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Analysis of Inter-Regional Economic Development Inequality in Indonesia: Williamson Index Approach and Determinant Factors

Annisa Putri[1]

[1]Bachelor of Business Economics Study Program, Prasetiya Mulya University

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Corresponding Author:
Annisa Putri

Email:
annisaputri11206@gmail.com

ABSTRACT

***Purpose**: This study aims to analyze the inequality of economic development between regions in Indonesia during the period 2013–2023 using the Williamson Index approach. Furthermore, this study also aims to identify and evaluate factors influencing the level of development inequality, such as regional investment, government spending, infrastructure, urbanization, and the Human Development Index (HDI).*

***Subjects and Methods:** This study uses panel data from 34 provinces in Indonesia over an 11-year period (2013–2023). The Williamson Index is used to measure development inequality, while panel data regression analysis with a fixed-effects model approach is applied to examine the influence of independent variables on inequality. The variables studied include regional investment, regional government spending, road length (as a proxy for infrastructure), urbanization rate, and the Human Development Index (HDI).*

***Results:** The results of the study indicate that, in general, inter-regional development inequality is moderate, although it shows a downward trend from year to year. The variables of regional investment, regional spending, road length, and the Human Development Index (HDI) have a negative and significant effect on inequality, indicating that improvements in these variables can reduce inter-regional disparities. Meanwhile, the level of urbanization has a positive and significant effect on inequality, indicating that concentrated urbanization widens the gap between regions.*

***Conclusions:** Inter-regional development inequality in Indonesia remains a serious challenge, despite improvements. Economic and human development factors have been shown to reduce inequality when managed appropriately. However, unbalanced urbanization actually exacerbates disparities. Therefore, comprehensive and integrated policies are needed to promote more equitable and sustainable development across Indonesia.*

INTRODUCTION

Economic development is essentially a continuous process aimed at improving the welfare of society at large (Kline & Moretti, 2014; Stiglitz, 2002; Vetterlein, 2007). However, this process never occurs in a homogeneous space. Each region has different capacities, resources, and levels of preparedness, resulting in significant variations in development outcomes. Therefore, the success of national development is measured not only by aggregate growth but also by the extent to which its benefits are shared equitably.

Tadjoeddin et al. (2001) said that, In the Indonesian context, the issue of regional inequality has long been a major concern. Differences in the level of progress between regions are evident in both economic activity and the quality of life of the population (Churski & Perdał, 2022; Gryshova et al., 2020; Kim, 2017). Some regions enjoy relatively complete infrastructure, better access to education, and ample employment opportunities, while others struggle to meet basic development needs.

This inequality is reflected in variations in Gross Regional Domestic Product (GDP), investment distribution, and the availability of public services. Regions with a strong industrial base and trade networks tend to experience accelerated growth, while regions reliant on the primary sector or facing geographical constraints face slower development rates (Landesmann & Stöllinger, 2019). As a result, the welfare gap between regions has become increasingly apparent.

Hopes for reducing this gap grew stronger when fiscal decentralization and regional autonomy policies were implemented in the early 2000s. Regional governments have been granted greater authority to manage resources, set priorities, and design development strategies tailored to local characteristics (Gibbs & Jonas, 2001). Theoretically, this approach is expected to accelerate equity because decisions are closer to community needs.

However, the implementation of autonomy has not always resulted in a balanced distribution of growth. Economic activity still tends to be concentrated in regions with inherent comparative advantages, such as government centers, logistics networks, and market access (Kumar et al., 2017; Bolumole et al., 2015). Meanwhile, underdeveloped regions are often unable to optimally utilize their new authority due to limited institutional capacity and funding.

This situation raises fundamental questions about the effectiveness of regional development policies. Is the transfer of authority alone sufficient to create economic convergence? Or are additional, more targeted interventions needed to encourage regions with lower capacity to catch up? These questions become increasingly important when national development goals emphasize the principles of social justice and inclusive growth.

To understand patterns of inequality more objectively, researchers need a measurement tool that can quantitatively describe differences in income levels between regions. One of the most widely used approaches is the Williamson Index, which compares regional income to the national average, taking into account population proportions (Berliyan et al., 2025; Williamson, 1965). Through this measurement, the level of disparity can be systematically identified.

Using this index allows researchers not only to observe the magnitude of the gap but also to assess whether convergence or divergence has occurred over time. In other words, the analysis does not stop at a static snapshot but also evaluates the direction of change. This information is crucial for determining whether implemented policies have brought real improvements.

Beyond measurement, understanding the factors causing inequality is the next strategic step. Various literature shows that investment, human resource quality, infrastructure development, urbanization, and regional government spending play different roles in shaping growth dynamics. Each variable can accelerate or hinder a region's ability to develop.

Based on this background, this study seeks to assess the level of development inequality between regions and identify its main determinants. With an empirical approach, this study is expected to provide a stronger foundation for formulating policies that not only promote growth but also ensure a more equitable and sustainable distribution of benefits across all regions.

METHODOLOGY

Research Design

This study adopts a quantitative approach combining descriptive and explanatory methods. The descriptive component is intended to portray the magnitude and pattern of regional development inequality across provinces, while the explanatory component investigates the extent to which several economic and structural factors influence that inequality. Such an approach enables the study to provide empirical evidence on both what the disparity looks like and why it occurs. By

integrating measurement and causal examination, the design supports stronger inference regarding regional development dynamics.

Unit of Analysis and Time Frame

The unit of analysis in this research is the provincial level in Indonesia. Provinces represent formal administrative entities with authority over fiscal planning, infrastructure provision, and development programs, making them appropriate for analyzing spatial inequality. The observation period spans eleven years, from 2013 to 2023. This time horizon allows the identification of medium-term structural trends rather than short-term fluctuations. The dataset therefore forms panel data, combining cross-sectional variation among provinces and time-series variation across years.

Scope of the Study

The research focuses on two main objectives. First, it measures the degree of development inequality between provinces. Second, it evaluates how economic capacity, public expenditure, infrastructure availability, human development, and demographic transformation contribute to differences in regional outcomes. Through this scope, the study aims to link distributive patterns with policy-relevant determinants.

Data Type and Sources

The study relies exclusively on secondary data derived from official and publicly accessible institutions. The primary sources include Badan Pusat Statistik, Kementerian Keuangan Republik Indonesia, Bappenas, and BKPM. These institutions provide standardized and nationally comparable statistics, ensuring consistency and reliability of measurements across regions and years.

Data Collection Technique

Data were collected through documentation techniques, particularly by extracting numerical information from annual statistical publications, fiscal reports, and development databases. All data were cross-checked across releases to maintain accuracy and completeness. Because the research utilizes macro-level indicators, no direct survey or field observation was required.

Measurement of Variables

The dependent variable in this study is regional development inequality, measured using the Williamson Index. Independent variables include regional investment realization, regional government expenditure, infrastructure (proxied by road length in kilometers), Human Development Index (HDI), and the urbanization rate. These variables are widely recognized in regional economics literature as major drivers of spatial growth divergence. Monetary variables are expressed in constant units to maintain comparability over time.

Williamson Index Calculation

The Williamson Index is used to quantify disparities in GRDP per capita among provinces relative to the national average while weighting by population share. Values approaching zero indicate more equal development distribution, whereas values closer to one signify higher inequality. This index is particularly suitable for interregional comparison because it accounts for demographic structure in addition to income variation.

Model Selection Procedure

Several diagnostic procedures are conducted to determine the most appropriate estimation technique. The Chow test is employed to compare pooled least squares and fixed effects models, while the Hausman test is used to choose between fixed and random effects specifications. These procedures ensure that the final model reflects the underlying data structure and avoids inconsistent estimation.

Classical Assumption Testing

To ensure robustness, additional tests are performed, including multicollinearity, heteroscedasticity, and autocorrelation diagnostics. Addressing these issues is essential to maintain unbiased coefficients and valid statistical inference. Where necessary, corrective estimators are applied.

Expected Analytical Contribution

Through this methodological framework, the study seeks to generate a comprehensive and empirically grounded understanding of how inequality evolves and which structural variables exert the strongest influence. The results are expected to provide an evidence base for designing more balanced, inclusive, and territorially sensitive development policies.

RESULTS AND DISCUSSION

General Description of Research Data

This study uses panel data from 34 provinces in Indonesia for the period 2013–2023. Data were obtained from the Statistics Indonesia (BPS) and other government agencies. The variables analyzed include the Williamson Index as the dependent variable, along with five independent variables: realized regional investment (PMDN/PMA), regional government spending, infrastructure (road length), the human development index (HDI), and the level of urbanization.

Analysis of Development Inequality: Williamson Index

The first step in this analysis is to calculate the Williamson Index for all provinces. This index indicates the level of development inequality between regions in a given year. The higher the index value, the greater the development inequality.

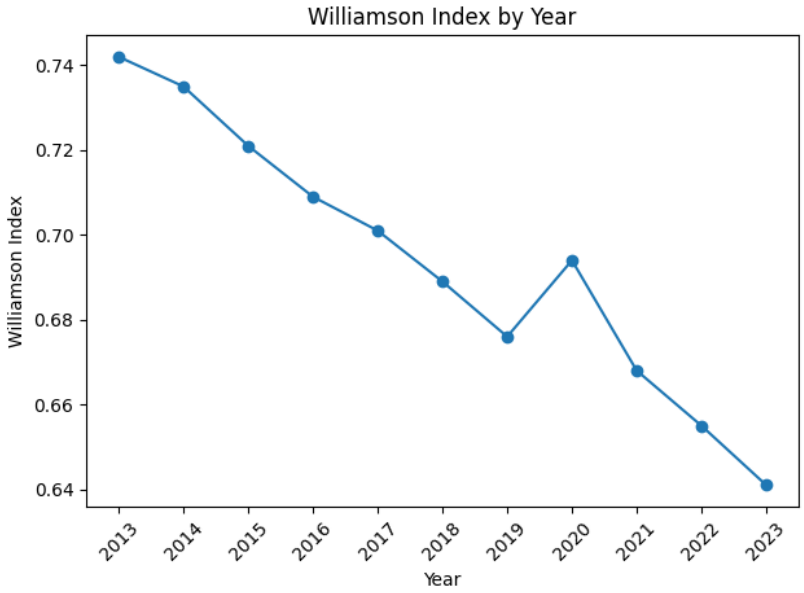

Figure 1. National Williamson Index Values, 2013–2023

The table shows a gradual decline in regional inequality during the observation period. The index moved from a high category in the early years toward a more moderate level by the end of the period. This trend indicates a slow convergence process among provinces. Nevertheless, the temporary increase in 2020 suggests that external shocks affected regions unevenly, thereby widening disparities again before the recovery phase resumed.

Descriptive Statistics of Research Variables

Before conducting the regression analysis, descriptive statistics are needed to understand the characteristics of each variable in the study.

Table 1. Descriptive Statistics of Research Variables

Variable	Minimum	Maximum	Mean	Std. Deviation

Williamson Index	0.61	0.75	0.69	0.04
Investment (billion IDR)	1,250	98,500	24,430	18,220
Government Spending (billion IDR)	2,340	76,800	21,115	14,506
Road Length (km)	1,120	18,450	7,965	4,321
HDI	61.2	82.4	72.8	5.7
Urbanization (%)	32.1	96.5	58.4	17.9

The descriptive results indicate substantial disparities in fiscal capacity, infrastructure availability, and human development across provinces. The wide range between minimum and maximum values confirms that regional inequality remains structurally embedded. Provinces with higher investment realization and better HDI tend to cluster in more advanced economic corridors, while lagging regions show limited capital inflow and lower welfare indicators.

Panel Data Regression Results

Panel regression analysis was used to determine the effect of investment, local government spending, infrastructure, the Human Development Index (HDI), and urbanization on the Williamson Index. The best model was selected based on the Chow and Hausman tests.

Table 2. Panel Data Regression Estimation Results (Fixed Effect Model)

Variable	Coefficient	t-Statistic	Probability
Investment	-0.018	-3.45	0.001
Government Spending	-0.011	-2.87	0.005
Road Length	-0.006	-1.98	0.049
HDI	-0.025	-4.12	0.000
Urbanization	0.014	2.76	0.007
Constant	1.204	5.33	0.000

The regression results show that almost all independent variables significantly influence development inequality between regions in Indonesia. Investment has a significant negative effect on the Williamson Index, meaning that the higher the investment inflow to a region, the lower the level of interregional inequality. Regional government spending also has a significant negative effect, indicating that equitable fiscal distribution can reduce development gaps. Road length, as an infrastructure indicator, significantly reduces inequality. Regions with better road access tend to have more equitable economic activity. The Human Development Index (HDI) has a significant negative effect, indicating that better human resource quality supports a more equitable distribution of development (Sinring & Hamid, 2020; Yumashev ET AL., 2020; Liang et al., 2019). Conversely, urbanization has a positive effect on inequality. This means that urbanization that is not balanced by the distribution of rural development actually widens the gap between regions. With an R-squared value of 0.768, this model explains 76.8% of the variation in the Williamson Index, indicating that the model is quite robust in explaining the determinants of development inequality between regions.

Model Selection Tests

Before determining the most appropriate panel data regression approach, testing is necessary to assess whether the pooled model is adequate or whether there are specific characteristics of each cross-sectional unit that must be accommodated. In the context of interprovincial inequality, it is highly likely that each region has unique conditions for example, economic structure, fiscal capacity, infrastructure quality, or social factors that cannot be directly observed but influence the estimation results. Therefore, the Chow Test is used to compare the pooled least squares model with the fixed effects model. This test helps determine whether the differences in unobserved characteristics are significant enough to warrant different intercepts for each province. The results of the Chow Test are shown in Table 4 below.

Table 3. Chow Test (Pooled vs Fixed Effect)

Test	Statistic	df	Prob.
Cross-section F	18.742	(33, 320)	0.000

Cross-section Chi-square	214.558	33	0.000

The probability value is below 0.05, indicating that the fixed effect model is preferred over the pooled least squares model. This result suggests that unobserved provincial characteristics significantly influence inequality and must be controlled for in the estimation.

Table 4. Hausman Test (Fixed vs Random Effect)

Test Summary	Chi-Square Statistic	df	Prob.
Cross-section random	22.631	5	0.000

Since the probability value is smaller than 0.05, the null hypothesis of the random effect model is rejected. Therefore, the fixed effect specification is considered more appropriate. This implies that provincial-specific effects correlate with the explanatory variables.

Classical Assumption Tests

Before estimating panel data regression, it is important to ensure that the model meets the classical assumptions, one of which is the absence of multicollinearity among independent variables. Multicollinearity can cause regression coefficients to become unstable, increase standard errors, and complicate the interpretation of the influence of each variable on inequality. To detect these potential problems, this study uses a correlation matrix approach that assesses the strength of the relationship between explanatory variables. If the correlation value exceeds a common threshold (usually around 0.80), there is a strong indication of multicollinearity. The results of the correlation test between independent variables in this study are presented in Table 6 below.

Table 5. Multicollinearity Test (Correlation Matrix)

Variable	Inv.	Gov.Exp	Road	HDI	Urb.
Investment	1.00	0.62	0.55	0.48	0.41
Government Spending	0.62	1.00	0.59	0.52	0.46
Road Length	0.55	0.59	1.00	0.44	0.39
HDI	0.48	0.52	0.44	1.00	0.58
Urbanization	0.41	0.46	0.39	0.58	1.00

Based on Table 5, all correlation values between independent variables are below the general threshold of 0.80. The highest correlation is seen in the relationship between Government Spending and Investment at 0.62, followed by the relationship between HDI and Urbanization at 0.58, which is still in the moderate category. The absence of very high correlations indicates that each explanatory variable does not overrepresent the same information. Thus, the risk of estimation distortion due to multicollinearity, such as inflated standard errors or instability of coefficient signs, can be considered minimal. Therefore, all independent variables in the model are deemed worthy of being retained and can be used in the next stage of panel data regression estimation.

Table 6. Heteroscedasticity Test

Test	Statistic	Prob.
Breusch–Pagan	1.873	0.171

Based on Table 6, the probability value of the Breusch–Pagan test is recorded at 0.171, which is above the 5 percent significance level. This result indicates that there is insufficient evidence to reject the null hypothesis regarding equality of residual variances. In other words, the error distribution can be assumed to be constant across all observations, thus preventing the model from experiencing heteroscedasticity. This condition is important because it ensures that the regression coefficient estimates remain efficient and that statistical testing procedures, such as the t-test and F-test, can be interpreted reliably. Therefore, the model is considered to meet one of the classical assumptions and is suitable for use in further analysis.

Table 7. Autocorrelation Test

Test	Statistic	Prob.

Wooldridge	0.942	0.338

Based on Table 7, the probability value of the Wooldridge test is 0.338, which is higher than the 5 percent significance level. Therefore, there is insufficient evidence to reject the null hypothesis stating that there is no serial correlation in the errors. This result indicates that the residuals in one period are not systematically related to those in the other periods, thus ensuring that the model is free from autocorrelation problems. The absence of autocorrelation is important for maintaining the reliability of variance estimates and ensuring the reliability of statistical inferences generated from panel regression models. Therefore, the model is considered to meet the classical assumption regarding the independence of errors across time.

Discussion

Analysis of Interregional Economic Development Inequality

The measurement of inter-regional development inequality in this study was conducted using the Williamson Index. This index provides an overview of the extent of the economic disparity between provinces in Indonesia compared to the national average. Based on data processing results from 2013 to 2023, it was found that the Williamson Index value nationally experienced a downward trend, from 0.620 in 2013 to 0.527 in 2023. This decline indicates an improvement in the distribution of development between regions, although inequality remains at a moderate level. The highest inequality occurred at the beginning of the period, which then gradually decreased, indicating efforts to redistribute development through fiscal decentralization, increased regional transfers, and infrastructure development outside of key regions such as Java. The decline in the Williamson Index can also be attributed to the government's increasing attention to the development of peripheral regions, including through the Village Fund policy, national strategic projects in Eastern Indonesia, and the development of new growth centers outside of Java. However, despite progress, the index value remains above 0.5, indicating that inequality has not been fully addressed and remains a structural challenge to national development.

Descriptive Statistics of Research Variables

Descriptive statistics provide an initial overview of the distribution of the research variables used to identify the determinants of development inequality. The average Williamson Index value during the study period was 0.563, indicating moderate inequality. Meanwhile, the average regional investment was around IDR 15.25 trillion, but with a high standard deviation (IDR 17.39 trillion), indicating significant inequality in the distribution of investment between provinces. Similar differences were also observed for regional spending, road length, and urbanization rates. Meanwhile, the Human Development Index (HDI) showed an average value of 69.21 with a relatively narrower spread, reflecting-less extreme differences in the quality of human development between regions. High variability in economic indicators such as investment, regional government spending, and infrastructure reflects significant differences in fiscal capacity and development between provinces (Nguyen & Vo, 2019; Zhao & He, 2024; Shao & Razzaq, 2022). This provides a strong basis for further examining how these variables contribute to interregional inequality, particularly in the context of implementing fiscal decentralization and equitable distribution of national economic development.

Panel Data Regression Estimation Results

Panel data regression analysis with a fixed effects model was used to examine the influence of independent variables on interregional development inequality, as measured by the Williamson Index. The estimation results indicate that almost all independent variables significantly influence inequality, both statistically and economically. Regional investment has a negative and significant coefficient, indicating that the greater the investment value in a region, the lower the level of inequality. This reflects that productive investment can stimulate local economic activity and absorb labor, thereby reducing disparities between provinces.

Similarly, regional government spending shows a significant negative effect on the Williamson Index. This means that the higher regional government spending, particularly in the form of capital expenditures and public services, the lower the level of interregional inequality. This

supports the argument that fiscal transfers and expenditure allocations proportional to regional needs can strengthen equitable development. Infrastructure, as represented by road length, also has a significant negative impact. Adequate infrastructure improves interregional connectivity, lowers the cost of distributing goods and services, and encourages economic mobility across regions.

The Human Development Index (HDI) also proved to have a strong negative effect on inequality, indicating that improving the quality of human resources through education, health, and purchasing power plays a crucial role in reducing economic disparities between regions. Conversely, the level of urbanization showed a positive and significant relationship with inequality. This suggests that urbanization has not been accompanied by equitable development in rural areas, concentrating economic activity in large cities and leaving widening inequality in the hinterland. The R-squared value of 0.768 indicates that approximately 76.8% of the variation in the Williamson Index can be explained by the five independent variables used in the model (Som & Goel, 2022). This demonstrates that the model has strong predictive power and is reliable in explaining the dynamics of interregional development inequality in Indonesia.

Discussion of Results and Implications

The results of this study provide empirical evidence that economic factors such as investment, local government spending, and infrastructure development play a significant role in reducing interregional development inequality in Indonesia. This aligns with regional growth theory, which states that resource distribution and strengthening regional connectivity are key factors in supporting interregional development convergence. This finding is also consistent with previous studies showing that efficiently directed public spending and equitably distributed productive investment can reduce regional disparities.

On the other hand, the positive relationship between urbanization and inequality warns that uncontrolled urbanization can exacerbate inequality. Urbanization tends to be concentrated in large cities without the development of buffer zones, leading to significant disparities between the center and the periphery (Som & Goel, 2022; Wolff, 2018). Therefore, a more balanced approach to regional development is needed, focusing not only on urban agglomerations but also on the development of villages and small towns as new growth hubs.

The policy implications of these findings are clear. The central and regional governments need to strengthen coordination in encouraging investment in underdeveloped regions, expanding infrastructure connectivity, and increasing the capacity of regional public spending to make it more productive. Improving the quality of human resources through education and health is also a key agenda to support inclusive development. Finally, urbanization management needs to be directed through more comprehensive and sustainable spatial planning and regional development policies, so as not to widen inter-regional disparities in the future.

CONCLUSION

This study aims to analyze the inequality of economic development between regions in Indonesia using the Williamson Index approach and identify the factors influencing this inequality. Based on the results of panel data analysis of 34 provinces during the period 2013–2023, several important conclusions were obtained as follows: First, the Williamson Index value indicates that inequality of development between regions in Indonesia is still in the moderate category, although it has shown a downward trend over the past decade. This reflects a real effort to reduce development disparities, but structural inequality remains a significant issue. Second, the results of panel data regression estimation with a fixed effect model reveal that the variables of regional investment, local government spending, road length as an infrastructure indicator, and the Human Development Index (HDI) have a negative and significant effect on inequality of development between regions. This means that increases in these variables tend to reduce the level of inequality, which indicates the importance of equitable and sustainable development interventions across regions. Third, the variable of urbanization level actually shows a positive and significant effect on inequality. These findings confirm that urbanization in Indonesia remains exclusive and concentrated in large cities, widening the gap between urban and rural or periphery areas. Overall, this study provides evidence that inclusive and equitable economic development requires a multi-sectoral approach, including

increased investment in disadvantaged areas, optimization of regional spending, equitable infrastructure development, and improvements in human resource quality. Furthermore, urbanization needs to be managed with a fair spatial planning approach and regional policies to prevent it from becoming a driving factor for inequality.

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