A Theil Decomposition of Regional Grouping in Indonesia's Human Development Index

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Article Information

Abstract

This research is designed to investigate regional differences in human development in Indonesia based on the Human Development Index (HDI) as a main indicator. With the use of the Theil Index decomposition method, this paper investigates the intra- and inter-regional disparities in Java vs. outside Java and KBI vs. KTI (Western Indonesia-Eastern Indonesia). Furthermore, the study uses convergence models (σ- and β-convergence) to examine the speed at which zones with lower HDI access regions with higher HDI. The dataset employed in the study was data from various competencies at each regency-cities in Indonesia during its period of 2010-2021, which was publicly available at the Indonesian Central Bureau of Statistics (BPS). The findings show a significant decrease in human development disparities over time, although the convergence process remains slow. Intra-regional inequality contributes more significantly to the overall disparity than inter-regional inequality, particularly within the KBI-KTI dichotomy. This study suggests that while Indonesia is on a path toward reducing regional disparities, more targeted policy interventions are needed to accelerate the convergence process, particularly in underdeveloped regions like Eastern Indonesia.

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INTRODUCTION

Studies related to the field of regional disparities have been a long-standing theme. However, there are a variety of development indicators to determine these regional disparities. As recently done by Chen & Zhang (2023), who highlighted the importance of a balanced approach to urban development that considers regional disparities and social justice issues. Jadhav (2023) emphasizes the importance of understanding the relationship between regional inequality and economic development in formulating public policies aimed at promoting balanced regional growth. More variedly, Jagódka & Snarska (2023) show how quickly weaker regions are catching up to more developed regions and that regional disparities are primarily the result of uneven accumulation of human capital. The authors wonder if human capital in the regions is being used equally to create innovation. Therefore, they checked the level of development of these two relationships.

Theoretically, this regional gap exists due to differences in labor skills that have implications for productivity and local characteristics of the region. Research results in Prasertsoong & Puttanapong (2022) show that workers education and experience influence wage differences. In addition to individual skills, workers also benefit from the agglomeration externalities of large cities. Bhushan (2021) Attempts to estimate and identify regional disparities in agricultural labor productivity growth by breaking them down into technical changes, changes in efficiency and accumulated inputs per worker. The study observed significant growth in agricultural labor productivity despite variations in the source.

When viewed from infrastructure development, it is viewed by Mačiulytė-šniukienė et al. (2022) as an important tool to promote economic growth. Infrastructure is funded in various programs to contribute to economic growth and reduce regional inequality. Furthermore, from the point of view of periodization, the post-reform period has witnessed high economic growth in the country's net domestic product. With higher income growth in the post-reform period, especially in the tertiary sector, the country witnessed a high regional gap in per capita income among its districts. The regional disparity was assessed by Sahoo & Senapati (2022) by looking at convergence or divergence.

Others use regional consumption data and recent demand models. Selvanathan et al. (2021) investigated regional differences in six Australian states. They found actual differences, and Ngouwouo et al. (2021) analyzed the determinants of inequality and polarisation of household spending. It is evident that rural environments, Cameroon's Far North and Northwest regions contribute more to intra-group polarisation. Aritenang (2021) also found that countries with less specialization and more advanced technology will have higher economic growth. His research reminds us of the importance of a higher share of high-tech industries and a more spatial spread of industries to accelerate economic growth. This is further enhanced by the research of Suhendra et al. (2020), which investigates the impact of human capital and several economic factors, including private investment, economic growth, government investment, inflation, and unemployment, on inequality.

The above studies boil down to a main goal, which is to measure the achievement of community welfare achievements in a region. It represents those who use economic measurement as a goal of regional development, mostly using per capita income indicators or the like. From these studies, it seems very important to know regional patterns so that the resulting policies are well coordinated to reduce regional disparities.

Meanwhile, studies have developed by trying other concepts in analyzing regional disparities through convergence. Two primary methodologies exist for examining regional convergence. Initially, regional convergence analysis is based on significant research topics at the global level. This approach primarily uses cross-sectional regression to examine the relationship between the growth rate and the

beginning per capita income rate (Barro et al., 1991; Barro and Sala-I-Martin, 1992).

The second approach, regional disparities, is studied using a growth theory approach. The classic reference of this approach is the study of Williamson (1965), The process of regional convergence is associated with national development, suggesting that regional income differences will diminish (converge) after progressing through three phases, from the early stage of growth to the maturity stage.

This article tries to combine the two approaches above to get the advantages of each approach's advantages and close the weaknesses. However, these studies still do not go too far in elaborating the advantages of each type of analysis. This study tries to dig deeper into this theme by analyzing the progress of the dispersion of human development results associated with regional issues, which are developments from previous studies by Ginanjar et al. (2020). From this, it is hoped that a clearer and more complete picture of the regional convergence process and its relation to the issue of group division in a region can be produced.

This research differs from existing studies, where previous studies investigating regional disparities mostly used economic indicators as a picture of regional development achievements. At the same time, we argue that human development indicators are more able to describe

the welfare of a society, which is the goal of development itself, such as Mendez (2018) and Mendez & Santos-Marquez (2022), which documents the evolution of human development gaps and convergence patterns using the Human Development Index (HDI) indicator.

The human development gap in the case of Indonesia has occurred for a long time, so it is still a major issue related to the quality of life that has implications for people's welfare and is expected to remain substantial shortly. Regional inequality is a major problem in Indonesia, ranging from different levels of development and resources among its regions to its population and ethnic distribution. On that basis, Indonesia's case study is relevant enough to answer questions related to regional disparities.

Fig. 1 shows the phenomenon of human development in Indonesia over the past decade, with the HDI size of all provinces grouped by island, where HDI, in general, has indeed increased in development. However, gaps still occur consistently when viewed from the positioning curve of each island. It can be seen that the island of Java-Bali continues to be at the top, while others seem to be playing catch-up. However, there is still a gap in HDI. The most severe condition occurred in the 2011-2015 period because the condition of the HDI gap in Indonesia is divided into three levels, the more visible the variation of the gap.
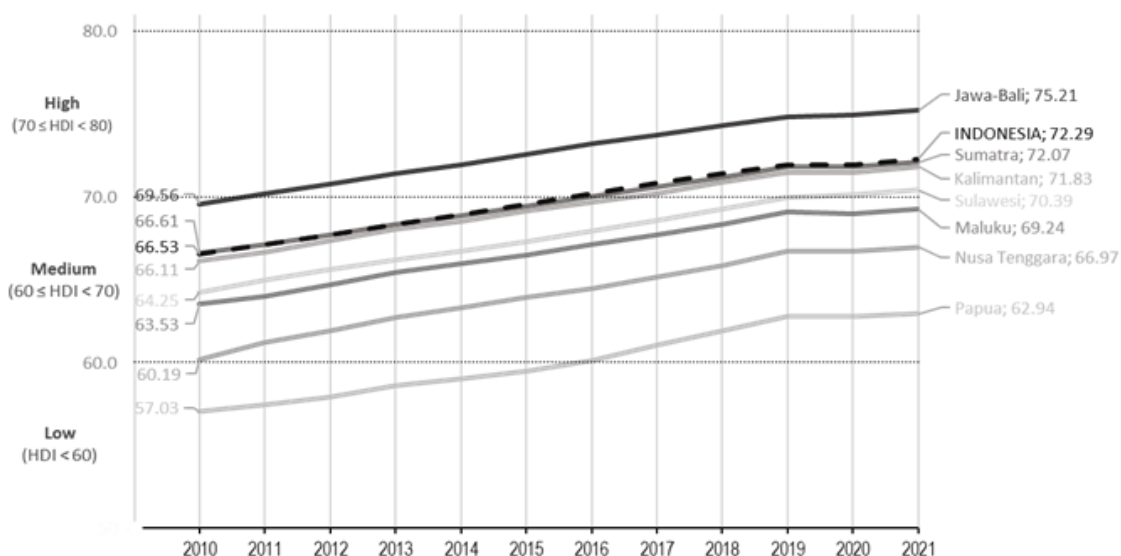
Figure 1. Human Development Index (HDI) grouping by main island in Indonesia, 2010-2021
Source: Source: Indonesia Central Bureau of Statistics (BPS), 2024 (Processed)

In addition, this study is also different because it will investigate the issue of group division in a region, so on that basis, we use the Theil index as its main analysis tool. After all, regional gaps can add information related to the spatial distribution of regional disparities with different geographical scales simultaneously.

In the regional science literature, we will find various measures of regional disparities ranging from the simplest to the most complicated. We can know various regional disparity indices, such as the coefficient of variation, Theil's entropy index, maximum to minimum ratio, Atkinson index, relative mean deviation, and Gini coefficient. These various indices for regional disparity measurement guarantee the complexity of the measurement, and no single index can capture the entire dimension of this disparity.

A consequence of great attention to the dispersion of convergence processes is a strong dedication to selecting appropriate indices. Of these various options, our choice falls on the Theil index. Studies using the Theil index began to be conducted by Cowell (1985). It has become a very popular index for analyzing multilevel decomposition of inequality. Various authors have pointed out the advantages of this index so that until today, it is still popularly used by Malakar & Mishra (2017), Mao & Ma (2021), Madan & Yadav (2022), and Shen et al. (2023)

The Theil index is not greatly affected by scales or averages, nor is it affected by extreme values. In addition, this index is also independent of the number of regions so that it can be best used as a tool for comparing disparities from different regional systems. Finally, this index can also be decomposed into inter- and intra-regional inequality indices so that by doing this decomposition, we can perform disparity analysis at different geographic scales simultaneously. In the case of this study, in the context of Indonesia, we can compare the disparity between the western and eastern regions of Indonesia and the intra-western and eastern disparities of Indonesia.

The various characteristics of the Theil index are very suitable for regional disparity analysis in Indonesia, where regional development shows a strong geographical agglomeration phenomenon. For this reason, we adopted the Theil index as the main analytical tool in this study. Meanwhile, in the literature on economic growth theory, there are two views on the concept of convergence. In one perspective, convergence occurs when poor economies tend to grow faster than rich economies, as suggested by Baumol (1986), Barro et al. (1991), and Barro & Sala-I-Martin (1992). This perspective is related to the concept of β-convergence obtained from regression analysis between regions.

The second concept draws attention to cross-sectional dispersion as proposed by Easterlin (1961), Angeletos & Pavan (2007; Krusell & Smith Jr. (1998), Moskowitz & Grinblatt (1999), Angeletos & Pavan (2007), Bilal (2023), Krusell & Smith Jr. (1998), Moskowitz & Grinblatt (1999), Sharma & Sharma (2022). From this viewpoint, convergence transpires when the disparity among regions diminishes over time, as quantified by standard deviations from logarithmic per capita income. This procedure is termed σ-convergence (Barro & Sala-I-Martin, 1992).

β-convergence tends to result in α-convergence, but this process is sometimes erased by new disturbances that increase dispersion. Therefore, β-convergence is not always synonymous with α-convergence. Although not identical, β-convergence will be verified empirically, while α-convergence will be verified. So that, in practice, the two concepts above can be done alternately. So on this basis, this study tries to elaborate both as done by Antón et al. (2023), Barro & Sala-i-Martin (1997), Chelli et al. (2023), Dańska-Borsiak (2023), Easterlin (1961), German-Soto & Brock (2023), Jeetoo & Jaunky (2023), Papyrakis &; Gerlagh (2007), Petrović & Gligorić Matić (2023), Rajesh & Rath (2023), Rodrik (2013), Sala-I-Martin (1996), Ventura (1997), Xie et al. (2023), Zhang et al. (2023), and Mendez (2019).

At the empirical level, the convergence coefficient indicates how quickly the output per labor of a region approaches its steady-state value. From a theoretical point of view, β-

convergence analysis is only a descriptive analysis and does not talk at all about the mechanism behind the convergence. However, this analysis directly tests the neoclassical growth theory hypothesis with its assumption of diminishing returns to capital.

RESEARCH METHODS

The study initiates with a dispersion analysis of regional human development in Indonesia, noting that convergence takes place while dispersion, often assessed by the standard deviation of the Human Development Index (HDI) among regions, is consistently decreasing. This process is termed σ-convergence (Barro & Sala-I-Martin, 1992), as demonstrated by Vidyattama (2013), who employed a weighted coefficient of variation, a version of the Williamson index, to assess inter-regional inequality as follows:

$$CV_w = \frac{\sqrt{\sum_{i=1}^{n}(Y_i - \bar{Y})^2 \frac{P_i}{P}}}{\bar{Y}} \quad \text{.....................................(1)}$$

where, CV_w = weighted coefficient of variation; n = number of regions; Y_i = human development index (HDI) of its region; = average of HDI; $\bar{Y} P_i$ = population of its region; and P = total population.

It is also assessed that the Theil index can be decomposed to provide additional information related to the absorption of gaps that occur within the regional group (*within inequality*) and gaps between regional groups (*between inequality*) as done Adelman &; Levy (1986), Blackburn (1989), Madan &; Yadav (2022), Wang &; Zhou (2018), Malakar et al. (2018), and Shen et al. (2023). This is done by applying Theil's inequality decomposition technique to the Human Development Index (HDI) data by breaking national inequality into intra- and inter-provincial components.

To obtain additional information related to the spatial distribution of regional disparities with different geographical scales simultaneously, such as Sorokina (2021), in this study, we decomposed the division of areas based on the main islands, Java-outside Java, west-east Indonesia and the

main development area according to the National Development Planning Agency (Bappenas).

Wang &; Zhou (2018) also reconsidered the question of regional convergence in China using the Barro convergence model and Theil's regional inequality index, which was decomposed into inter-regional inequality and intra-regional inequality, as below:

$$IC = \sum_i y_i \log(y_i/x_i) = IC_{br} + IC_{wr} \quad \text{............ (2)}$$

$$IC_{br} = \sum_r Y_r \log(Y_r/X_r) \quad \text{.............................. (3)}$$

$$IC_{wr} = \sum_r Y_r \left[\sum_i (y_i/Y_r) \log\left(\frac{y_i/Y_r}{x_i/X_r}\right)\right] \quad \text{............ (4)}$$

where IC is the total inequality, IC_{br} is the inter-regional inequality, IC_{wr} is the intra-regional inequality, y_i and x_i are the respective shares of the HDI and population of each province, municipality and autonomous region over the sum of these parts of a targeted region; Y_r and X_r are, as far as the various regions are concerned, the share over the total value.

Although the Williamson index and Theil index have been used extensively to analyze changes in regional inequality and, therefore, regional convergence cannot demonstrate the significance of convergence itself, further regression of CV_w, IC, and $StDev$ values against time trends is carried out to test the level of dispersion significance that occurs as follows:

$$Y_t = a_1 + a_2 T + e_t \quad \text{..................................... (5)}$$

where Y is an indicator of *the variables σ-convergence*, namely CVw, IC, and StDev; T represents the time trend between 2010 and 2019.

Additionally, the analysis of convergence speed, referred to as β-convergence, is incorporated into growth analysis to assess whether regions with lower levels of human development experience significantly faster growth than those with higher levels, suggesting a reduction in regional inequality. A primary benefit of β-convergence is its dynamic analytical nature. If short-term observations fail to elucidate the effects of public policy, the long-term consequences become apparent.

In empirical studies of β-convergence analysis, tests evaluating the convergence hypothesis are conducted by examining the behaviour and attributes of the region, thereby applying conditional β-convergence under the assumption of inherent differences in technology, preferences, and institutions among regions. The characteristic homogeneity hypothesis posits that human development growth is solely controlled by the beginning human development index level, hence endorsing the application of absolute β-convergence (Barro & Sala-I-Martin, 1992); consequently, this study will employ both methodologies.

The convergence model estimate is conducted by dynamic panel data analysis through the Generalised Method of Moments (GMM) methodology. This results from the inclusion of the lagged dependent variable, specifically labour productivity, as an independent variable in the model parameters. Dynamic relationships lead to endogeneity issues; thus, estimating the model using static panel data analysis yields biassed and inconsistent estimators (Verbeek, 2004).

Dynamic panel data analysis is influenced by the interdependent interactions among economic variables concerning adjustment dynamics analysis. This dynamic relationship features lagged bound variables as independent variables, leading to endogeneity issues. Consequently, estimating the model using static panel data analysis yields biased and inconsistent estimators, which can be addressed through the GMM approach. Thus, the model in this study is estimated using the dynamic panel data method with the GMM approach as has been done by Caselli et al. (1996), Conley (1999), Windmeijer (2005), Paradise & Yusop (2009), Ginanjar et al. (2020), Setyadi et al. (2023), and Anwar et al. (2023).

To conduct an empirical test of the convergence predictions of neoclassical growth theory with its assumptions of diminishing returns to capital, this study used a regression model of Barro & Sala-I-Martin (1992). This model uses an equation that relates the growth rate of the human development index between two-time points to the initial level of the human development index. To test the absolute and conditional β-convergence hypotheses, the following model will be used:

$$Y_{i,t} = \frac{1}{T} ln\left(\frac{Y_{i,t}}{Y_{i,t-1}}\right) = \frac{1}{T}\left[\left(ln\left(Y_{i,t}\right) - ln\left(Y_{i,t-1}\right)\right)\right] (6)$$

Yi,t in equation 6 is then used as the dependent variable in equation 7 as follows:

$$Y_{i,t} = \alpha - \beta\, ln\, Y_{i,t-1} + \gamma X_{i,t-1} + u_{i,t-1} \,\ldots\ldots\ldots (7)$$

$$-\beta = (1 - e^{-\lambda}) \quad or \quad e^{-\lambda} = 1 + \beta \,\ldots\ldots\ldots\ldots (8)$$

where: Y = growth variable; X = determinant explanatory variable of *steady state*; T = number of observation time periods; t = year; i = province; e = natural logarithm number; u = error term.

The number of observation periods in this study is in 1 period, so $1/T$ in equation 6 above has been eliminated. The model specifications for the absolute β-convergence approach *are written in* equation 9 as follows:

$$ln\left(HDI_{i,t}\right) - ln\left(HDI_{i,t-1}\right) = \beta_0 + \beta_1\, ln(HDI_{i,t-1}) + u_{i,t} \,\ldots\ldots (9)$$

The convergence process occurs when the coefficient of $β1$ is less than 1, with the convergence rate expressed as $λ$, which then evaluation of the dynamic panel data model needs to be done to determine the right model so that it must meet the criteria of unbiased, consistent, and valid.

Equation 11 shows that the speed of convergence can measure how quickly an economy is converging toward a steady state, and the half-life test in equation 12 shows the time it takes to reach a steady state from the process of convergence of inflation or the time required to achieve half of the convergence of human development expressed by $τ$.

$$\lambda = -\frac{ln\left(\beta_1\right)}{T} \,\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

$$\tau = \frac{-ln(0.5)}{-ln(\beta_1)/T} = \frac{ln(2)}{\lambda} \,\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

where: $λ$ = convergence speed of the human development variable; $β1$ = lag coefficient of human development variable; T = number of observation periods; $τ$ = half-life of convergence.

RESULTS AND DISCUSSION

The results of this study provide a deeper understanding of the regional disparities in human development across Indonesia, utilizing both σ-convergence and β-convergence analyses, as well as the decomposition of the Theil Index. By highlighting the trends in human development inequality from 2010 to 2021, this research contributes significantly to the ongoing literature on regional inequalities and convergence processes. In particular, the findings support previous studies while also introducing new insights into the dynamics of inequality across different regional groupings, such as the Java-outside Java and KBI-KTI (Western-Eastern Indonesia) dichotomies.

Significant disparities are revealed by regional groupings, specifically between the Western (KBI) and Eastern (KTI) regions of Indonesia, which are referred to in the study. The σ-convergence evidence that those differences have been reduced, but to a very low rate. This finding supports other studies such as Barro and Sala-I-Martin (1992), which suggest that while β-convergence is necessary, it is a very slow process of reducing regional disparities. Policymakers should continue focussing on this trend to drive the disparities downward with all deliberate speed.

β-convergence is a necessary condition but not a sufficient condition for σ-convergence. In practice, β-convergence will be verified while σ-convergence is verified. That's why the study of convergence analysis begins with static analysis. Strong evidence for the σ-convergence hypothesis can be seen.

The results of σ-convergence estimation show that there has been convergence for human development in all provinces in Indonesia. Fig. 2 shows that the general dispersion in the human development index gap between provinces seems to continue to decline during 2010-2019.

This is assessed from the various coefficients of variation used in this study, where the coefficient values of the CVw, IC, and StDev indicators seem to decline from the initial observation period in 2010 to the final observation period in 2019. However, the rate of decline is slow. Valuation using the Williamson Index indicator decreases from 0.783 to 0.771, the Theil Index indicator decreases from 0.570 to 0.540, and the Standard Deviation indicator decreases from 4.392 to 3.974. This slowdown is thought to be due to the absence of policies specifically targeting human development, so it can be seen that the dispersion that occurs continues to slow down, or there has been no acceleration in the rate of decline.
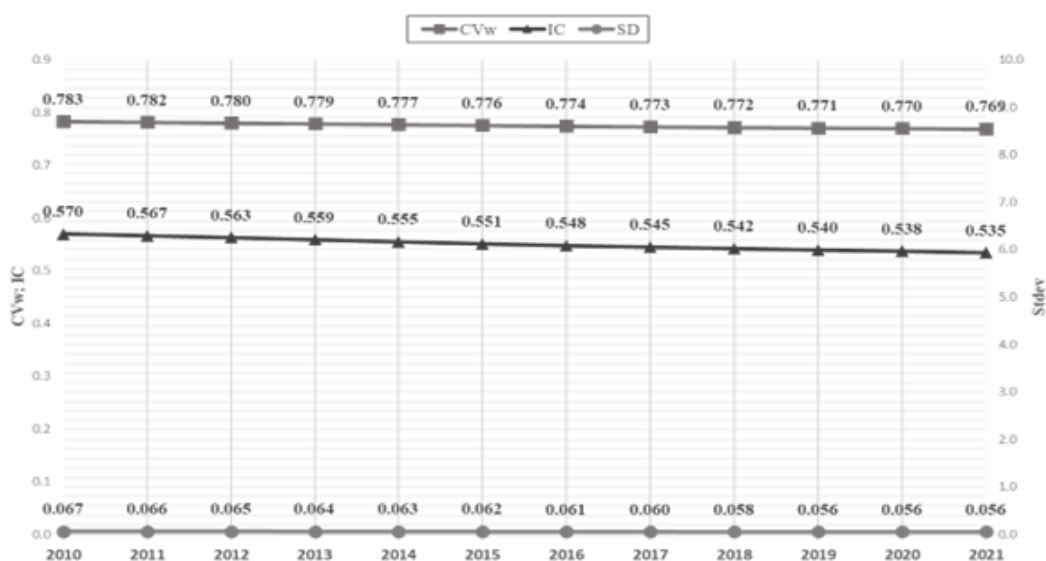
Figure 2. Dispersion of human development index gaps in Indonesia, 2010-2021 (σ-convergence)
Source: Indonesia Central Bureau of Statistics (BPS), 2024 (Processed)

To clarify the convergence or decrease in dispersion of the human development gap in Indonesia, a regression analysis of the values of the coefficient of variation against the time trend was further carried out in testing the significance of the decrease in the values of the coefficient of variation. The results of OLS estimation can be seen in Table 1, which shows that the value of the time trend coefficient for the human development index in Indonesia with various indicators of the coefficient of variation converged and was significant at the level of 1% during the study observation period. The negative value of the coefficient indicates this on the time trend variable against the human development index.

Table 1. Estimation results for trend of σ-convergence

Parameters	CVw	IC	StDev
Trend	-0.001300	-0.003257	-0.001086
	(0.0000)	(0.0000)	(0.0000)
_Cons	0.782865	0.568995	0.067075
	(0.0000)	(0.000)	(0.000)
Adjusted R2	0.990918	0.991534	0.972851
F-stat Prob.	1,201.132	1,289.286	395.1745
(F-stat)	(0.0000)	(0.0000)	(0.0003)

Note: *Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

Source: Data Processed, 2024

The calculation of table 1 based on Central Bureau of Statistics (BPS), Ministry of Finance Republic of Indonesia (Kemenkeu-RI) and Indonesia Investment Coordinating Board (BKPM) data from various years. These results are in line with trends observed globally in other developing economies. Research such as Firdaus and Yusop (2009) have shown that they are usually of σ-convergence, but reinforced with related policies such as fiscal decentralisation, public investment, or private sector development can facilitate faster this type of convergence. It means that the Indonesian regional convergence process could be improved by following examples from what has been experienced in globally dealing with regional disparities.

The author is interested in elaborating this for the human development gap in Indonesia by decomposing based on regional division, as seen in Figure 3 and Table 2. A lot of disparities are across provinces in Indonesia. This gives a visual representation of the unevenness of human development progress across regions. The growing rift between KBI and KTI regions is a particularly dismal policy front.

By decomposing the division of regions divided by KBI-KTI and ABCD regions, it can be seen that almost all gaps are absorbed by intra-KBI-KTI and intra-region ABCD gaps. Meanwhile, the gap between KBI-KTI and ABCD regions is relatively smaller, only less than 33.46%. This does not support the long-standing assumption that there has been a wide disparity in human development between provinces. In other words, provinces in KBI-KTI and various ABCD regions can grow simultaneously. Then it should be noted that the gap between KBI-KTI is widening even though the figure is still small, but if left unchecked, this will continue to exacerbate the condition of the gap between KBI-KTI, where it is seen that it continues to increase from the initial observation period in 2010 to the final observation period in 2021, the Interregional Theil Index (ICbr) indicator shows an increase from 32.79% to 33.49%.

Decomposition of the division of areas divided by islands and Java-outside Java was also carried out, and the results showed that intra- and inter-regional gaps looked more balanced. It can be seen that regional issues are more relevant to be applied between islands and Java-outside Java, although the gap between the two seems to fade over time in the case of islands.

Looking at the case of Indonesia, we can observe that other countries faced with regional disparities took bold action in neighbouring China and India to provide such support. For example, the Chinese government used a package of fiscal, infrastructure, and human capital investment policies to reduce regional disparities (Wang and Zhou, 2018). This will benefit Indonesia as well, particularly the eastern parts of the country, which lend themselves to better-balanced development.

The most important lesson from this static analysis is that regional convergence can be

monotonous. It can be seen that the decline in disparity continues, albeit gradual, and thus still needs to be accelerated. Although it shows a significant and sustainable trend in dispersion, Theil index analysis gives us an early picture that the convergence process is declining. Thus, a priori, we can predict that the convergence speed measured by the β coefficient in β-convergence analysis will be slow.

Table 2. Contribution of dispersion absorption from intra- and inter-regional human development index gaps in Indonesia

Year	IC	Island		Java-Outside Java		KBI-KTI		Region	
		ICwr	ICbr	ICwr	ICbr	ICwr	ICbr	ICwr	ICbr
2010	0.570	0.317	0.253	0.292	0.278	0.383	0.187	0.430	0.140
		55.56%	44.44%	51.25%	48.75%	67.21%	32.79%	75.38%	24.62%
2011	0.567	0.316	0.250	0.291	0.276	0.380	0.186	0.427	0.139
		55.81%	44.19%	51.30%	48.70%	67.10%	32.90%	75.41%	24.59%
2012	0.563	0.315	0.248	0.289	0.274	0.377	0.186	0.425	0.138
		55.88%	44.12%	51.29%	48.71%	67.01%	32.99%	75.46%	24.54%
2013	0.559	0.313	0.246	0.286	0.273	0.374	0.185	0.422	0.137
		55.93%	44.07%	51.23%	48.77%	66.94%	33.06%	75.46%	24.54%
2014	0.555	0.311	0.245	0.284	0.271	0.371	0.184	0.419	0.136
		55.94%	44.06%	51.19%	48.81%	66.85%	33.15%	75.46%	24.54%
2015	0.551	0.309	0.242	0.282	0.269	0.369	0.183	0.417	0.135
		56.05%	43.95%	51.23%	48.77%	66.84%	33.16%	75.58%	24.42%
2016	0.548	0.307	0.241	0.281	0.267	0.366	0.182	0.414	0.134
		56.06%	43.94%	51.24%	48.76%	66.81%	33.19%	75.60%	24.40%
2017	0.545	0.306	0.239	0.279	0.266	0.364	0.181	0.412	0.133
		56.08%	43.92%	51.23%	48.77%	66.72%	33.28%	75.60%	24.40%
2018	0.542	0.304	0.238	0.278	0.265	0.362	0.181	0.410	0.132
		56.07%	43.93%	51.20%	48.80%	66.64%	33.36%	75.58%	24.42%
2019	0.540	0.303	0.237	0.276	0.264	0.359	0.181	0.408	0.132
		56.09%	43.91%	51.16%	48.84%	66.54%	33.46%	75.55%	24.45%
2020	0.538	0.302	0.236	0.276	0.262	0.358	0.180	0.407	0.131
		56.19%	43.81%	51.26%	48.74%	66.55%	33.45%	75.62%	24.38%
2021	0.535	0.301	0.234	0.274	0.260	0.356	0.179	0.405	0.130
		56.23%	43.77%	51.29%	48.71%	66.51%	33.49%	75.74%	24.26%

Source: Data Processed, 2024

From static analysis, we move to β-convergence analysis. Table 3 shows the regression results of Equation 9 for tests against the absolute convergence hypothesis. The estimated coefficient from the initial Human Development Index (HDI) log shows a positive direction that matches the initial prediction and is significant, which means that the convergence process has been proven. In line with σ-convergence analysis, regression results provide strong evidence for absolute convergence and show a slow convergence rate. We can say that convergence speed is sluggish– hence, it will take longer to close the initial gap. The results of this estimate imply that if this condition continues as in regression periods, then the half-life of convergence - that is, the time needed to close half of the initial gap - is successively about 10.16-10.54 decades or about one hundred years.

Although β-convergence is observable in this study, the dead-slow convergence rate highlights several helter-skelter of regional development in Indonesia. Unity has a half-life of approximately 10-28 years, suggesting that substantial unity is so far off as to be practically impossible without changes in policy. As is consistent with results shown in Rodrik´s (2013) work that states a direct public intervention for places suffering from structural disadvantages. Here, targeted interventions in Indonesia's KTI regions would have a big impact.

The use of β-convergence further supports the notion that provinces with lower initial HDI values have experienced faster growth relative to those with higher HDI values. This finding is consistent with the convergence theory put forward by Barro and Sala-i-Martin (1992), which suggests that less developed regions tend to grow more quickly, allowing them to "catch up" to more developed regions. Nevertheless, the slow speed of convergence (estimated half-lives between 10 and 28 years) implies a sluggish catch-up process. A slower rate of progress, on the other hand, can be explained by various structural constraints in developing territories—insufficient access to quality education and health care, infrastructure, and so forth.

The convergence is taking place at a very dawdling speed, for which one probable explanation is that the government tends to invest less in some of the regions as against others widely discussed by Sahoo and Senapati (2022) that come up with the observation that 'infrastructure development plays a vital role in promoting regional convergence. Without addressing these issues, those regions that are lagging behind in terms of infrastructure and service accessibility will struggle to fully benefit from national economies of scale and growth and development strategies, thereby prolonging the process of convergence.
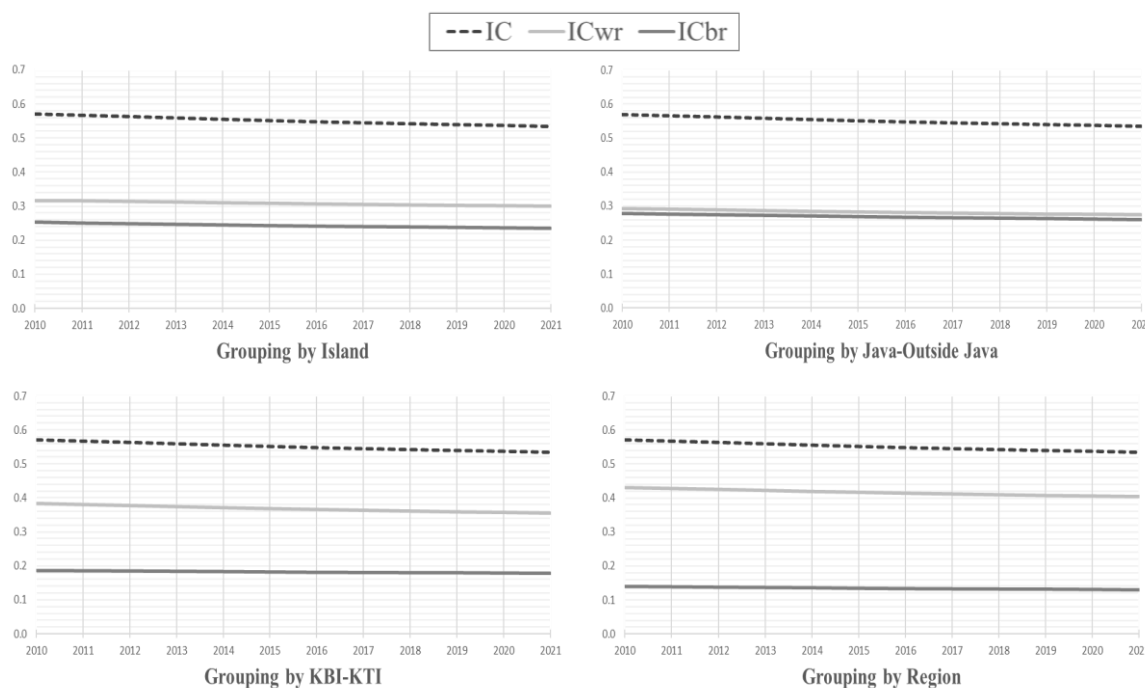

Figure 3. Dispersion of intra- and inter-regional human development index gaps in Indonesia
Source: Indonesia Central Bureau of Statistics (BPS), 2024 (Processed)

The decomposition of the Theil Index highlights the spatial underpinnings of regional disparities and indicates that such disparities are predominantly linked intraregionalesde unrelated rather than inter-regional. It is interesting to note that most of the inequality in human development between Nusa Tenggara and Indonesia as a whole ends up within regions and not between KBI (Western Indonesia) and KTI (Eastern Indonesia). Consistent with studies

by Shen et al. Some of the researchers like (2025) and Malakar & Mishra (2017): intra-regional inequality often exaggerates in case of geographically large countries with widely dispersed regions.

Viewed in this context, the still expanding gap between western and eastern regions of Indonesia—manifest in the increasing differences from KBI to KTI—raises questions about the extent to which national policies designed to

promote regional equity are attuned to their disparate circumstances. The literature on regional disparities in Indonesia has long noted the socio-economic and infrastructural disadvantages of the eastern part of the country, where low access to education and health and poor access to transport infrastructure are still a handicap for human development. These findings indicate that efforts geared towards addressing these intra-regional disparities must be intensified, especially in resource allocation and infrastructure provision, if regions like KTI are to do away with backlogs experienced among settings with richer experiences from more developed areas like KBI.

Java-outside Java is more balanced; the territory separation of these two regions is reduced through the years. Such an outcome is important, as Java—by far the most historically developed region in Indonesia—has long comprised the nexus for economic activity and development. Indent The closer convergence of Java with other regions reveals the success in

attempts to decentralise development and promote economic growth outside Java. This is in line with other studies, such as Aritenang (2021), that argued balanced regional development policies as an effort to mitigate regional disparities between economically leading regions and lagging regions.

The slow convergence trends, especially in the case of the KBI-KTI dichotomy, are important to address when designing Indonesia's development agenda. Evidence points to the fact that market forces are unlikely to be enough on their own to close regional human development gaps. This result is consistent with Rodrik's (2013) assertion that direct public intervention must be required for convergence to take place, especially in the structurally disadvantaged regions. This could mean in the case of Indonesia favouring fiscal policies that are more targeted to narrowing the differentials by public service provision both for education, health care, and infrastructure.

Table 3. Estimation results for absolute of β-convergence models

Parameters	Absolute β-convergence model			
	PLS	FE	FD-GMM	Sys-GMM
ln_HDIL1.	0.97546494	0.93414275	0.93635577	0.93406795
	(0.000)	(0.000)	(0.000)	(0.000)
_Cons	0.11136637	0.28597975	0.27662492	0.28629518
	(0.000)	(0.115)*	(0.000)	(0.000)
Implied λ	2.48	6.81	6.58	6.82
Half-life	27.90	10.17	10.54	10.16
Arellano-Bond test				
for AR(1)			−4.3234	−4.3224
			(0.000)	(0.000)
for AR(2)			−1.2215	−1.2149
			(0.2219)	(0.2244)
Sargan test			33.98362	33.99983
			(0.9849)	(0.9993)

Note: *Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*
Source: Data Processed, 2024

Moreover, the regional disparities in Indonesia can be placed in context by comparison with those of other large developing countries. In India, for instance, the differences between the northern states and the south are almost as strong. In reaction, India has adopted a range of policies designed to reduce regional inequality: investments in infrastructure projects

tailored to less developed regions, tax breaks for businesses operating out of these areas, and education reforms. Success in these policies has been felt, bridging the urban-rural dichotomy to an extent.

China is another case where progress in reducing regional disparities has been substantial. The Chinese government has

pursued aggressive fiscal and monetary policies, including investing huge amounts of money in the less developed western regions of China and setting up special economic zones to encourage foreign investment. Indonesia could follow suit, in particular their Eastern provinces, where this is needed to stimulate economic growth and reduce human development disparities.

This suggests that wider policies like a national minimum wage may not be suitable to mitigate intra-regional inequalities. Sahoo and Senapati (2022) have argued that infrastructure development is a major factor of regional convergence. The pressure to converge in underdeveloped areas, particularly upon the convergence rate, can be accelerated only if there is a strong investment trigger that focusses on the growth of education and health infrastructure. This result is in line with the results from Mendez and Santos-Marquez (2022), which stress human capital working toward a riddance of regional inequality.

Additionally, the decomposition of Theil reveals that differentiated regional policies should be adopted as they contribute to reductions in both intra- and inter-regional inequalities. Policies to address intra-regional inequities, notably within KTI, will have to emphasise those that promote local economic development around investing in human capital, promoting private sector growth, and strengthening infrastructure. On the other hand, with Java catching up fast to its less developed region counterpart, this shows that existing development and connectivity regionalisation policies are working well but also at the same time, a wake-up call that further aggressive efforts need to be in place.

In Indonesia, one of the most interesting results generated by this research was that the intra-regional disparities within the country as a whole have continued to persist. Instead of examining inter-regional disparities as much other work has done, the further unpacking of intra-regional matters examines the difficulties faced between less-developed provinces in a single geographical region. Yet on this overall advance, Java also shows up more informatively,

as certain provinces are significantly lagging behind the others in terms of human development, which illustrates well the unequal distributions of resources and opportunities.

As to intra-regional disparities, there is a higher difference in development between regions than within the region when analysing the Theil Index. This means that policy interventions have to do more than just address very broad regional disparities—tthey must also zoom in on the exact provinces or even districts within those regions that are experiencing a lack of convergence.

This study also adds to the wider literature on regional convergence and inequality in Indonesia by giving a full description of differences with respect to human level of development. While most studies have focused on economic indicators such as GDP and income, this study contributes to the literature by showing that human development, measured by the HDI, better reflects regional well-being from a global perspective. Results from the application of Theil Index and β-convergence models show strong evidence of a convergence process in human development across provinces of Indonesia but proceeding very slowly. These questions could be relevant to the political debate of how accurately we measure regional disparities and which differentiation process results in regional reduction, respectively increasing poverty, reinforcing that multi-dimensional development indicators matter.

Several policy recommendations can be made given the results of this study. The first is appropriate and tailored fiscal support that focusses on the problems endemic to underdeveloped regions, particularly in KTI. Similarly, investment in education and healthcare infrastructure is required to be the second priority, as these are sectors that have a direct impact on human capital formation, accelerating convergence. Secondly, the Indonesian government must also take a more nuanced, regional approach to policy craft—recognizing and addressing intraregional and interregional disparities simultaneously.

The government of Indonesia needs to have a multi-faceted approach if the convergence process is to be expedited While it may be increasing investment in physical infrastructure, that is secondary to policies aimed with building up human capital — education, health care essential. These sectors drive regional innovation, economic growth and the livability of regions. The government is also called on to develop development plans specific to regions that identify the individual challenges of those areas.

A further important recommendation concerns the need to reinforce the process of decentralization. Like in many such countries with large regional disparities, devolving more decision-making power and resources to state governments might ensure development strategies are closer to the ground. This frees up local governments to spend time on what they think is best to do unto themselves, and also allows for better use of resources.

This study has several limitations, despite its contributions, that need further exploration. For one thing, the long-run convergence we have seen is so slow that it says structured factors—differences in government, institutions, and regional autonomy—must be affecting human development over time. Future research might investigate how these determinants act with respect to human development and contribute to the reproduction of regional disparities. Moreover, the data used in this study is at the level of states; therefore, it may fail to account for heterogeneity within those states. Further disaggregated analysis at the district level may reveal some more nuanced underground of regional disparity in Indonesia.

Finally, the study considers HDI as the main human development indicator. While HDI gives an extensive insight into education, health, and income dimensions, future research could include other indicators such as environmental sustainability, gender equality, and digital access for a more contextual understanding of regional development disparities with Indonesia evolving socio-economic scenarios.

Recognising the methodological problems of measuring convergence is crucial. Although the σ-convergence and β-convergence models have their strengths, they may not completely represent all aspects of regional development. Currently, for example, these models largely revolve around economic and human development factors; however, the relevance of environmental sustainability, gender equality, or digital access is ever more paramount to understanding regional variation. This paper suggests that future work may want to build them into a more comprehensive concept of convergence, which provides a more holistic view on regional development.

Final assessment this research represents the inaugural comprehensive attempt to evaluate regional differences in human development within Indonesia. Convergence is occurring; nonetheless, it remains gradual, especially in the eastern regions. Indonesia must implement a more targeted and region-specific development policy to tackle these difficulties. Improving its human capital, decentralising the decision-making process, and adopting best practices from other nations can assist Indonesia in expediting the convergence process and promoting more equitable regional development.

CONCLUSION

This study provides clear evidence of regional convergence in human development across Indonesian provinces, particularly through the use of σ- and β-convergence models, and Theil Index decomposition. The results indicate a gradual reduction in human development disparities over the 2010-2021 period, though the pace of convergence remains slow. Intra-regional disparities, especially within the western (KBI) and eastern (KTI) regions, contribute more significantly to overall inequality than inter-regional disparities. The persistent gap between KBI and KTI regions, coupled with the relatively balanced Java-outside Java disparity, underscores the importance of geographically targeted development policies.

The study contributes to the theoretical understanding of regional convergence by integrating human development indicators, such as HDI, into traditional economic measures of inequality. While previous studies have focused on income-based indicators, this research demonstrates the importance of a multi-dimensional approach to measuring human development disparities. By applying Theil Index decomposition, this study adds a new layer of understanding to the spatial distribution of regional inequalities, providing insights into both intra- and inter-regional dynamics. This research supports the need for differentiated policy strategies that address both dimensions of inequality in Indonesia's diverse regional landscape.

Looking forward, future research could explore the structural factors that influence the slow pace of convergence, such as governance, institutional quality, and regional autonomy. Additionally, more granular, district-level studies may reveal further nuances in regional disparities, especially in provinces with high internal inequality. Expanding the scope of human development indicators, including environmental, gender, and digital metrics, would provide a more holistic perspective on regional development challenges. Such studies could offer valuable insights for policymakers aiming to foster more equitable and sustainable development across all regions of Indonesia.

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