International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 9, Issue 9, 2019

The Impact of Total Factor Productivity and Spatial Dependence on Per Capita Income Convergence

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This study aims to analyse the spatial dependence on the convergence of per capita regency/city income in Central Sulawesi Province in the period 2007–17. Total factor productivity (TFP) is related to the existence of a knowledge gap between developed and underdeveloped regions. Unsurprisingly, the underdeveloped regions want to catch up with the developed regions. The analysis used in this study was the Spatial Durbin Model. The results of the study showed that there was a gap in regencies/cities because of poor connections among those in the local area. A highly competitive character disadvantaged lower competitors. This resulted in divergence, meaning no regional spillover occurred. The regional economic priority improvement mostly related to the regencies/cities in quadrant III and showed low economic improvement through the regional connection, which had a highly competitive character, human resources improvement, knowledge and technology, investment, infrastructure provision and strengthening regional economic activities.

Key words: *Spatial dependence, convergence of per capita income, Spatial Durbin Model.*

Introduction

Inequality of development among regions is normal at the beginning of the development process, particularly in the eastern part of Indonesia. The different rates of economic growth among regions can also be due to regional economic activity concentration, investment allocation, mobility level of production factors among regions, different natural resources, different geographical conditions among regions, and less effective trade between provinces due to inadequate infrastructure (Tambunan, 2011). In the development process, particularly in Eastern Indonesia, development inequality between regions is natural, and unequal economic growth between regions occurs because of differences in natural resources potential. This condition takes place in 12 regencies and one city in Central Sulawesi

Province, with relatively different potential. The Gini Ratio is a measurement used to view inequality between regions. In general, until 2017 Central Sulawesi Province has had an average Gini (G) Ratio of 0.355, indicating that income distribution in Central Sulawesi Province is at a moderate level of inequality (G is between 0.3 and 0.5 – see Oshima, in Rosyidi, 2006). The disparity level in Central Sulawesi is still below the national average disparity level of 0.419. The factors causing this economic gap are low accessibility to economic facilities and poor infrastructure, particularly in rural areas.

The neoclassical growth theory, new growth theory and new economic geography suggest that the heterogeneity or disparity between regions is influenced by the mobility of resources owned by a region, including capital, human resources, natural resources, trading, knowledge spillover effects, economics to scale and externality. This is the view of Solow-Swan's neoclassical growth theory, which states that an economic growth process depends on the form of the production function. This production function relies on the roles of accumulated capital, human resources, and knowledge or technology level (Barro & Sala-i Martin, 2004)

In addition to human resources and capital, the age factor is relevant (Solow residual); it influences economic growth in a process known as total factor productivity (TFP). TFP is related to the existence of a knowledge gap between developed and underdeveloped regions. Unsurprisingly, the underdeveloped regions want to catch up with the developed regions, and this catch-up process allows convergence between underdeveloped and developed regions to occur.

Sectorally speaking, the primary sectors are those with the highest human resources productivity in Central Sulawesi – that is, Rp 292.03 human resources in the secondary sector at Rp 813.97 human resources and Rp 207.56 human resources in the tertiary sector. These data indicate that the primary sector's growth does not result in any increase in human resources absorbed into the production process, as this process is also energy efficient. It is suspected that the less balanced transformation of economic and human resources structures might cause impoverishment and exploitation of human resources in the primary sector (Kariyasa 2003). Furthermore, these different patterns between economic and employment transformations lead to changes in the human resources productivity level sectorally. Due to the different economic structures among regions, these sectoral human resources productivity differences will result in development disparity among regions.

Very few studies on convergence, particularly in Indonesia, have used spatial dependence, where the economy is viewed as an independent unit. Most have also ignored the possibility of space interactions between countries or regions. Thanks to this spatial economic activity, non-natural factors and economic clusters spatially drive a region to have an association with other regions. Therefore, economic growth is not only related to initial income, human

capital, investment, physical infrastructure and institution; spillover effect is also an important element in explaining inter-region economic growth. For this reason, the geographical dimension needs to be studied. Empirically, economic growth is correlated with initial income, human capital, investment, physical infrastructure and institution. However, the role of geography in economic growth should also be taken into consideration. Non-natural factors and a spatially regional economic cluster can cause a region to be associated with other regions (Rey, 2001; Gezici et al., 2003). From the perspective of spatial dependence, particular patterns play an important role since it they may impact the economic activities concentration factor. This economic concentration results in a condition that supports regional economic growth as a determinant of regional dependence and inequality. Observing the distribution of economic activities in Central Sulawesi, the regencies/cities are geographically separated by long distances between them, and there are also some islands. In addition to distance, inadequate infrastructure, such as poor roads, influences carrying capacity and increases travel time, and may increase the cost and frequency of distributing goods and services between regions, which eventually influences the regional economy.

Research has been conducted in various countries using a neoclassic model of economic growth as its basis in consideration of the spatial dependence role. Hanlon and Miscio (2017), Billings and Johnson (2016), Dall'erba and Llamosas-Rosas (2014) and Alvarez and Barbero (2016) have conducted empirical study using a spatial MRW model, analysing the influence of spatial dependence on regional economic growth in the United States and Spain. Sun et al. (2017) conducted an empirical study on regional economic growth in China using the economic growth model initiated by Ertur and Koch (2007). Fabbri (2016) studied geographical structure and convergence. The research results show that analysis of convergence or agglomeration of capital depends on geographic structure (Rey & Janikas, 2004; Canh & Liem, 2018).

Some Indonesian research that indicates spatial dependence does not affect economic growth includes studies by Vidyattama (2014), Nuryadin et al. (2007) and Takeda (2013).

Literature Review

Spatial MRW Model

The Spatial MRW Model was developed by Fisher (2011) from the standard MRW model. It is assumed that each region has a production function in the Cobb-Douglas form. The N region is assumed to have a Cobb-Douglas production function along the T period:

$$Y_{it} = A_{it}K_{it}^{\alpha k}H_{it}^{\alpha H}L_{it}^{1-\alpha K-\alpha H} \quad (1)$$

Where Y_{it} is the output of region i period t, K_{it}, H_{it} and L_{it} states the physical capital level, human capital and the total labour force of region i period t. A_{it} is the level of technological

knowledge. Equation (1) can be converted into a per capita output equation by dividing both sides with L_{it}:

$$Y_{it} = A_{it}K_{it}^{\alpha K}H_{it}^{\alpha H} \quad (2)$$

Where y_{it}, k_{it} and hit are output per worker, physical capital per worker and human capital per worker.

Quoting Alvarez and Barbero (2016), technological knowledge is a function of the total stock of knowledge, factors of production in one region itself and factors of production from other regions. It is stated by:

$$A_{it}=\Omega k_{it}^{\theta}h_{it}^{\gamma k}\prod_{j=1}^{N} kjt^{\theta pwij}h_{jt}^{\gamma pwij} \quad (3)$$

Where Ω reflects 'the exogenous common knowledge', θ and γ show the technological parameters with $0 <\theta, \gamma <1$. W_{ij} is the connectivity structure between regions and p reflects the interdependence of technology between regions with $0 <p <1$.

By entering equations (2) and (3), we get:

$$y_{it}=\Omega k_{it}^{\alpha k+\theta}h_{it}^{\alpha H+\gamma}\prod_{j=1}^{N} kjt^{\theta pwij}h_{jt}^{\gamma pwij} \quad (4)$$

Equation (4) states that output per worker in one region depends on factors of production in the region itself and factors of production from other regions.

The neoclassical economic growth model assumes that labour in region i grew by n^i. Meanwhile, the share of income invested in physical capital and human capital is assumed to be a constant of equal to s_i^k with s_i^H at an exogenous rate of investment growth, while capital is assumed to depreciate at the same level as δ. Changes to physical capital per worker and human capital per worker can be stated as:

$$k_{it} = s_i^k y_{it} - (n_i + \delta)k_{it} \quad (5)$$
$$h_{it} = s_i^H y_{it} - (n_i + \delta)h_{it} \quad (6)$$

On the steady state conditions, physical capital per worker and human capital grow at a constant rate g:

$$\frac{kit}{kit} = g \quad (7)$$

$$\frac{hit}{hit} = g \quad (8)$$

In an economy, the total output produced by an area can be approached with Gross Regional Domestic Product (GRDP) data, the value of which is the same as the amount of income in that region (Mankiw, 2012). From the equations above it can be concluded that the economic growth of an area is not only influenced by initial per capita income, physical capital investment and human capital, and population growth in the region, but is also influenced by initial per capita income from other regions, physical capital investment and human capital in other regions, as well as population growth from other regions and economic growth in other regions.

Analysis of economic growth per capita convergence implies neoclassical economic growth analysis; in particular, neoclassical economic growth must involve aspects of spatial dependence. According to Arbia et al. (2008) research including spatial autocorrelation in the convergence model was initiated by Vaya et al. (2004), Lopez-Bazo et al. (2004) and Ertur and Koch (2007).

Endogenous Growth Model

The prominent thinking in the endogenous growth model (Amstrong & Taylor, 2007) is that regions with lower levels of knowledge of technology are able to achieve faster growth of output by means of their human resources, meaning the convergence process is predicted to occur in endogenous growth models with accelerated versions of technology (technological catch-up).

According to Etzo (2008), a growth model is developed from three rationales. The first is the Romer Model (1986), where the diminishing return from capital is eliminated by knowledge spillovers resulting from investment, assuming that knowledge stock will increase as the investment increases through a learning-by-doing process, and the knowledge created by a firm is accessible to other firms; thus knowledge becomes a public goods. In this way, the knowledge stock in an economy will increase as investment increases, and therefore it will be proportional to the aggregate capital stock. Second, according to Lucas (1988), there are two sectors in the human capital model: one sector produces physical capital and the other sector produces human capital. The production of human capital can improve technology and cover the losses from the diminishing return of physical capital. Third, Romer's (1990) and Grossman and Helpman's (1991) model, where technology advancement (of an exogenous nature in the neoclassical model) is determined endogenously by new ideas produced by research and development (R&D).

The development of the neoclassical model refers to endogenous growth theory, which suggests that technology advancement itself is determined by a growth process. Thus, technical knowledge is inherent to the human resources model known as the AK model,

where capital should be viewed extensively by adding the physical capital and human capital components (Barro & Sala-i Martin, 2004) so the production function becomes:

$$Y = K^{\alpha} (AL)^{1-\alpha} \quad (9)$$

Research Method

Research Location and Approach

This research was conducted in Central Sulawesi. It took place in 12 regencies and one municipality during the decade 2007–17. This research uses the Spatial Durbin Model as its analysis technique.

Operational Definitions

The variables used in this study are:

a). Y_{it}: regional income per capita – i at time t or end of period. The proposed income per capita from the GRDP distribution by mid-year population at 2010 Constant 2010.
b). Y_{it} – T is the regional income per capita variable – i,
c). $S_{it}^{K}$is a variable that is proxied as the capital goods position formed from an investment accumulation process within a certain time period, usually called a Gross Fixed Capital Formation (in the Statistics of National Terminology Account of 1968).
d). S_{it}^{K} is a variable that is proxied in knowledge stock and labour skills production using a graduated education level starting from elementary, through junior high, high school and university level.
e). S_{it}^{H} is a variable that represents the productive age population aged 15-64 years belonging to those categories who are actively working according to the business field.
f). $g + \delta$ is a variable that represents the technological growth level and capital depreciation level which is assumed to be constant and equal value for all regencies/cities – that is, 0.05 according to Mankiw et al. (1992) and Islam (1995).

Spatial Durbin Model (SDM)

The Spatial Durbin Model (SDM) is an extension of the Spatial Autoregressive (SAR) model by adding spatial lag to independent variables. Parameter estimation using Maximum Likelihood Estimation (MLE) is:

$$y = \rho WY + X\beta + WX\gamma + \varepsilon \quad (10)$$

By defining A = (I – ρW),Ž = [X W X], Ḃ [β,γ], then the log likelihood function above is obtained :

$$\text{Ln } Y = -NT/2 \ln (2\pi\sigma^2) + \ln |A| - 1/2\sigma^2 (Ay - \check{Z}\dot{B})^T (Ay - \check{Z}\dot{B}) \quad (11)$$

so that the estimated parameters ρ, Ḃ dan σ^2 are obtained as follows :

$$\dot{B} = (\check{Z}T\ \check{Z})^{-1}\ \check{Z}^T\ Ay \quad (12)$$
$$\tilde{\delta}^2 = 1/NT\ (Ay - \check{Z}\ \dot{B})^T\ (Ay - \check{Z}B)$$

In a simple production function, Fingleto and Bazo (2005) suggest that technology in a region is assumed depending on the technology level of the surrounding regions. Therefore, in a case where spatial externality is positive, the certain technology level used in a production process and the steady state position in a region positively depend on the physical capital and human capital existing in the neighbouring regions. Therefore, the model equation is written as follows:

$$\ln \left(\frac{yi0+\tau}{yi0}\right) = \alpha + p\ [\ W.\ \ln \frac{yi0+\tau}{yi0})]_i + \beta \ln (y_{0i}) + \tau\ ln\ Wyoi + \delta X + \mathcal{E}i \quad (13)$$

Results and Discussion

Description of Total Factor Productivity Growth (TFPG) in Central Sulawesi Province

The growth of Total Factor Productivity (TFP) in this research was calculated using the growth accounting method (GAM). According to Comin (2006), TFP is a part of output that is not explained by a number of inputs used in the production. Figure 1 shows that North Morowali is the regency with the highest TFPG value of 2.334; other regencies/municipalities which are also classified as having high TFPG are Banggai Kepulauan, Banggai Laut, Buol, Morowali, and Poso. The high TFPG indicates that the growth of technology advancement is increasingly better.

The LISA Map in Figure 1 shows no spatial linkage of TPFG between regencies/municipality in Central Sulawesi at the end of the research period (2017).

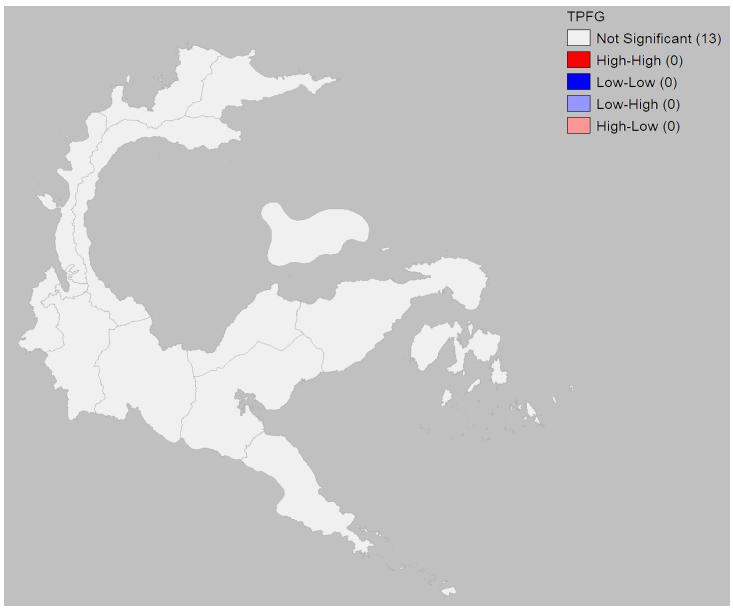
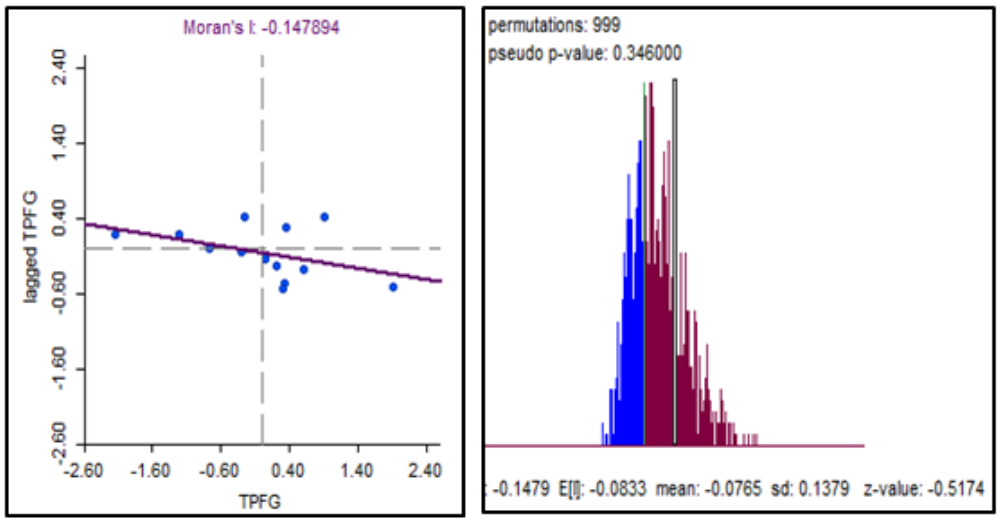


Figure 1. LISA Map of TFPG in Central Sulawesi Province

Based on the information in Figure 2, it can be seen that all regencies and the municipality in Central Sulawesi do not have spatial links in TPFG at the end of the research period. The test of spatial dependence of per capita income in regencies/municipality in Central Sulawesi can be seen from the Moran's I value in Moran's Scatterplot and its significance value (Figure 2).



(a) (b)

Figure 2. (a) Moran's I in Moran's Scatterplot of TFPG of regencies/municipality in Central Sulawesi; (b) Pseudo p-value of Moran's I value of regencies/municipality in Central Sulawesi at the end of the period (2017)

The measurement of global spatial autocorrelation was based on Moran's I value, which was used to determine the existence of spatial clustering. At the end of TFPG period, the absence of spatial autocorrelation is significant in the growth distribution. The per capita income in Central Sulawesi is shown by Moran's I value at –0.147894 with a pseudo p-value of 0.346,which is greater than the error rate α (0.05); hence it is stated that there is no significant spatial dependence in the overall TPFG of regencies/municipality in Central Sulawesi at the end of the period (2017).

This shows that during period 2007–17, no decrease was seen in the per capita income dispersion among regencies/municipality in Central Sulawesi. The income dispersion was more likely to be constant during the observation period. Based on this fact, it could be concluded that in Central Sulawesi no convergence sigma process occurred. The Moran's pattern from one year to another showed an increasing trend, despite the decrease at the end of the observation period (2017). This indicates an increasing regional interaction trend – or, in other words, spatial autocorrelation was increasing and it had a positive direction, meaning that there was a tendency for per capita income clustering to occur in Central Sulawesi. The divergence occurred due to the high disparity of income composition or economic potentials between regions as a result of such factors as difference in natural resources, geographical condition, mobility level of production factors among regions, and the less fluent trading among regions resulting from in adequate infrastructure. The convex was similar to assumptions in the neoclassical growth model. It was also possible for different balance to occur in a long term to occur. This new view of growth theory did not conclude that there was convergence in the economy. Empirical research also showed that poor countries did not grow faster than rich countries. This raises the suspicion that the differences in conditions of some countries result in conditional convergence, where convergence occurs for each region (Schmitt & Starke, 2011).

The dependence spatial regency/city in Central Sulawesi province can be seen in terms of quadrants.

Quadrant I shows that Banggai Regency, Morowali Regency and North Morowali Regency had a high tendency towards geographical concentration. However, the finding of KPPOD (2005) states that spatial proximity of a region with economic growth centres may drive the growth of surrounding regions. Banggai Regency has natural resources potential. There are mega projects of oil and fas management in two blocs: Senoro bloc and Matindok bloc. LNG bloc in Banggai Regency is the fourth largest LNG bloc in Indonesia and the sixth largest in Southeast Asia. Morowali Regency has natural resources potential in the form of featured commodities from the plantation sector, namely oil palm and nickel shed renowned for its first-class quality in Southeast Asia as well as the oil potential of Tiaka field in Tomori bloc, Sulawesi, in which one well is successfully exploited by Medco Energi JOB Pertamina E & P

and generates 6,000 barrels per day. North Morowali Regency, apart from its potential in crop agriculture, forestry, plantation and maritime sectors, also has nickel and oil and gas mining potential under the management of JOB Pertamina and PT Tomori Sulawesi.

Quadrant II shows that Toli-Toli Regency is the only one surrounded by regencies/cities with a high economic rate; these are Parigi Moutong City and Palu City. The low public investment leads to improved quality of road and other infrastructure. Various economic activities cause geographically non-concentrated economic activities, leading to high transportation costs. For regional growth, Toli-Toli Regency should therefore be driven by its regional capabilities through enhancement of public investment, quality of human resources and sufficient infrastructure.

Quadrant III shows regencies that lack geographic advantage. Banggai Islands Regency, Banggai Laut and Tojo Una-Una are islands areas consisting of small islands separated by ocean, affecting their access to economic activities due to transportation constraints.

In quadrant IV, Banggai Regency has potential resources and adequate infrastructure and is surrounded by Banggai Islands and Banggai Laut Regencies, with their limited regional potential development and TojoUna-Una Regency. Meanwhile, Palu City has geographic concentration, sufficient human resources and sufficient infrastructure compared with Sigi, Donggala, Buol and Toli-Toli Regencies, with their insufficient access to economic activities. The spatial association between regencies/cities will drive efficiency from the perspective of public investment and infrastructure quality, which may result in productive economic sectors.

Beta absolute convergence hypothesis testing was used to test whether poor regions could grow faster than rich regions. The relationship between income at the initial (observation) period and average per capita income growth level during several period of convergence rate (β) was negative. The beta absolute convergence hypothesis could be accepted if the estimated β was statistically significant and had negative value. This absolute convergence testing was done by selecting the model based on the stages suggested by Anselin (2004) using three model types: classic (OLS), the spatial autoregressive model (SAR) and the spatial error model (SEM). The estimation method in the classical model used Ordinary Least Square (OLS), and the estimation method in SAR and SEM used Maximum Likelihood (ML). The initial test used OLS, and the test result for OLS is presented in Table 1.

Table 1: Result of absolute convergence model estimation of per capita income of regencies/municipality in Central Sulawesi for 2007–17

Absolute convergence model	Coefficient	p-value
Constant	–0.491675	0.04940
Initial per capita income (2007)	7.59576	0.00083
Moran's I	–0.8908	0.37304
LM error	1.4992	0.22079
LM lag	0.6355	0.42534

The conditional convergence model estimation was made by inserting all control variables into the model, thus resulting in the full model. The control variable in this case was Total Factor Productivity Growth (TPFG). The test was made using the Spatial Durbin Model (SDM). Performing this conditional convergence test allowed us to test the research hypotheses, namely: (1) influence of total factor productivity in the per capita income convergence process of regencies/municipality in Central Sulawesi for the period 2007–17; and (2) influence of spatial dependence in the per capita income convergence process between regencies/municipality in Central Sulawesi for 2007–17. The result of the conditional convergence test using the SDM is presented in Table 2.

Table 2: Result of conditional convergence model estimation with all control variables (full model)

Conditional convergence model	SDM	
	Coefficient	p-value
Constant	283.6612	0.0001717
Initial per capita income (2007)	2.1893	0.1725424
TFPG	10.7223	0.0124155
Spatial lag (ρ)	0.40426	0.18081
Spatial initial income (τ)	–21.0343	0.0000168

The result of estimation for club convergence model is presented in Table 2. This table shows that the Coefficient β (initial income) in OLS model was 7.59576, significant at the 5 per cent degree of error (α) of initial per capita income in 2007, and was positive and significant for all models, both in rich and poor areas. This indicates a divergence process both between rich and poor regions. In other words, there was increasingly greater inequal per capita income in each area. It could then be concluded that the regional spillover in Central Sulawesi was more likely to be local in nature.

This research result was consistent with the New Economic Geography (NEG) theory and New Growth Theory. As a result of this local spillover, the divergence in the economy and the inequality in per capita income tended to be persistent (Arbia, 2005; Rumayya, 2005).

The result of estimation for the conditional convergence model using the Spatial Durbin Model (SDM) was found to be the most suitable model. Total Factor Productivity Growth (TPFG) had positive and significant influence on per capita income of the regencies/municipality in Central Sulawesi. This could be seen in the coefficient of TFPG influence at 10.7223, with a p-value of 0.0124155, less than the degree of error (α) of 5 per cent. The positive sign in β TFPG indicated a positive influence of TFPG on per capita income of the regencies/municipality in Central Sulawesi. In other words, it was proven that the better the TFPG owned by a regency/municipality, the faster the per capita income growth of regencies/municipality in Central Sulawesi would be.

The spatial lag coefficient (ρ) at 0.40426 with p-value of 0.18081 was greater than the degree of error (α) of 5 per cent, meaning that there was no spatial dependence of per capita income between the regencies/municipality in Central Sulawesi. However, the coefficient value of Spatial Initial Income (τ) was obtained at –21.0343 with p-value of 0.0000168, less than the degree of error (α) of 5 per cent, meaning that there was a significant spatial dependence between initial per capita income of the regencies/municipality in Central Sulawesi. The coefficient of Spatial Initial Income (τ) at –21.0343 had a negative direction, meaning that every time the average initial per capita income of regions around a regency/municipality in Central Sulawesi increased, there was potential to decrease the current per capita income in that regency/municipality.

Contrary to the neoclassical growth model, the relatively newer model – that is, the endogenous growth model –had different features (Romer, 2011). In this new growth model, it is possible for a production function to not necessarily be convex like the assumption in the neoclassical growth model. A different balance over the long term is also possible. This new view of growth theory does not conclude that there is a convergence in an economy. The empirical research showed that poor countries do not grow faster than rich countries, raising the suspicion that the differences in conditions of some countries result in conditional convergence, where convergence occurs for each region (Schmitt & Starke, 2011).

Technically, human capital, which is part of total factor productivity, explains the economic growth theory developed by Lucas (1990), Mankiw, Romer and Weil (1992), thus revising Solow's neoclassic growth theory. The study shows that Solow's theory only explains a country's growing economy, but is unable to explain the inequality of per capita income between countries. It is only after the human capital variable is considered too that income inequality can be explained. The underlying assumption in assessing the contribution of human capital to economic growth in disparity reduction is that human capital increases the productivity of human resources. When the productivity of human resources increases, economic growth also increases. It is therefore appropriate to say that human capital not only serves as human workers who help to create output along with other production factors; it is

concerned with the continuous innovation and capital accumulation capabilities of human capital, which may continuously drive economic growth (sustainable development) in a broader sense than mere externality.

The result of LM spatial lag test states that spatial dependence does not support economic growth convergence between regencies/cities in Central Sulawesi Province. Proven income growth centres in Central Sulawesi, Palu and Donggala cities are unable to generate a spillover impact on surrounding regencies/cities. Growth centres in Central Sulawesi have a high demand for goods from other areas, while people in the growth centres of Central Sulawesi tend to migrate to growth cenres outside Central Sulawesi, such as Kalimantan and Java. This confirms that spatial dependence does not occur in Central Sulawesi Province.

Some factors cause spatial independence between regencies/cities, including (1) a tendency towards low interaction between regions due to long distances between regencies/cities, which inhibits the flow of goods and services; (2) structural difference resulting from economic activities that have a high level of reliance on certain sectors (primary and traditional agricultural sectors); and (3) limited resources, which have implications for the high rate of unemployment and poverty in Central Sulawesi.

A region's economic growth is highly associated with the availability of qualified human resources, which relies not only on the quantity, but also sufficient qualifications, of secondary education graduates. Without the support of well-educated human resources, a large proportion of the workforce will influence the improvement of the productivity of human resources, which will in turn influence regional growth rate. The research conducted by KPPOD (2005) states that the condition of labour affairs in rural areas is, from the perspective of the availability and quality of human resources, better than that in marginal areas as the result of a better quality education system and the existence of industries that drive the productivity of manpower and working age population. Therefore, rural areas such as Palu City are based on the availability and qualifications of human resources, which are better than in regencies/cities in geographically marginal areas, such as Tojo Una-Una Regency, Banggai Islands Regency and Banggai Laut Regency. Knowledge and technology mastery may increase efficiency and drive economic growth. As estimated by Chen (1996), education positively influences a region's productivity, with a region's education endowment measured using the percentage of higher education graduates in its population.

Conclusion and Suggestion

Conclusion

1. The growth of Total Factor Productivity which relies on educational level, is able to accelerate the process of regencies/cities' convergence of income per capita in Central

Sulawesi Province with the support of human resources, infrastructure, knowledge and technology development, which may drive economic growth to a higher degree.

2. Spatial dependence between adjacent regencies/cities does not influence the convergence of economic growth between regencies/cities in Central Sulawesi Province. Regencies/cities' regional development in Central Sulawesi Province is oriented more to competitive advantage, which serves a role in increasing regional economic growth through the development of human resources, investment, infrastructure and strengthening of regional economic activities.
3. There is inequality of competition between regencies/cities due to non-improvement of connectivity between regions with a high competitive advantage and those with a low competitive advantage. Geographically adjacent regencies/cities may utilise spatial overflow to enhance their own competitiveness.

Policy implications

The following suggestions are presented with regard to implementation of this research:

1. Total factor productivity improvement through developing the capacity of qualified human resources is the key to enhancing regencies/cities' economic growth prioritised in developing human resources in Banggai Laut Regency, Banggai Islands Regency, Tojo Una-Una Regency, Sigi Regency, Buol Regency and Toli-Toli Regency.
2. The efforts to develop regencies/cities need to focus on formation of productive economic agglomeration activities based on local advantages with support of an infrastructure network, particularly for south and east parts of Central Sulawesi and island areas in Tojo Una-Una Regency, Banggai Laut Regency and Banggai Islands Regency, where regional productivity is still low.
3. Regional development is prioritised more to regencies/cities in quadrant III, which are regencies/cities with a low economic growth rate through strengthening economy and enhancing productivity of primary sectors and enhancing the quality of human resources.
4. It is necessary to encourage exploration of regencies/cities with limited resources (resources endowment) through infrastructure provision, technology utilisation and a knowledge-based economy.
5. Regional productivity and development improvement are prioritised for Banggai Regency, Morowali Regency and North Morowali to enhance regional attraction, such as regional policies enhancing physical infrastructure and the skill of human resources, and to encourage people's creativity and innovation.

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