HUMAN CAPITAL, ECONOMIC GROWTH, AND CONVERGENCE: A CASE STUDY IN INDONESIA

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ABSTRACT

Economic development is a process in which a country is experiencing economic growth for a long period accompanied by a better distribution of income. Human capital is one of the inputs of the production process with an important role in increasing productivity and creating new technology through the accumulation of knowledge. Human capital builds the economy through transmission of economic growth increases and inequality reduction. This study aims to analyze the effect of human capital on economic growth and convergence in Indonesia using panel data regression with generalized least squares and robust standard error. The sample is 33 provinces observed from 2000 to 2016. The variables are GRDP, GRDP per capita, human capital, investment, labor force, and technology (total factor productivity). This study finds that human capital has a significant positive effect on economic growth, but the effect is relatively small. The study also finds absolute convergence and conditional convergence at the speed of, respectively, 0.06% and 0.23%. Human capital also influences conditional convergence and increases the speed of convergence from 0.23% to 0.41%.

Keywords: human capital, economic growth, absolute convergence, conditional convergence, panel data regression

INTRODUCTION

Economic growth is one of the long-term problems for all countries in the world. It lies in how much national income is able to grow considering that the aggregate output is very dependent on the use of aggregate input. In general, inputs are classified into three, namely land, physical capital, and labor. All three are components of production factor, although there are other intangible production factors such as human capital, which reflect all human qualities from health, morals, knowledge to skills (Chang and Shi 2016). A phenomenal research by Mankiw, Romer, and Weil (1992) presented Solow's Growth Model by including human capital as an additional production factor. The research found a positive and significant relationship between the proportion of adults enrolled in secondary education and GDP per capita. However, Klenow and Rodriguez-Clare (1997) questioned the results of Mankiw, Romer, and Weil (1992) about the proportion of income per capita variations explained by human capital variations. Klenow and Rodriguez-Clare (1997) argued that the definition of the variables by Mankiw, Romer, and Weil (1992) regarding human capital is a little too narrow because it only considers higher education. Kalaitzidakis et al. (2001) concluded that the effect of human capital accumulation on economic growth is still controversial. As in many issues, conclusions are very dependent on the definition of variables, research methodology, and the period of the model. A recent study by Chang and Shi (2016) observed the influence of human capital and economic growth in China. They found that basic human capital and advanced human capital can spur economic growth in a very good way, that is, basic human capital contributes directly to the increase in final output due to advanced human capital that drives through technological innovation. The results of Chang and Shi (2016) are supported by Zhang, Jin-kai, and Tie-mei (2016) in that it is important to increase investment in education to overcome technological underdevelopment. According to Atmanti (2005), education is indeed something that is very much needed in building an economy; higher education tends to enrich people's knowledge and improves the quality of their thinking. Better knowledge will enable the creation of new technologies, which later will increase efficiency and productivity. Becker (1993 in Abbas 2010) mentioned that the economic advancements of Japan, Taiwan and other Asian countries contribute to the belief in the importance of human capital in economic growth, so investment in human capital makes some Asian countries earn the title of Asian Tigers. The success of development in East Asian countries that are poor in natural resources makes them focused more on spurring human capital. Like several Asian countries that have proven their success, Indonesia, which is still in a developing country, continues to make developments, and the results are quite palpable even though the speed of development between regions is different. The non-uniform pattern of development makes some areas are able to grow quickly but not with some others. Kuznets (1955) made the inverted U curve hypothesis, which explains that, in the early stages of development, the income distribution is bad, but, after reaching a certain level of development, the income distribution is better. Seeing the occurring inequality problems, many studies observe the convergence of economic growth and factors influencing it. Convergence is simply interpreted as a condition where a low-income economy and a high-income economy will one day meet at the same point. Researches on convergence are widely carried out in various countries including Europe (Barro and Sala-i-Martin 1991), Japan (Barro and Sala-i-Martin, 1992), Canada (Coulombe and Tremblay, 1998), India (Cashin and Sahay, 1996), the Philippines (Balisacan and Fuwa, 2003), China (Gundlach, 1997) and (Jian, Sachs, and Warner, 1996), Mexico, Argentina, and Brazil (Serra, 2006). In the context of research in Indonesia, this research differs from previous studies in terms of measuring human capital. If previous studies directly measure human capital using proxies such as school enrollment rates, average length of schooling, literacy rates, test scores in certain fields, government spending in education, government spending in health, and life expectancy, this research measure human capital by making the Human Capital Index first. This study contributes as follows. (1) The results of this study provide the latest method (2) The results of this study provide empirical evidence based on the latest data (3) The results of this study can be used as material for study and evaluation of government policies, especially in the field of education. This research focuses on Indonesia because of the lack of calculation of the human capital index. This study aims to prove whether human capital is a determining factor for economic growth and convergence in Indonesia.

LITERATURE REVIEW

Human Capital Theory

The importance of human capital has emerged in many recent studies on economic growth (Berg, 2005). Lucas (1988 in Anwar 2014) built one of the first endogenous growth models in the late 1980s by defining education as the driving force behind technological progress in an economy. Becker (2002) defines human capital as knowledge, information, ideas, expertise and health of an individual. According to Todaro and Smith (2011), human capital is a term often used by economists to refer to education, health, and other human capacities which, if increased, can increase productivity. Meanwhile, according to Acemoglu and Autor (2005), human capital is defined as matters relating to the knowledge or characteristics of workers either innate or acquired which will later make a contribution called productivity. Becker (1993 in Anwar 2014) explains that human capital is not limited only to education, but other factors such as health and training can be interpreted as a way to improve individual quality. Decision making by individuals to invest in themselves must consider the benefits and costs. According to Becker (2002), economic success both individually and in aggregate depends on how much individuals invest in themselves. Becker (1962 in Anwar 2014) emphasizes the importance of investing in human capital because investment in human capital can affect life in the future. Improving the quality of human capital cannot be done in a short time. Investment in human capital is actually the same as investment in other production factors because it also pays attention to the rate of return or benefits (Atmanti 2005). According to Acemoglu and Autor (2005), the sources of human capital formation are innate abilities, schools, school quality, non-school investment, training and the influence of the labor market. Schools are an important part of developing human capital. The results of the formation of human capital will increase self-capacity which in turn will increase the production capacity and economic capacity of a country (Anwar 2014). According to Card and Krueger (1992), many economists believe that income reflects the value of skills and knowledge acquired through the educational process.

Endogenous Growth Theory

This theory tries to identify and analyze the factors that influence the process of economic growth originating from within the economic system itself. Technological progress is considered endogenous in that economic growth is the result of decisions by economic actors to invest in science. In addition, the definition of capital here is broader, not just physical capital but also includes human capital. According to this theory, the main factors that cause differences in the level of income per capita between countries are due to differences in knowledge transfer mechanisms, investment capacity of physical capital, human capital and infrastructure. Robert E. Lucas, one of the propenents of endogenous growth theory emphasizes the importance of human capital in development. Romer expressed his thoughts on the importance of research and development (R&D) in economic growth which became known as the theory of endogenous growth. In addition, Romer also views economic growth as a tangible result of the accumulation in the field of science. Structurally, this endogenous growth theory has similarities with the Neoclassical theory (Solow-Swan), but differs in several assumptions and conclusions drawn. This model does not use the assumption of diminishing marginal returns to capital investment but uses the assumption of increasing returns to scale in its aggregate production function. This theory clearly describes how capital accumulation does not experience diminishing returns but will instead experience increasing returns with specialization and investment in science. According to Romer (1994), the theory of endogenous growth has three basic elements as follows.

1. There is an endogenous technological change through a process of accumulation of knowledge.
2. There is the creation of new ideas by the company as a result of the knowledge overflow mechanism.
3. The production of consumer goods produced by the factors of production of science will grow indefinitely.

The production function in the endogenous growth model can be shown by the following formula:

$$Y = F(R, K, H)$$

where Y is the total output, R is the research and development (R&D) carried out by every firm in the economy, K is the accumulation of physical capital, and H is the accumulation of human capital. In practice, the formulation of the production function is often described by the production function "AK" which is represented by the equation:

$$Y = AK$$

where Y is the total output, K is the capital stock (both physical and human capital), and A is the technological factor.

Solow Growth Theory

Some countries are growing faster than others, some are experiencing a slow pace of growth and some are experiencing stagnant growth. All of these problems are what is meant by long-term economic growth. Long-term economic growth is growth whose orientation is to increase aggregate supply, in other words, how to increase production capacity in the economy. The growth of labor and capital productivity is the main factor. The more productive a country is, the higher its standard of living will be. Economists developed a theory of economic growth called the Solow growth model. According to Mankiw (2016), the Solow growth model is designed to show how the capital stock, labor force, and technological progress interact in the economy, and how they affect the overall output of goods and services of a country. Based on his research, Solow (1956) stated that the role of technological progress in economic growth is very dominant. Solow's findings show that the United States' economic growth which reached 2.75% per year in the period 1909 to 1949, more than half (1.5%) was a contribution from technological progress, while the rest was caused by the addition of the use of factors of production. This theoretical view is based on the assumption that underlies classical economic analysis, namely that the economy is at the full employment level and the full utilization level of its

production factors. In other words, the economy will continue to develop and all of it depends on the growth of the capital stock, the growth of the labor force, and technological progress.

Convergence Theory

Convergence is the process of reducing the gap / inequality between high-income areas and low-income areas or can be understood as the process of pursuing low-income areas against high-income areas. This theory says that low-income areas and high-income areas will one day converge (meet at one point). The ability to pursue this is based on the assumption that high-income areas will experience a steady state condition, ie when their income cannot increase because additional investment can no longer increase income. This happens because all production costs have been covered by existing investments so that additional savings cannot be used as additional investments.

σ Convergence

Sigma convergence is a commonly used measure to measure the level of disparity between regions in a certain period. Barro and Sala-i-Martin (1997) measure the convergence of sigma through the distance that occurs between economies based on the standard deviation of real income per capita between regions. If the distance from real income per capita between regions decreases, then convergence occurs. However, if the real income per capita gap between regions increases, there will be a divergence which means a slowdown in economic growth for low-income areas to catch up with high-income regions.

β Convergence

Beta convergence has two hypotheses, namely absolute convergence and conditional convergence. Absolute convergence is said to occur if low-income areas grow larger than high-income areas. At the empirical level, this can be done by estimating the econometric model in which the income at the beginning of the period is the only explanatory variable for income growth. Meanwhile, conditional convergence indicates that the model specification includes a number of variables other than the initial income of the period which are estimated to affect the level of income growth. Conditional convergence is considered more adequate to be used if you want to know the impact of a particular policy.

METHODOLOGY

This research uses a quantitative approach with a sample of 33 provinces in Indonesia. This research period is 2000 – 2016. Human capital index was calculated based on the method developed by the World Economic Forum (2017) which was modified as follows.

Table 1. The Structure of Human Capital Index

Dimension (weight)	Indicator
Capacity (15%)	Elementary school education facility
	Junior high school education facility
	Senior and vocational high school education facility
	Higher education facility
Development (50%)	Literacy rate
	Elementary school participation rate
	Junior high school participation rate
	Senior and vocational high school participation rate
	Higher education participation rate
Know-how (25%)	Elementary school education quality
	Junior high school education quality
	Senior and vocational high school education quality
	Higher education quality
Deployment (10%)	Labor force participation

Source: World Economic Forum, 2017 (modified by the authors)

Table 2. The Operational Definition of the Dimensions

Dimension	Operational Definition
Capacity	Capacity measures the ability to provide education facilities at certain education levels
Development	Development measures the number of population members who participate in certain formal education levels
Know-how	Know-how measures the quality of certain formal education levels
Deployment	Deployment measures the number of population members who are able to actively participate in professional world as the impact of past education investments

Source: World Economic Forum, 2017 (modified by the authors)

Table 3. Indicator Measurement

Capacity	
Indicator	Measurement
Elementary school education facility	Ratio between the number of elementary schools and the number of children aged 7 to 12 years
Junior high school education facility	Ratio between the number of junior high schools and the number of teenagers aged 13 to 15 years
Senior or vocational high school education facility	The ratio between the number of senior high schools and the number of teenagers age 16 to 18 years
Higher education facility	The ratio between the number of higher educations and people aged 19 to 24 years
Development	
Indicator	Measurement
Literacy rate	The percentage of population members of above 15 years old who are able to read and write
Elementary school education participation rate	The percentage of population members of between 7 and 12 years old who are currently attending elementary school
Junior high school education participation rate	The percentage of population members of between 13 and 15 years old who are currently attending junior high school
Senior and vocational Junior high school education participation rate	The percentage of population members of between 16 and 18 years old who are currently attending senior and vocational high school
Higher education participation rate	The percentage of population members of between 19 to 24 years old who are currently attending higher education
Know-how	
Indicator	Measurement
Elementary school education quality	Teacher-student ratio at elementary school level
Junior high school education quality	Teacher-student ratio at junior high school level
Senior and vocational high school education quality	Teacher-student ratio at senior and vocational high school level
Higher education quality	Teacher-student ratio at higher education level
Deployment	
Indicator	Measurement
Labor force participation	The percentage of population members who are above 15 years of age and actively participate in labor market, both working and looking for jobs

Source: World Economic Forum, 2017 (modified by the authors)

Index Calculation Method

Indicator Index

The calculation of Human Capital Index used in this research is the modification of the Human Development Index calculation method developed by the UNDP (2016). According to Santos (1999), due to variations in indicator unit values, the formula for indicator index calculation is as follows.

$$Indicator\ Index = \frac{(Actual\ Value - Minimum\ value)}{(Maximum\ Value - Minimum\ Value)}$$

The minimum value is the lowest value of all data observed during the observation period. The maximum value is the highest value of all data observed during the observation period. Therefore, the highest index value is 1, and the lowest index value is 0. The minimum and maximum values will be different each year.

Dimension Index

According to Ritonga (2014), dimension index is the arithmetic average of the indicator indices that comprise the dimension. This study uses arithmetic average instead of geometric average because the former gives a fairer result than the latter. For example, if a dimension consists of 4 indicators, and if one of the indicators has a zero value, the final result of the geometric average will be zero even though the other 3 indicators are good. This condition does not occur if arithmetic average is used. World Economic Forum (2017) uses an index scale of 0-100; therefore, the index calculation results must be multiplied by 100. The formula for calculating the dimension index is as follows.

$$Dimension\ Index = \frac{I_{indicator-1} + I_{indicator-2} + \cdots + I_{indicator-n}}{n}\ x\ 100$$

where *I* is the indicator index and *n* is the number of indicators comprising the dimension.

Human Capital Composite Index

After calculating the dimension index and indicator index, the next step is calculating human capital composite index. The calculation still refers to the calculation of human development index used by UNDP (2016). The formula is as follows.

$$HCI = w_1 * DI_1 + w_2 * DI_2 + ... + w_n * DI_n$$

where HCI is human capital index, w is the weight of dimension index, DI is dimension index, and n is the number of dimensions.

Panel Data Analysis Method

Widarjono (2017) explained that panel data is the combination between cross-section and time-series data. There are several methods used to estimate a regression model using panel data; they are Common Effect, Fixed Effect, and Random Effect. The models to be estimated in this study are as follows.

Model 1: Human Capital on Economic Growth

$$Log\_GRDP_{it} = \alpha_0 + \alpha_1 HCI_{it} + \alpha_2 Log\_INV_{it} + \alpha_3 Log\_LF_{it} + \alpha_4 TFP_{it} + \mu_{it}$$

Model 2: Absolute Convergence

$$Log\_(\frac{GRDP\_per\_cap_{it}}{GRDP\_per\_cap_{it-1}}) = \beta_0 + \beta_1 Log\_GRDP\_per\_cap_{it-1} + \nu_{it}$$

Model 3: Conditional Convergence without Human Capital

$$Log\_(\frac{GRDP\_per\_cap_{it}}{GRDP\_per\_cap_{it-1}}) = \theta_0 + \theta_1 Log\_GRDP\_per\_cap_{it-1} + \theta_2 Log\_INV_{it} + \theta_3 Log\_LF_{it} + \theta_4 TFP_{it} + \varepsilon_{it}$$

Model 4: Conditional Convergence with Human Capital

$$Log\_(\frac{GRDP\_per\_cap_{it}}{GRDP\_per\_cap_{it-1}}) = \delta_0 + \delta_1 Log\_GRDP\_per\_cap_{it-1} + \delta_2 Log\_INV_{it} + \delta_3 Log\_LF_{it} + \delta_4 TFP_{it} + \delta_5 HCI_{it} + \gamma_{it}$$

where: Log_GRDP=Logarithm of Real Gross Regional Domestic Product; Log_(GRDP_per_cap/GRDP_per_cap$_{it-1}$)=Logarithm of the Ratio Between Real per Capita Gross Regional Domestic Product of year t and t-1; Log_GRDP_per_cap$_{it-1}$= Logarithm of Real per Capita Gross Regional Domestic Product of the Beginning Year of Analysis; HCI=Human Capital Index; Log_INV=Logarithm of the Control Variable of Investment; Log_LF=Logarithm of the Control Variable of Labor Force; TFP= Control Variable of Total Factor Productivity; i=Province; t=Year. Convergence coefficient of β_1, θ_1, and δ_1 are units that can be used to calculation the speed of convergence. If β_1, θ_1, $\delta_1 < 0$, convergence occurs, and if β_1, θ_1, $\delta_1 > 0$, divergence occurs. Perfect convergence is reached if β_1, θ_1, $\delta_1 = -1$, and perfect divergence is reached if β_1, θ_1, $\delta_1 = 1$. The speed of convergence (λ) of a country or region can be calculated using the following formulas.

$$\lambda = -\frac{[\ln(\beta_1 + 1)]}{T} \qquad \lambda = -\frac{[\ln(\theta_1 + 1)]}{T} \qquad \lambda = -\frac{[\ln(\delta_1 + 1)]}{T}$$

T is the number of observation year. By using the value of each coefficient of convergence, the half-life of convergence (h), i.e. time required to close a half of the inequality, can be calculated using the following formula.

$$h = \frac{\ln(2)}{\lambda}$$

The unit of half-life of convergence is year.

Williamson Index

To support the convergence estimation result, Williamson index calculation is required. Theoretically, the economy is converging if the value of the Williamson index is decreasing over times. Conversely, the economy is diverging if the Williamson index is increasing over times. To see whether the economy is converging or diverging, a simple estimate with the following equation can be made (Goschin, 2014).

$$Vw_t = a + b_t + \mu_t$$

Where Vw_t is the Williamson index in year t, and b_t is the trend line. The equation can be estimated using a simple regression. The Williamson index can be calculated using the following formula (Williamson, 1965):

$$Vw_t = \frac{\sqrt{\sum_i^n (y_i - y)^2 \left(\frac{f_i}{n}\right)}}{y}$$

where:
Vw = Williamson index
yi = Provincial income per capita
y = National income per capita

fi = Provincial population
n = National population

According to Williamson (1965 in Arsyad 2016), there are three criteria of Williamson indices' calculation; they are
1. 0.0 – 0.2 indicates low inequality;
2. 0.21 – 0.35 indicates medium inequality; and
3. > 0.35 indicates high inequality.

RESULTS AND DISCUSSION

The Effect of Human Capital on Economic Growth in Indonesia

The result of the regression using fixed effect model show that human capital significantly and positively influences economic growth at α=1%. Based on the t test, the HCI coefficient of 0.0091 means that one-point increase in human capital improves economic growth by 0.0091%. In empirical perspective, Solow's growth model using the augmented Solow's growth model with human capital is proven relevant in Indonesia. This is evidenced by the t and F test, in which all variables, i.e. investment, labor force, technology (total factor productivity) and human capital individually and simultaneously have significant effects on economic growth. The coefficient of determination of 84.47% also supports that Solow's growth theory is proven relevant in Indonesia.

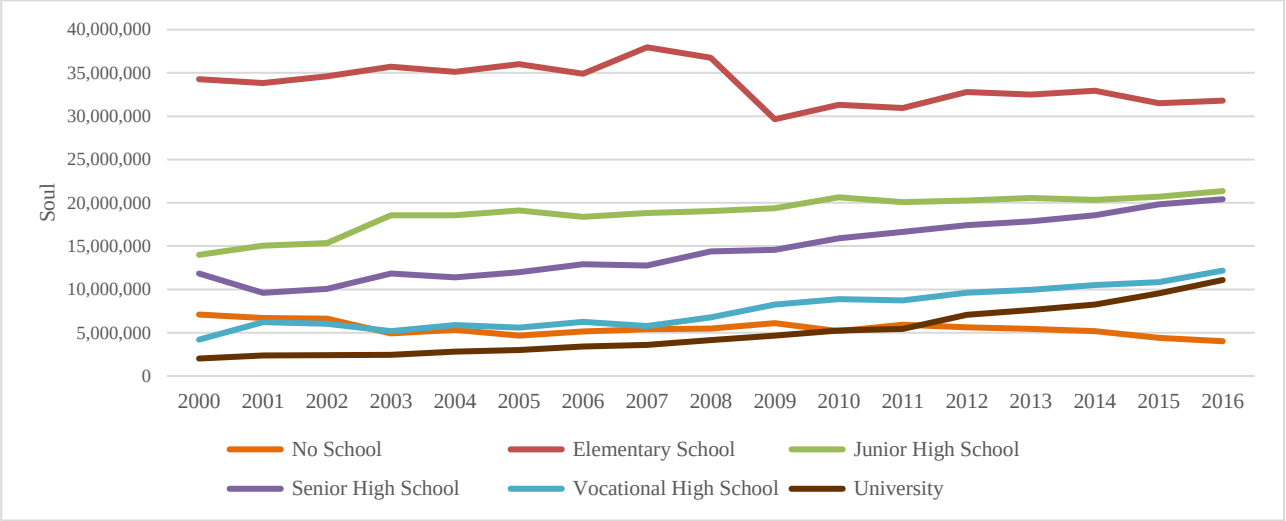
Table 4. Estimation Result of Model 1

Dependent Variable: Log_GRDP		
Independent Variable	Fixed Effect Model: Robust Standard Error	
	Coeff	Prob
C	1.8916***	0.008
HCI	0.0091***	0.000
Log_INV	0.2276***	0.000
Log_LF	0.2048*	0.097
TFP	0.0008**	0.046
R-Squared	0.8447	
Prob (F-Stat)	0.0000	
Note: *** significant at 1% ; ** significant at 5% ; * significant at 10%		

Source: Authors, 2021

The result of this study is relevant to the results of Altiner and Toktas (2017), Chang and Shi (2016), Zhang, Jin-kai, and Tie-mei (2016), Ecevit and Kuloglu (2016), Peleniscu (2015), Akpolat (2014), Sheidaei and Tash (2014), Hanushek (2013), Vinod and Kaushik (2007), Barro (2001), Murthy and Chien (1997), and Mankiw, Romer, and Weil (1992), which show that human capital has a significant and positive influence on economic growth. The control variables, namely investment, labor force, and total factor productivity, also have a significant positive effect on economic growth. An increase of 1% in investment, labor force, and total factor productivity increases economic growth by, consecutively, 0.2276%, 0.2048%, and 0.0008%. Compared to several previous studies, this result has a high degree of similarity with the results of Altiner and Toktas (2017), who observed the effect of human capital on GDP in 32 developing countries from 2000 to 2014, in which Indonesia was also included in the observation. The magnitude of the influence of human capital in this study and is not much different with the finding of Altiner and Toktas (2017), where human capital has the smallest influence of all variables, namely investment and labor force as control variables. This result is also strongly supported by Akpolat (2014), who concluded that human capital has a relatively small influence in developing countries compared to in developed countries. Referring to Cobb-Douglas' production function, "A" (total factor productivity) is influenced by several factors including research and development, technological advancement level, labor quality, education quality, government, social institutions, and geography (Hubbard, O'Brien, and Rafferty 2014). This study also finds TFP coefficient of 0.0008, which is similar to the coefficient of human capital (0.0091), relatively lower than the two control variables, i.e. investment and labor force with the coefficient of 0.2276 and 0.2048. This means that the influence of human capital and the effect of total factor productivity will not be far off because TFP also includes factors that describe human quality. In short, the estimation result for TFP is able to provide a supporting analysis for human capital in explaining its effects on economic growth.

Figure 1. The Number of Labor in Indonesia Based on Completed Higher Education, 2000-2016



Source: BPS, 2021

The significant and positive influence of human capital in Indonesia is caused by the decrease in the number of workers with elementary school education, which is followed by an increasing number of workers with junior, senior high school, vocational high school, and higher education. This shows an increase of the productivity, knowledge, and the quality of thinking of the labor force. Human capital has a significant effect, but its effect is relatively small. Based on Figure 1, the composition of labor force has not changed from 2000 to 2016. The number of workers until 2016 is still dominated by elementary school graduates, followed by junior, senior, and vocational school, and higher education graduates. This pattern is exactly the same as the pattern of school participation rate in Indonesia. Observing the trend, the quality of labor in Indonesia tends to increase, indicated by a decrease in the number of workers with elementary education, because they are no longer entering the working age. The growth of junior high school education graduates is also slowing. Based on Figure 1, the number is almost the same as the labor force of high school graduates. In accordance with the classification of the International Standard Classification of Education (ISCED), workers with elementary and junior high school education are only able to do basic work. They are categorized as unskilled workers, namely workers with low knowledge who only rely on their physical ability such as porters, transport workers, housemaids, sweepers, pedicab drivers, rice farmers, etc. Those jobs are needed, but at least the quality must be improved so that, when quality improvement takes place, productivity is increased followed by welfare. This analysis is supported by the results of Sheidaei and Tash (2014), which show a non-linear relationship where human capital has a significant and negative effect and then significant and positive, which means that a minimum level of education is needed to grow output. Compared to some other countries, the percentage of labor force with higher education in Indonesia is relatively low. Developed countries with high GDP per capita tend to have a larger population of labor force with higher education. The greater influence of human capital in developed countries than in developing countries is due to the fact that developed countries have high GDP per capita, so the population gets better access to education. Conversely, developing countries like Indonesia, which have relatively low GDP per capita, have lower access to education, proven by the decreasing school participation rate along with an increase in education levels. Becker (2002) mentioned that economic success, whether individually or as a whole, depends on how much individuals invest in themselves. Implicitly, Becker (2002) wanted to say that only those with more economic capacity are able to get access to higher education. According to Card and Kruger (1992), many economists believe that income reflects the value of acquired skills and knowledge, so that human capital (education) and economic growth (increase in income) are reciprocal. High human capital will affect the increase in income, and such increase can be used to access education. The cycle repeats continuously. However, in the context of developing countries like Indonesia, increasing human resource through education still needs government intervention due to low income per capita. In addition, higher education costs in each level will cause an increasingly heavy economic burden. The fact also shows that the high subsidies for education after elementary school from governments in developing countries (Jimenez, 1986) prove that the cost of education in developing countries tends to be relatively high.

Absolute Convergence in Indonesia

One prediction of Solow's growth theory is income per capita convergence among countries or regions related to their disparity conditions (Sala-i-Martin 1996 in Tajerin et al. 2013). According to Barro (1994), the growth of a country's or region's income per capita tends to be inversely related to the level of initial income, so an indication of convergence arises if a negative relationship between growth in income per capita and income per capita at the beginning of the analysis year is found.

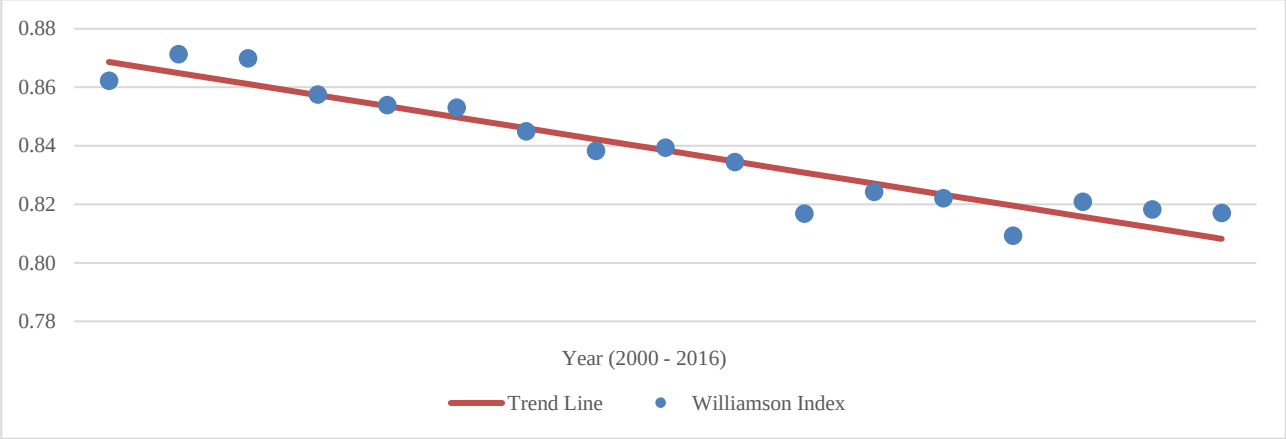
Table 5. Estimation Result of Model 2

Dependent Variable: Log ($GRDP\_per\_cap_t$ / $GRDP\_per\_cap_{t-1}$)		
Independent Variable	Random Effect Model	
	Coeff	Prob
C	0,0804	0,004
$Log\_GRDP\_per\_cap_{t-1}$	-0,0095**	0,020
R-Squared	0,0025	
Prob (F-Stat)	0,0195	
Convergence / Divergence	Convergence	
Speed of Convergence (λ)	0,06%	
The Half-life of Convergence	1151 years	
The Whole Life of Convergence	2302 years	
Note: *** significant at 1% ; ** significant at 5% ; * significant at 10%		

Source: Authors, 2021

The estimation results using the random effect model show that GRDP per capita in the beginning year of the analysis has a significant negative effect on GRDP per capita growth at α = 5%. That is, provinces in Indonesia are experiencing absolute convergence at a rate of 0.06% per year. The half-life of convergence and the whole life of convergence are 1151 years and 2302 years. Based on Table 5, the coefficient is 0.0025, which means that the variation in growth of GRDP per capita can be explained by the model by 0.25%, and the remaining 99.75% is explained by other variables outside the model. The results of this study are in accordance with the studies of Gomleksiz, Sahbaz, and Mercan (2017), Yusop and Firdaus (2009), Margono (2009), Resosudarmo and Vidyattama (2006), Serra (2006), Balisacan and Fuwa (2003), Gundlach (1997), Cashin and Sahay (1996), Jian, Sachs, and Warner (1996), Sala-i-Martin (1995), Barro and Sala-i-Martin (1992), and Barro and Sala-i-Martin (1991).

Figure 2. Williamson Index for Indonesia, 2000-2016



Source: Authors, 2021

Based on Figure 2, the results of the Williamson index calculation show a declining disparity. It strengthens the estimation results that empirically prove the theory of convergence in Indonesia. The relatively low speed of convergence is also supported by the magnitude of changes in the Williamson index over time, where a declining trend is observable, although the change is very small. The Williamson index was 0.87 in 2000 and 0.81 in 2016, decreasing only 0.06 in 17 years. The Williamson index calculation results are in the category of "high inequality", seen in the calculation results in the interval of 0.8 to 0.9. Thus, it can be concluded that index values exceeding 0.35 are categorized into high inequality. This result is in accordance with the research of Resosudarmo and Vidyattama (2006) that the disparity between provinces in Indonesia is relatively large. Absolute convergence estimation results have empirically proven the convergence process, even though the speed is very low, i.e. 0.06% per year, with the half-life of convergence of 1151 years. This process took a very long time, in which until 2016 the Special Region of Jakarta is still on the highest GRDP per capita of IDR 55,115,896 and East Nusa Tenggara is still on the lowest GRDP per capita of IDR 3,287,521. This figure shows that the highest provincial GRDP per capita is 16 times the lowest. This condition explains that it still takes a very long time to equate areas with high income with regions with low income. Therefore, an analysis on variables thought to accelerate the convergence process is needed, one of which is by using the conditional convergence model, namely by adding explanatory variables to the convergence model. Thus, the results of absolute convergence estimation, the results of Williamson index calculation, and a simple descriptive analysis of raw data are able to empirically prove that the disparity of provinces in Indonesia is still relatively high.

Conditional Convergence in Indonesia

The estimation result shows that GRDP per capita of the initial year of analysis significantly and negatively influences the GRDP per capita growth at α=5%. It means that provinces in Indonesia is experiencing conditional convergence at the speed of 0.23% per year. This result shows the conditional convergence with Solow model's explanatory variables, i.e. investment, labor force, and technology (total factor productivity). The speed of conditional convergence in this study is similar to the finding of Yusop and Firdaus (2009), in that the speed of conditional convergence of the similar object, provinces in Indonesia, is 0.29% per year. If the time required to cover one half of the initial inequality is 303 years, the time required to cover the whole life of convergence is 606 years.

Table 6. Estimation Result of Model 3

Dependent Variable: Log ($GRDP\_per\_cap_t$ / $GRDP\_per\_cap_{t-1}$)		
Independent Variable	Fixed Effect Model: FGLS	
	Coeff	Prob
C	-0,2683**	0,047
$Log\_GRDP\_per\_cap_{t-1}$	-0,0359**	0,013
Log_INV	-0,0203**	0,016
Log_LF	0,0941***	0,000
TFP	0,0012***	0,000
R-Squared	0,2038	
Prob (F-Stat)	0,0000	
Convergence / Divergence	Convergence	
Speed of Convergence (λ)	0,23%	
The Half-life of Convergence	303 years	
The Whole Life of Convergence	606 years	
Note: *** significant at 1% ; ** significant at 5% ; * significant at 10%		

Source: Authors, 2021

This means that low-income provinces can match high-income provinces in 2622 (606 years after 2016). Referring to the results of F test and t test on the explanatory variables, namely investment, labor force, and total factor productivity, they have a significant effect on GRDP per capita growth at α = 1%. Partially, investment, labor force, and total factor productivity have significant positive effects on GRDP per capita growth at 5%, 1%, and 1%. Thus, to accelerate inter-provincial convergence in Indonesia, enhancements in investment, labor force, and technology (total factor productivity) are required.

The Effect of Human Capital on Conditional Convergence in Indonesia

The result of this study indicates that human capital influences conditional convergence in Indonesia at α = 1%. This result confirms the findings of several previous researchers concerning the effect of human capital on conditional convergence, e.g. Timakova (2011), who observed conditional convergence in 86 countries; Coulumbe and Tremblay (1998), who observed the conditional convergence of provinces in Canada; and Garcia and Soelistianingsih (1998), who observed the conditional convergence of provinces in Indonesia. The estimation result shows the small influence of human capital on GRDP per capita growth. One-point increase in human capital index is only able to increase the GDP per capita growth by 0.0006%. This result is still consistent with the finding of previous researches on the small effect of human capital in developing countries and shows that human capital is a variable that can accelerate convergence process.

Table 7. Estimation Result of Model 4

Dependent Variable: Log ($GRDP\_per\_cap_t$ / $GRDP\_per\_cap_{t-1}$)		
Independent Variable	Fixed Effect Model: FGLS	
	Coeff	Prob
C	-0,0266	0,865
$Log\_GRDP\_per\_cap_{t-1}$	-0,0638***	0,000
Log_INV	0,0249***	0,003
Log_LF	0,0830***	0,000
TFP	0,0012***	0,000
HCI	0,0006***	0,003
R-Squared	0,3193	
Prob (F-Stat)	0,0000	
Convergence / Divergence	Convergence	
Speed of Convergence (λ)	0,41%	
The Half-life of Convergence	168 years	
The Whole Life of Convergence	336 years	
Note: *** significant at 1% ; ** significant at 5% ; * significant at 10%		

Source: Authors, 2021

Based on Table 7, in addition to influencing conditional convergence, human capital also increases the speed of convergence to 0.41% per year, almost twice of the initial speed before human capital is included in the model, which is 0.23% per year. The half-life of convergence is also almost twice faster, from 303 years to 168 years. If the time needed to close one half of the initial gap is 168 years, then the time to close the whole life of convergence is 336 years. It means that low-income provinces match the high-income provinces in 2352 (336 years after 2016). This indicates that, to accelerate the convergence between provinces in Indonesia, human capital increase and its even distribution are needed. Then, the estimation results also show a coefficient of determination of 0.3193 (31.93%). This figure is higher than the estimation results before human capital is included in the conditional convergence model, which is 20.38%. The small increase in the coefficient of determination and the small number of the coefficient of determination itself indicate that there are still many other variables outside the model that can affect the convergence process. The results of this study indicate that human capital can accelerate the process of convergence, but the time is still relatively long. One of the biggest factors influencing the convergence process is inequality in the economic sector. Inequality is caused by migration due to strong economic attraction in the modern sector. Regions with modern sectors become the target of the labor force, as shown by the data that, until recently, islands with GDP contribution from the largest to the smallest are Java, Sumatra, Kalimantan, Sulawesi, Bali, Nusa Tenggara, Maluku, and Papua. Inequality is more visible when we learn data that around 50% of Indonesia's GDP is contributed by Java. This makes the convergence process in Indonesia relatively slow. In fact, if the economic sector in a province with low GRDP per capita is developed, it is not impossible for the province to develop and to catch up. No matter how good the policies are used to overcome disparities are, if there are no "seeds" to grow the economic sector in a province that has low GRDP per capita, then the convergence process will not be able to run quickly.

CONCLUSION

Based on the estimation and analysis of human capital, economic growth, and convergence in Indonesia, the following results are obtained.

1. Human capital has a significant positive effect on economic growth in Indonesia. However, the magnitude of the effect of human capital is very small. The results of this estimation are relevant with the results of some previous studies, where the effect of human capital on economic growth in developing countries is not as strong as in developed countries.
2. Provinces in Indonesia are experiencing absolute convergence at the speed of 0.06% per year; the time required to cover the half-life of convergence is 1151 years.
3. Provinces in Indonesia are experiencing conditional convergence with explanatory variables of investment, labor force, and technology (total factor productivity). The speed of conditional convergence is 0.23% per year, and the time needed to cover the half-life of convergence is 303 years. The results of the convergence estimation, in both absolute and conditional terms, are supported by the Williamson index, which shows a downward trend.
4. Human capital affects conditional convergence in Indonesia and increases the speed of convergence from 0.23% to 0.41%. The speed of half-life of convergence is almost twice as fast, from 303 years to 168 years.

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