Examining Sigma and Beta convergence of economic growth in South Sulawesi, Indonesia

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ABSTRACT

Purpose — *The purpose of this study is to determine the convergence of economic growth in the regencies and cities of South Sulawesi.*

Method — *The type of data utilized in this study is quantitative, sourced from secondary data obtained from the Indonesian central statistics agency/ Badan Pusat Statistik of the districts and cities within South Sulawesi Province. The convergence analysis in this study is divided into two categories, namely sigma convergence and beta convergence. The application of sigma convergence aims to assess the level of disparity based on economic growth.*

Result — *The results of the sigma convergence analysis indicate that there has been sigma convergence in South Sulawesi Province from 2015 to 2022, as evident from the decreasing Unweighted Coefficient of Variation value. Furthermore, the analysis of beta convergence was conducted using both absolute convergence and conditional convergence models, focusing on the economic growth of all districts/cities in South Sulawesi. The findings also reveal that the average length of schooling does not have a significant effect on economic growth. However, investment demonstrates a significant impact on the economic growth of districts/cities within the province of South Sulawesi.*

Contribution — *The academic contribution of this study lies in its novel focus on convergence analysis of economic growth in regions/cities within South Sulawesi Province, specifically investigating the potential catching-up process and convergence in rising per capita income, which has been relatively overlooked in prior research predominantly centered on overall economic development at regional or national levels.*

Keywords: *economic growth, income per capita, convergence, beta convergence, sigma convergence*

INTRODUCTION

Indonesia, as a developing country, has a goal in national development, which is based on Pancasila and the 1945 Constitution. This development focuses on economic growth, a process aimed at increasing the per capita income of the population or society in the long term, accompanied by fundamental changes in the economic structure and equal distribution of income for residents of the country. This development should not neglect other fields, which form a strong foundation in carrying out the life of the nation and state (Solihin et al., 2021).

One of the essential benchmarks in determining the success of economic development is economic growth, which reflects the real impact of the implemented development policies. If a country seeks high economic growth, equity is often ignored because the government tends to concentrate on increasing growth, leading to disparities between regions. According to (Bappeda Sulawesi Tengah, 2019), the economic growth of South Sulawesi Province on Sulawesi Island tends to be high, even above the national economic growth. However, rapid economic growth has not provided benefits evenly to all districts/cities, resulting in increasing disparities in regional development.

Figure 1. Average GRDP per capita of districts or cities in South Sulawesi during 2020 - 2022
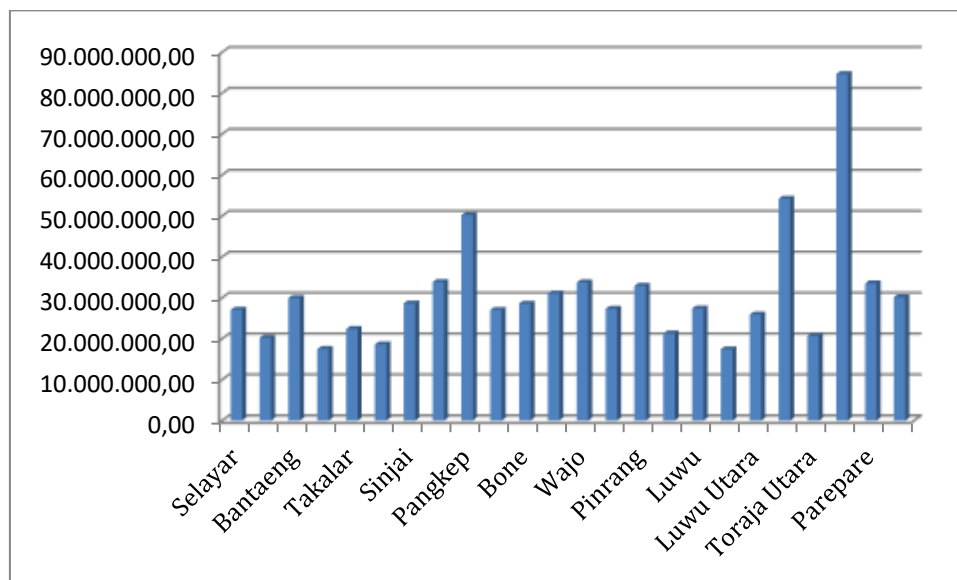
Source: Badan Pusat Statistik (2023)

The relatively high economic growth in South Sulawesi Province is still overshadowed by the imbalance in economic development between regions. This can be seen from the large gap between districts/cities with the highest per

capita GRDP and the lowest per capita GRDP, with the capital of the province being an example.

However, in the long run, when economic conditions are moving towards maturity and assuming a free market mechanism and the mobility of all factors of production between regions without the slightest hindrance or distortion, the difference in the rate of output growth between regions tends to shrink along with the level of per capita income and economic growth, which is getting higher in each region. Ultimately, this reduces regional economic disparities (equality). This process is called convergence (Agostini et al., 2020). To overcome the problem of inequality in a region, the government can implement planning using the convergence model, which is expected to facilitate effective planning.

By definition, in its most general sense, convergence is a process of equalizing or a trend of decreasing income disparities between different entities, such as countries with varying wealth. The theory, based on assumptions of constant returns to scale, diminishing marginal returns from capital and labor, and perfect mobility of factors of production, predicts that regional income inequality tends to diminish over time (Solihin et al., 2021).

The concept of convergence, as discussed so far, pertains to whether countries that are poorer (in absolute terms or relative to their established positions) tend to grow faster than richer countries (Barro, 2016). Similarly, according to Nur and Prabowo (2011), convergence occurs when areas with weaker economies tend to grow faster than areas with stronger economies, allowing the poorer regions to catch up in terms of income level or per capita product. Ge et al. (2007) explain that convergence serves as a measuring tool to observe trends in the rate of economic growth and income inequality occurring between regions. It manifests when developed regencies/cities reach a steady state, where income levels cannot increase further, and relatively lagging regencies/cities experience substantial growth.

From several definitions of convergence put forward by experts, it can be concluded that convergence can be understood as a process of reducing income disparities between regions, akin to a "catching up" of low-income areas towards high-income areas, calculated based on GDP per capita.

Convergence conditions are present in every country, both developing and developed. However, the achievement of convergence conditions varies in speed and time according to the unique circumstances of each region or country (Cabral & Castellanos-Sosa, 2019). Global crises, such as the one experienced in Europe, have been found to decrease the level of convergence between countries in that region (Schmitt & Starke, 2011). In developing countries like India, there

has been an accelerated convergence among different income groups, while African countries have experienced a slower convergence process based on convergent sigma and convergent beta (Baumol, 2023).

From the above literature, it can be concluded that convergence remains a crucial aspect in reducing regional disparities between rich and poor regions or countries (Solihin et al., 2021).

Bahana (2023) conducted a study period that showed convergence of local and regional economies in Sulawesi Province, with values around -0.09 and -0.03, falling between -1 and 0. However, the convergence process is slower for absolute and incremental convergence. Additionally, the Williamson index decline from year to year is very slow.

Muzani and Benardin (2020) found that the variables Health and Capital Formation Fixed Gross have a significant positive effect on economic growth convergence. However, the Education variable does not affect economic growth convergence. The combined impact of Health, Education, and Establishment of Fixed Capital Gross affects the Convergence of Economic Growth.

In a research conducted by Santoso and Junaeni (2022), the estimation results indicate that West Java's economic growth demonstrates a low level of convergence. To increase the acceleration of convergence, the study recommends pursuing four economic policies: (i) increasing the production sector of agriculture as household consumption and raw materials for the industrial sector to occur with increasing value-added, (ii) equal distribution of the trade sector and expanding trade centers, especially in underdeveloped areas, and (iii) increasing the budget for the health sector in lagging regions.

The novelty of this study lies in its unique focus on convergence analysis of economic growth in regions/cities within South Sulawesi Province. It also seeks to explore the process of catching up with the backwardness of the regions, known as convergence, specifically in the context of rising per capita income. This study stands out from prior research, which mostly concentrates on overall economic development at the regional or national level, overlooking the crucial aspects of regional/city inequality and convergence potential.

Therefore, the purpose of this study is to determine the convergence of economic growth in regencies/cities in South Sulawesi, Indonesia.

METHOD

The type of research used is explanatory and descriptive quantitative. The study employs quantitative data, sourced from secondary data obtained from the Indonesian central statistics agency (BPS) in South Sulawesi Province. The data includes both time series data from 2015 to 2022 and cross-sectional data. It covers 24 regencies and cities, forming panel data comprising GDP per capita, investment, and average length of schooling in districts/cities within South Sulawesi Province.

In this study, the convergence analysis is divided into two categories: sigma convergence and beta convergence. The purpose of employing sigma convergence is to assess the level of disparity based on economic growth. The approach used involves examining the Unweighted Coefficient of Variation, which is utilized to identify indications of disparities in the distribution of real per capita income in a given area (Dey & Neogi, 2015). A lower value of the Unweighted Coefficient of Variance signifies a lower disparity in the area. Consequently, the Unweighted Coefficient of Variation can be utilized as an indicator in sigma convergence analysis.

$$Unweighted\ Coefficient\ of\ Variation = \sqrt{\frac{(Y_i - \hat{Y})^2}{n}}$$

Yi is the GRDP per capita of the province at constant prices, ȳ is the average of the GRDP per capita of the province at constant prices n is the number of study areas.

Hypothesis development

Regional development is an integral part of national development. Development carried out by regions aims not only to increase per capita income and welfare of the people but also to catch up and align themselves with developed regions in terms of income, productivity, wages, and various other economic indicators. As a result, the gap between regions is reduced, which is known as "Interregional Convergence."

Furthermore, the convergence analysis, as referred to in the model developed by Amalia et al. (2018), is based on the difference between the logarithm of per capita income for the current period and the logarithm of per capita income for the previous period in the regression. This model is called absolute convergence. The regression equation is modeled as follows:

$$Ln\ y_{i,t} = \alpha_0 + \alpha_1 ln y_{i,t-1} + \mu_{it}$$

In testing using α = 5% (0.05), the following hypotheses are used:

H0: If the probability of Lnyt-1 > α (0.05), it means that there is no absolute convergence of economic growth.

H1: If the probability of Lnyt-1 < α (0.05), it means that there is an absolute convergence of economic growth.

The conditional convergence model regression equation is as follows:

$$Lnyit – lnyi,t\text{-}1 = α0 + α1\ lnyi,t\ \text{-}1 + α2\ lnRLS + α3\ inv + μ$$

Where:

Lnyit = natural logarithm of GRDP per capita per district/city in year t

lnyi,t-1 = natural logarithm of GRDP per capita per district/city in year t-1

Inv = investment

RLS = average length of schooling

RESULT AND DISCUSSION

Sigma convergence analysis

Sigma convergence serves to measure the level of economic inequality at a certain time. Convergence is seen through the dispersion of the Unweighted Coefficient of Variation value.

Figure 2. Sigma convergence graph of cities and districts of South Sulawesi
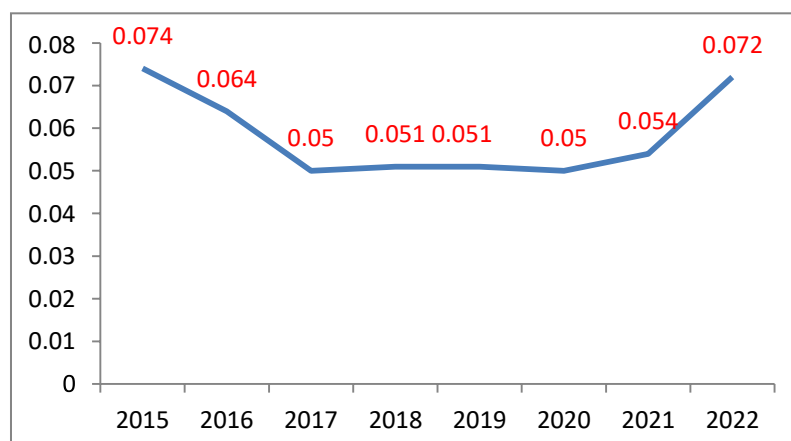
Source: processe data (2023)

Based on the results of the sigma convergence analysis, it is evident that the coefficient of variation becomes smaller each year compared to the previous year. A decrease in the coefficient of variation over time indicates the occurrence of sigma convergence in regencies and cities within South Sulawesi Province. To conduct conditional convergence tests, beta convergence is employed by incorporating other independent variables in this study, namely the average length of schooling and investment.

To analyze the convergence process using panel data regression with secondary data, a chow test is conducted to determine whether the model used is common effect or fixed effect. Subsequently, the hausman test is applied to choose between the fixed effect or random effect model.

Absolute convergence

Table 1. Absolute convergence of chow test calculation result

Redundant Fixed Effects Tests Equation: Untitled			
Test cross-section fixed effects			
Effect Test	**Statistics**	**df**	**Prob.**
Cross-section F	2.526868	(7.55)	0.0250
Chi-square cross-sections	17.846027	7	0.0127

Source: processed data (2023)

From the estimation results, the Chow test found that the value of the probability of cross-section F, which is equal to 0.1653, is greater than alpha 5%. As a result, it was decided that the best model is the fixed effect model. The model selection was then carried out using both the fixed effect model approach and the random effect model through the Hausman test.

Table 2. Hausman test

Test Summary	Chi-Sq. Statistics	Chi-Sq. df	Prob.
Random cross-sections	6.645088	1	0.0099

Source: processed data (2023)

From the results of the Hausman test, the probability value of Cross-section F is 0.0099 which is less than alpha 5% so that H0 and the best model are fixed, the following are the results of the fixed effect model:

Table 3. Absolute convergence of fixed effect calculation result

Variables	coefficient	std. Error	t-Static tic	Prob.
C	7.472927	0.965347	7.741180	0.0000
GRDP	0.896949	0.022776	39.38141	0.0000
Effects Specification				
Cross section fixed (dummy variables)				
Weighted Statistics				
R squared	0.977607	Mean dependent var		79.94761
Adjusted R squared	0.974389	SD dependent var		28.61684
SE of regression	4.226201	Sum squared res id		2982750
Fs statistics	303.7822	Durbin-Wats on stat		2.086986
Prob(Fs statistic)	0.000000			
	Unweighted Statistics			
R squared	0.943079 Mean dependent var			45.10891
Sum squared resid	4208.155 Durbin-Watson stat			1.691813

Source: processed data (2023)

The estimation results above can be explained as follows: The coefficient value of the variable Ln yi, t-1, representing the GRDP per capita in the initial year, is 0.913528. This means that if the GRDP per capita in the initial year increases by 1%, it will lead to a 0.91% increase in GRDP in the study year, assuming all other factors remain constant.

The constant value of 8.047798 indicates that the GRDP per capita in the study year increased by 8.0477%, assuming all other factors remain constant.

The conditional convergence results are calculated by adding explanatory variables other than the GRDP per capita variable, such as the average length of schooling and investment, which are believed to influence the conditional convergence process. Before estimating the data, the chow test and hausman test are conducted to determine the best model to use in examining conditional convergence.

Table 4. Calculation results of conditional convergence Chow test

Redundant Fixed Effects Tests Equation: Untitled Test cross-section fixed effects			
Effect Test	Statistics	df	Prob.
Cross-section F	4.309627	(7.55)	0.0007
Chi-square cross-sections	27.986269	7	0.0002

Source: processed data (2023)

From the estimation results of the Chow test it was found that the cross-section F probability value was 0.1653 greater than alpha 5% so it was decided that the

best model was the fixed effect model. Then a model was selected using the fixed effect model approach and the random effect model through the Hausman test.

Table 5. Calculation results of the conditional convergence Hausman test

Test Summary	Chi-Sq. Statistics	Chi-Sq. df	Prob.
Random cross-sections	25.897331	1	0.0000

Source: processed data (2023)

From the results of the Hausman test, the probability value of Cross-section F is 0.0099 which is less than alpha 5% so that H0 and the best model are fixed, the following are the results of the fixed effect model:

Table 6. Calculation results of the conditional convergence fixed effect model

Dependent Variable: PDRB
Method: Panel EGLS (Cross-section weights)
Date: 07/28/23   Time: 15:31
Sample: 2015 2022
Periods included: 8
Cross-sections included: 24
Total panel (balanced) observations: 192
Linear estimation after one-step weighting matrix

Variable	Coefficient	Std. Error	t-Statistic	Prob.
	--			
C	-4.991927	0.965347	7.741180	0.0000
PDRBT	0.018782	0.020676	0.908424	0.0000
RLS	0.463647	0.381003	1.21514	0.2268
INV	0.249302	0.129298	1.930133	0.0000

		Effects Specification		

		Cross-section fixed (dummy variables)		

		Weighted Statistics		

R-squared	0.924607	Mean dependent var	18.21319
Adjusted R-squared	0.923389	S.D. dependent var	6.191937
S.E. of regression	5.46203	Sum squared resid	6.839454
F-statistic	763.3462	Durbin-Watson stat	2.24381
Prob(F-statistic)	0.000000		

		Unweighted Statistics		

R-squared	0.765346	Mean dependent var	14.91979
Sum squared resid	7.174683	Durbin-Watson stat	2.481058

Source: processed data (2023)

The estimation results above can be explained as follows:

1. The coefficient value is -4.991, indicating that GDP per capita in the study year decreased by 4.91% when other variables are considered constant.

2. The coefficient value of the variable GDP or GRDP per capita in the initial year is 0.018782, meaning that if the GRDP per capita in the initial year increases by 1%, it will lead to a 1.87% increase in GRDP in the study year, assuming other variables are considered constant.

3. RLS (average length of schooling) has no significant effect on GDP per capita in the study year since the probability value of 0.2268 is greater than alpha 5%.

4. The coefficient value of the INV (investment) variable is 0.249, indicating that if investment increases by 1%, the GRDP per capita in the study year will increase by 24.9%, assuming all other factors remain constant (ceteris paribus).

Discussion

Sigma convergence

Based on the results of the sigma convergence analysis, it can be concluded that there has been sigma convergence in South Sulawesi Province from 2015 to 2022. This implies that less developed areas in South Sulawesi Province have the potential to catch up with the economic growth of more prosperous regions. For cities, the government's role in each district/city in South Sulawesi Province is crucial in improving their leading sectors and addressing regional development issues to maximize regional income.

As mentioned in previous studies, the concept of convergence suggests that each region has its own potential, and over time, less developed regions can grow faster than areas with better initial conditions. Ultimately, the less developed regions can catch up with the more advanced regions, achieving both economic growth and equity among regions. The Central Bureau of Statistics highlights that agriculture, forestry, and fisheries remain the leading sectors for all regencies and cities in South Sulawesi Province.

This study's findings are contrary to those of Fashollatain (n.d., 2014), which showed a downward trend in the results of the sigma convergence analysis of economic growth in Indonesia. Moreover, this research provides evidence that the economy of a region does not automatically converge according to Solow's neoclassical theory.

Beta convergence

Based on the calculation results, it was found that there is a process of conditional convergence in the economic growth of districts and cities in the province of South Sulawesi, as calculated by per capita income. However, achieving a truly even economic situation takes a very long time.

This finding contradicts the endogenous theory of capital accumulation, which emphasizes the role of human capital, including elements of education and health, in economic growth. Solow (1956) also supports the contribution of education to economic growth and reducing inequality, as increased education leads to higher worker productivity and consequently, increased economic growth.

Harrod-Domar's theory highlights the economic relationship between the amount of capital stock (investment) and total output. Investment plays a vital role in macroeconomics in two ways: determining the level at which an economy will grow and enhancing long-term growth and labor productivity. Baumol (2023) further emphasizes that investment can stimulate the real sector, create employment opportunities, increase public and government consumption, and contribute to the growth of capital stock, leading to improved productivity and economic growth. Conversely, a lack of investment can impede the rate of economic growth and hinder long-term revenue generation.

Convergence is a continuous process that takes a significant amount of time to achieve. Therefore, encouragement and support from more developed regions are essential to expedite the convergence process in less developed areas.

CONCLUSION

The study conducted a sigma convergence analysis to examine economic growth patterns in regencies and cities in South Sulawesi Province from 2015 to 2022. The findings indicated the presence of sigma convergence, as evidenced by the decreasing trend in the coefficient of variation each year. Additionally, a conditional convergence analysis revealed that investment significantly influenced the economic growth of districts and cities, while the average length of schooling did not have a significant effect on economic growth in the region.

The identification of sigma convergence in South Sulawesi Province suggests that less developed areas have the potential to catch up with the economic growth of more prosperous regions. This finding has practical implications for policymakers and local governments in the region. To promote regional economic convergence, targeted investments in key sectors, such as

infrastructure, human capital development, and industries with growth potential, could be prioritized. By focusing on reducing regional disparities, the government can foster a more balanced and inclusive economic growth trajectory.

Despite the valuable insights gained from this study, there are opportunities for further research to enhance understanding and inform policymaking. Future studies could explore the specific factors that contribute to investment's significant influence on economic growth in the region. Additionally, investigating the potential effects of other socio-economic variables, such as technological advancements, labor market dynamics, and institutional factors, would provide a more comprehensive understanding of the convergence process. Comparative studies with other provinces or regions in Indonesia could also be conducted to gain broader insights into the country's economic development and convergence patterns. Finally, longitudinal studies tracking economic growth trends over more extended periods could provide deeper insights into the speed and sustainability of the convergence process in South Sulawesi Province.

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