	0.9998	0.9998	0.9996	0.9997
9	0.9995	0.9995	0.9998	0.9998	0.9996	0.9997
8	0.9995	0.9995	0.9998	0.9998	0.9996	0.9997
7	0.9995	0.9995	0.9998	0.9998	0.9996	0.9997
6	0.9995	0.9995	0.9998	0.9998	0.9996	0.9997
5	0.9994	0.9994	0.9998	0.9998	0.9995	0.9997
4	0.9994	0.9994	0.9998	0.9998	0.9995	0.9997
3	0.9994	0.9994	0.9998	0.9998	0.9996	0.9997
2	0.9994	0.9994	0.9998	0.9998	0.9995	0.9996
1	0.9994	0.9994	0.9998	0.9998	0.9995	0.9996
	log(K)	**log(K) and log(H)**	**log(K)**	**log(K) and log(H)**	**log(K)**	**log(K) and log(H)**
10	0.9997	0.9998	0.9982	0.9982	0.9995	0.9996
9	0.9997	0.9995	0.9983	0.9982	0.9995	0.9996
8	0.9997	0.9998	0.9983	0.9983	0.9995	0.9996
7	0.9997	0.9998	0.9982	0.9982	0.9995	0.9996
6	0.9997	0.9998	0.9983	0.9983	0.9996	0.9996
5	0.9997	0.9998	0.9982	0.9981	0.9996	0.9996
4	0.9997	0.9998	0.9981	0.9981	0.9996	0.9996
3	0.9997	0.9998	0.9978	0.9978	0.9996	0.9996
2	0.9997	0.9997	0.9977	0.9977	0.9996	0.9996
1	0.9996	0.9996	0.9954	0.9954	0.9995	0.9995

We have employed the $\bar{R}^2$ in view of the fact that it is the result of penalty for the additional variables where these variables' t-test result are less than one. Very weakly we may say that physical capital may cause the human capital and human capital may cause physical capital for Japan. However, there is no causality either one of the variable for Indonesia. It may be concluded that that physical capital caused by human capital for India.

We have checked whether the ECM parameter has I(0) or not. It is concluded that yes it is I(0).

India

$$\Delta LnK = \underset{(6.52)}{0.53}\Delta LnK_{t-1} - \underset{(-0.97)}{0.097}\Delta LnH_{t-1} + \underset{(4.19)}{0.004}ECM_{t-1}$$

Number of obs = 109; R - squared = 0.7622

$$\Delta LnH = -\underset{(-1.10)}{0.106}\Delta LnH_{t-1} - \underset{(-1.46)}{0.113}\Delta LnK_{t-1} + \underset{(7.70)}{0.007}ECM_{t-1}$$

Number of obs = 109; R - squared = 0.6393

$$\Delta LnK = \underset{(4.04)}{0.37}\Delta LnK_{t-1} + \underset{(4.35)}{0.38}\Delta LnK_{t-2} - \underset{(-0.62)}{0.0.56}\Delta LnH_{t-1} - \underset{(-0.92)}{0.0.56}\Delta LnH_{t-2} + \underset{(2.43)}{0.003}ECM_{t-1}$$

Number of obs = 108; R - squared = 0.8120

$$\Delta LnH = -\underset{(-1.49)}{0.14}\Delta LnH_{t-1} - \underset{(2.91)}{0.29}\Delta LnH_{t-2} - \underset{(-0.76)}{0.07}\Delta LnK_{t-1} - \underset{(-1.4)}{0.12}\Delta LnK_{t-2} + \underset{(7.97)}{0.009}ECM_{t-1}$$

Number of obs = 108; R - squared = 0.3570

Indenosia

$$\Delta LnK = \underset{(11.07)}{0.75}\Delta LnK_{t-1} - \underset{(1.33)}{0.42}\Delta LnH_{t-1} - \underset{(-0.28)}{0.0009}ECM_{t-1}$$

Number of obs = 109; R - squared = 0.6298

$$\Delta LnH = \underset{(5.80)}{0.48}\Delta LnH_{t-1} - \underset{(-1.28)}{0.023}\Delta LnK_{t-1} + \underset{(5.43)}{0.005}ECM_{t-1}$$

Number of obs = 109; R - squared = 0.8136

$$\Delta LnK = \underset{(9.53)}{0.91}\Delta LnK_{t-1} - \underset{(-2.41)}{0.24}\Delta LnK_{t-2} + \underset{(0.63)}{0.23}\Delta LnH_{t-1} + \underset{(0.42)}{0.15}\Delta LnH_{t-2} + \underset{(0.1)}{0.0003}ECM_{t-1}$$

Number of obs = 108; R - squared = 0.6512

$$\Delta LnH = \underset{(4.14)}{0.4}\Delta LnH_{t-1} + \underset{(1.28)}{0.12}\Delta LnH_{t-2} - \underset{(-0.57)}{0.015}\Delta LnK_{t-1} - \underset{(-0.51)}{0.13}\Delta LnK_{t-2} + \underset{(4.40)}{0.004}ECM_{t-1}$$

Number of obs = 108; R - squared = 0.8190

Japan

$$\Delta LnK = \underset{(5.88)}{0.5}\Delta LnK_{t-1} + \underset{(0.71)}{0.15}\Delta LnH_{t-1} + \underset{(3.87)}{0.006}ECM_{t-1}$$

Number of obs = 109; R - squared = 0.6984

$$\Delta LnH = \underset{(7.95)}{0.59}\Delta LnH_{t-1} + \underset{(2.56)}{0.08}\Delta LnK_{t-1} + \underset{(0.35)}{0.0002}ECM_{t-1}$$

Number of obs = 109; R - squared = 0.6193

$$\Delta LnK = \underset{(4.11)}{0.39}\,\Delta LnK_{t-1} + \underset{(2.64)}{0.26}\,\Delta LnK_{t-2} - \underset{(-0.52)}{0.13}\,\Delta LnH_{t-1} + \underset{(0.95)}{0.25}\,\Delta LnH_{t-2} + \underset{(2.38)}{0.004}\,ECM_{t-1}$$

Number of obs = 108; R - squared = 0.7191

$$\Delta LnH = \underset{(6.84)}{0.62}\,\Delta LnH_{t-1} + \underset{(0.87)}{0.078}\,\Delta LnH_{t-2} + \underset{(4.50)}{0.14}\,\Delta LnK_{t-1} - \underset{(-4.42)}{0.15}\,\Delta LnK_{t-2} + \underset{(1.80)}{0.001}\,ECM_{t-1}$$

Number of obs = 108; R - squared = 0.6815

It may be said that what it is concluded previously for previous test goes as for error correction estimation. All short run adjustments are significantly effective.

CONCLUDING REMARKS

There are very strong reasons to belief that there is a complementary interaction between physical and human capital, and it is focused on whether this can be supported by data. Testing for causality between investment in physical and human capital ratio for India, Indonesia and Japan at the period of 1890 to 2000, it has been found very weak causality. We may say that it is much clear for Japan. It may be because of Japan is much better organized and planed economy than the others. Also there is no reason to assume that one growth theory is applicable and others are not. Application of growth theories may be diverse over time and among countries where these concerns are addressed while focusing on three Asian countries, a successful (Japan) and two less successful economic developers (India and Indonesia), where Japan plans its future much carefully than others.

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