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**The Impact of Unemployment, Human Development Index
and Internet Penetration on Income Inequality:
Evidence from the Sulawesi Region, Indonesia**

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Abstract: This study examines the impact of unemployment, the Human Development Index (HDI), and internet penetration on income inequality in six provinces of the Sulawesi region during 2019–2023. Inclusive development remains a central pillar of Indonesia's strategy to achieve the Sustainable Development Goals (SDGs) by 2030. Nevertheless, income inequality continues to pose serious challenges, particularly in Sulawesi, where several provinces record relatively high Gini ratios. Using panel data regression with a two-way fixed effects model, the results indicate that unemployment and HDI have negative but statistically insignificant effects on income inequality, while internet penetration is associated with a significant reduction in inequality. Jointly, the explanatory variables are statistically significant, suggesting that these factors collectively play an important role in shaping income inequality in the Sulawesi region. The findings highlight the importance of digital inclusion, alongside improvements in human development and labor market conditions, in fostering more balanced and inclusive regional economic growth in Indonesia.

Keywords: Income Inequality, Unemployment, Human Development Index,
Internet Penetration

Introduction

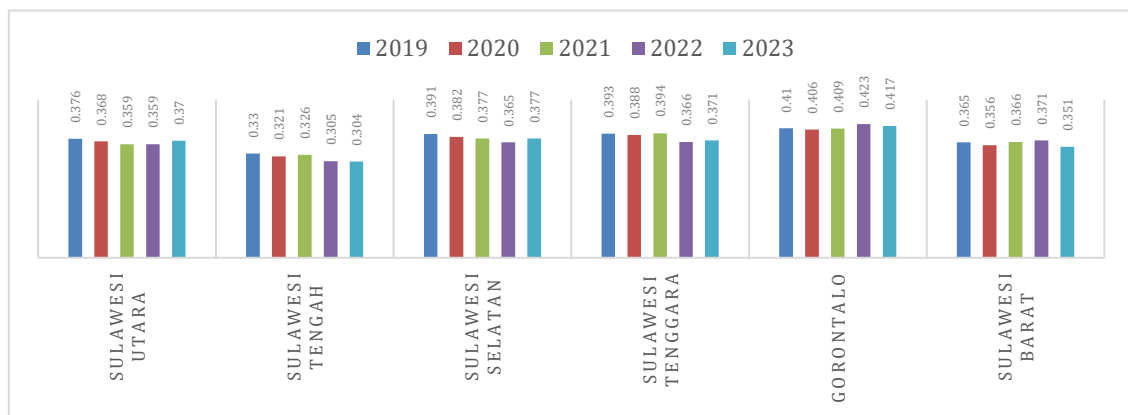
Inclusive development is a key strategic objective for Indonesia in its efforts to achieve the 2030 Sustainable Development Goals (SDGs). However, Indonesia, like many other developing countries, faces significant challenges, such as striking income disparities between different regions. As an archipelagic nation, Indonesia exhibits highly diverse geographical and socio-economic characteristics across provinces.

Differences in access to infrastructure, natural resources, and human capital quality directly impact regional disparities in driving economic growth and income distribution equity. As a result, income inequality, as reflected in the Gini coefficient, constitutes a structural issue that is difficult to address uniformly across all regions, including in eastern Indonesia such as Sulawesi (Farhan & Sugianto, 2022).

One of the most commonly used methods for measuring income inequality is the Gini coefficient, also known as the Gini ratio. The Gini ratio is a measure used to assess the level of inequality in income distribution within a region. The Gini ratio score ranges from 0 to 1. The closer the score is to 0, the more evenly distributed the income among the population. Conversely, a value closer to 1 indicates increasingly sharp inequality. In Indonesia, the Gini ratio is divided into three levels: if the value is between 0 and 0.3, it is categorized as low inequality; between 0.3 and 0.5, it is categorized as moderate inequality; while a value above 0.5 indicates high inequality.

Based on data from the Central Statistics Agency, four of the ten provinces in Indonesia with the highest income inequality are located in the Sulawesi region. In these provinces, the level of income inequality is still classified as moderate to high. The national Gini coefficient for 2023 stands at 0.388, but several provinces in Sulawesi have recorded figures higher than the national average. This issue of income inequality reflects that the quality of development is still not optimal, as its benefits have not been felt evenly by all segments of society (Silaban et al., 2024).

Figure 1. **Gini Ratio of Six Provinces in the Sulawesi Region (2019-2023)**



Source: Statistics Indonesia, 2025

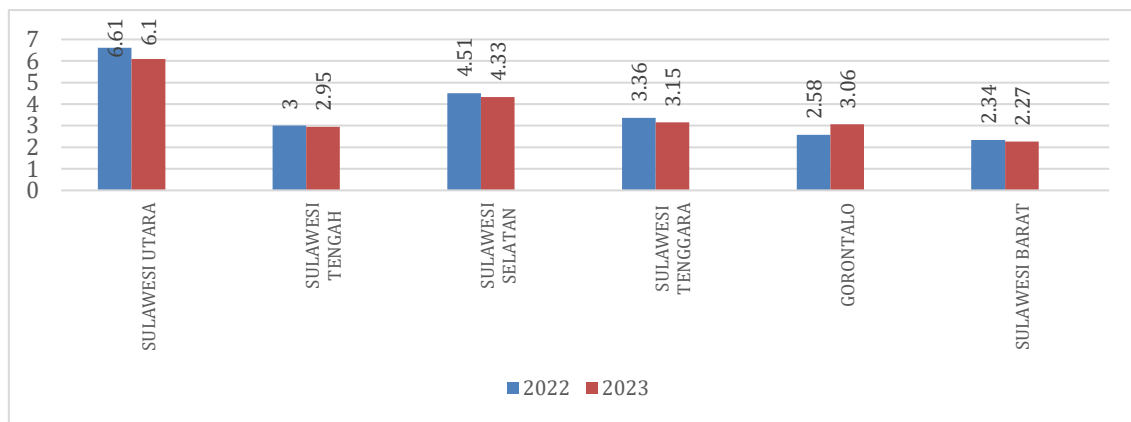
Based on the data above, there has been a change in the Gini ratio between 2019 and 2023 in the Sulawesi region. Central Sulawesi recorded the most consistent decline, from 0.33 in 2019 to 0.304 in 2023. North Sulawesi and South Sulawesi initially improved, but inequality rose again in 2023. Southeast Sulawesi and West Sulawesi showed fluctuations, with a tendency to improve toward the end of the period. Meanwhile, Gorontalo consistently recorded the highest Gini Ratio above 0.4. Higher income inequality reflects substantial imbalances in wealth distribution, which can exacerbate social disparities and create various social challenges, ultimately hindering economic growth.

The higher the level of income inequality, the greater the gap between the rich and the poor. This condition indicates a significant imbalance in the distribution of wealth, which will

ultimately exacerbate social inequality and trigger various problems in society (Arafah & Khoirudin, 2022). Inequality or disparities in income distribution also lead to economic inefficiency because resources are not utilized optimally, as wealthier groups tend to accumulate wealth, while poorer groups lack adequate access to opportunities for development.

Unemployment is one of the factors considered to contribute to increasing inequality. High unemployment highlights the challenges faced by most people in finding decent work. This problem often arises due to low levels of education and skills, coupled with limited access to job opportunities. These limitations make it difficult for individuals to compete in the formal sector, forcing them to work in the informal sector with low wages. As a result, the income gap between low-income and high-income groups continues to widen (Vionita & Artha, 2024). Data on the unemployment rate in six regional areas of Sulawesi from 2022 to 2023 shows a downward trend in most areas.

Figure 2. Unemployment Rate in the Sulawesi Region (2022-2023)



Source: Statistics Indonesia, 2025

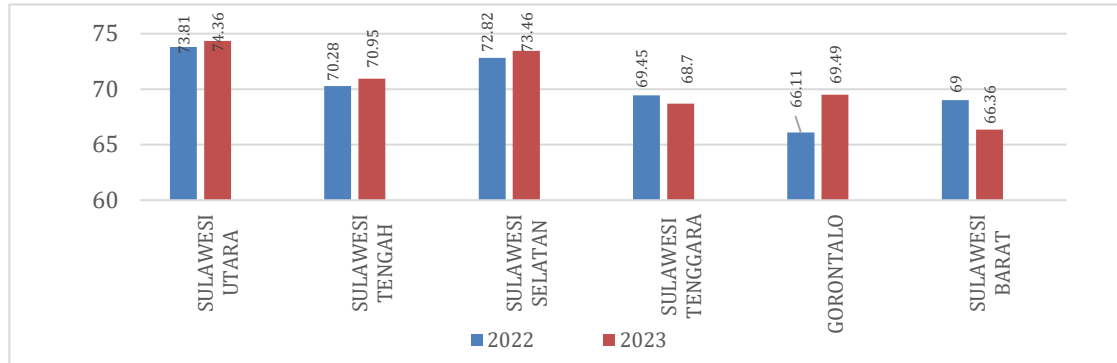
North Sulawesi continues to have the highest unemployment rate, although it decreased from 6.61% in 2022 to 6.10% in 2023. South Sulawesi also saw a decrease from 4.51% to 4.33%. Meanwhile, the province with the consistently lowest unemployment rate is West Sulawesi, which dropped from 2.34% to 2.27%. Central Sulawesi and Southeast Sulawesi showed a slight decrease, while Gorontalo experienced an increase from 2.58% to 3.06%. In general, the above shows an improvement in employment conditions in most parts of Sulawesi, although some areas still face challenges. This reflects the government's efforts to improve the economy's ability to absorb labor (Ikridah & Ramli, 2024).

Another factor that can cause income inequality is Human Development. The Human Capital Theory explains that an individual's education, skills, and health are forms of investment that can increase their productivity and income in the future. This theory can be used to explain how investment in education and health can reduce inequality and increase economic growth (Handayani & Hanafi, 2024).

The HDI considers aspects of well-being such as education, which assesses average years of schooling and expected years of schooling, health, which reflects life expectancy, and standard of living, which is measured by per capita expenditure (Mulia & Putri, 2022). The human development index according to the United Nations Development Program (UNDP)

standard consists of several criteria, namely an HDI value between 50-80 indicates a moderate level of development, while an HDI above 80 indicates a high level of development. A higher HDI means a better quality of life for the community, which in turn drives productivity and increases per capita income (Kusuma et al., 2019).

Figure 3. **Human Development Index in the Sulawesi Region (2022-2023)**

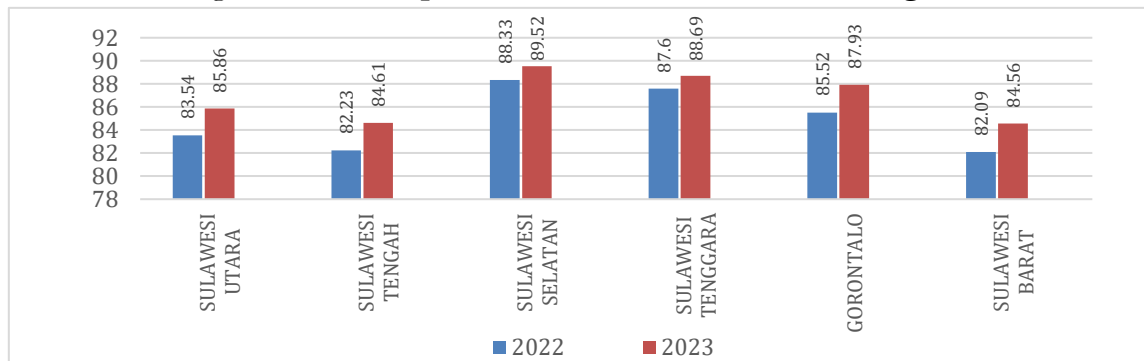


Source: Statistics Indonesia, 2025

North Sulawesi is the province with the highest HDI in the Sulawesi region. Central Sulawesi also showed an increase in HDI from 69.55 to 70.95. South Sulawesi has a high HDI that continues to increase from 72.82 in 2022 to 73.46 in 2023. South Sulawesi also saw an increase in its HDI to 68.70 in 2023. Gorontalo showed an increase in its HDI from 69.81 in 2022 to 70.45 in 2023. West Sulawesi is the province with the lowest HDI among the six provinces, at just 66.36 in 2023, even declining from 71.66 in 2021. Overall, among the six provinces, the indicator that consistently contributes the most to the HDI is expected years of schooling, primarily because its value is high in most provinces.

In the era of digital transformation, internet penetration has become a new variable that cannot be ignored in the analysis of income inequality. Internet penetration is a measure that shows the percentage of the population in a region that has access to and uses the internet. Widespread internet penetration opens up opportunities to create jobs and increase income, which in turn can reduce income inequality. Internet access enables communities, including those in remote areas, to access the digital economy through e-commerce, online services, and freelance work (Huda, 2025).

Figure 4. **Internet penetration Rate in the Sulawesi Region**



Source: Statistics Indonesia, 2025

Based on internet penetration data in the Sulawesi region, there has been an increase in internet access in 2023 compared to the previous year. The province with the highest internet penetration is South Sulawesi, which reached 89.52% in 2023, up from 88.33% in 2022. This is followed by Southeast Sulawesi with a penetration rate of 88.69%, and Gorontalo at 87.93% in the same year. Meanwhile, West Sulawesi recorded the lowest internet penetration rate, although it still saw an increase from 82.09% to 84.56% in 2023.

In developing countries such as Indonesia, the growth of the digital economy is now considered one of the main drivers of growth. Its presence has opened up new opportunities through innovation, job creation, and increased productivity. The internet has opened up many opportunities, such as the ease of selling through e-commerce, access to digital financial services (fintech), and the creation of various new types of jobs in the technology sector (Sudaryo et al., 2020).

Provinces in the Sulawesi region are currently still facing serious challenges, namely significant income distribution disparities, despite a decline in unemployment rates, an increase in the human development index, and rising internet penetration rates. The improvement in welfare has not been felt evenly by all levels of society, as seen from the increasing Gini ratio in 2023. This means that the wealthier groups tend to benefit more from the post-pandemic economic recovery, while the poor are still struggling to meet their basic needs. Thus, rapid economic growth is not always directly proportional to a reduction in inequality.

Based on the above studies, there is inconsistency in the research findings regarding the influence of unemployment, the Human Development Index (HDI), and internet penetration on income inequality, indicating the complexity of the relationships between variables. This requires further in depth analysis to provide clearer insights for formulating more effective policies and programs to address income inequality in the Sulawesi region.

Literature Review

The Impact of Unemployment on Income Inequality

Several scholars have analyzed the relationship between unemployment and income inequality, emphasizing the complex macroeconomic and structural linkages between labor market dynamics and income distribution. Unemployment represents a crucial macroeconomic indicator that reflects an economy's inability to fully utilize its labor resources. Conceptually, high unemployment reduces aggregate income, limits access to economic opportunities for low income groups, and concentrates earnings among those who remain employed. This process widens the gap between high- and low-income households, exacerbating income inequality within society.

From a theoretical standpoint, Keynesian economics provides the foundation for understanding this relationship. Keynes as discussed in (Zhang & Li, 2024) posits that unemployment primarily results from insufficient aggregate demand. When consumption and investment decline, production decreases, compelling firms to reduce labor demand. The subsequent reduction in income and purchasing power triggers a downward spiral of economic stagnation, rising unemployment, and deepening inequality. Keynesian theory also rejects the classical notion that wage reductions necessarily restore employment equilibrium.

Instead, lower wages suppress aggregate demand, reducing output and worsening inequality between workers and capital owners.

Empirical evidence on the relationship between unemployment and income inequality remains inconclusive. As Suryani and Woyanti (2021) found in their research, the unemployment rate has a significant effect on income inequality distribution. Dosi et.al (2018) In his research using the Schumpeter meets Keynes agent-based model, he also shows that unemployment has a significant effect on income inequality.

In contrast, research by Ermatry Hariani (2019) shows that the unemployment rate does not have a significant effect on income inequality. This means that even though there has been a decrease in the unemployment rate, it has not led to a decrease in income inequality among the population. Muhammad Farhan and Sugianto (2022) found that unemployment does not have a significant impact, while the Human Development Index (HDI) does influence income inequality. These contrasting findings may stem from contextual variations, including differences in labor market structure, industrial diversification, regional economic development, and the presence (or absence) of effective social protection mechanisms.

Synthesizing the existing literature, it is evident that the link between unemployment and income inequality is context dependent. While several studies confirm a positive and significant relationship, others find no substantial effect. The divergence in findings suggests that the unemployment inequality nexus may vary depending on a country's stage of development, labor policies, and institutional frameworks. In developing regions such as Sulawesi, where structural transformation, digitalization, and economic modernization are ongoing, understanding this relationship is particularly relevant. A more nuanced empirical examination is therefore required to clarify whether unemployment in such regions primarily acts as a driver or merely a symptom of income inequality. Based on theoretical and empirical evidence, the hypothesis proposed in this study is as follows:

H1: Unemployment has a positive and significant effect on income inequality.

The Impact of Human Development Index (HDI) on Income Inequality

The Human Development Index (HDI) serves as a comprehensive measure of societal welfare, encompassing key dimensions such as education, health, and income. It reflects how effectively a population benefits from development outcomes across these sectors. The Central Bureau of Statistics (BPS) classifies HDI into four levels: low (below 60), medium (60–69.99), high (70–79.99), and very high (80 and above). This categorization provides a clearer understanding of disparities in human development across different regions of Indonesia.

The relationship between HDI and income inequality can be understood through Human Capital Theory, initially introduced by Adam Smith and later refined by Theodore Schultz and Gary Becker. The theory posits that investments in education, health, and skills enhance individual productivity and future income (Handayani & Hanafi, 2024). By improving human capabilities, these investments foster more equitable economic opportunities, reducing income disparities and promoting sustainable economic growth. In this context, improvements in HDI are expected to narrow income gaps by increasing the earning potential of lower-income groups.

Amartya Sen's Capability Approach further strengthens this view by asserting that development should expand people's freedoms and opportunities rather than merely increase economic output. Thus, a higher HDI implies not only improved living standards but also greater access to education and healthcare factors that empower individuals to participate more equally in economic activities.

Ghifara et.al (2022) examining the effect of HDI on income inequality through a panel data regression approach, the study found that the Human Development Index (HDI) has a negative and significant effect on income inequality in metropolitan cities in Indonesia. Arkum and Amar (2022) also found that human development has a significant negative effect on income inequality.

However, not all findings align with this perspective. Research by Muhammad Ersad, Amri Amir, and Zulgani (2022) shows that the Human Development Index (HDI) and poverty rates do not affect income inequality; only the unemployment rate affects income inequality in South Sumatra from 2010 to 2019. Their findings suggest that improvements in HDI may not automatically translate into a more equitable distribution of wealth, especially when access to education and healthcare remains uneven between urban and rural areas.

These differences indicate that the impact of HDI on income inequality may be context-dependent. While higher HDI tends to correlate with reduced inequality, the extent of this relationship depends on how inclusively human development benefits are distributed across regions and social classes. Therefore, policies aimed at enhancing human development should not only focus on aggregate improvements in education, health, and income but must also address structural and spatial disparities to ensure equitable outcomes. Based on theoretical foundations and empirical evidence, the hypothesis proposed in this study is as follows:

H2: The Human Development Index (HDI) has a negative and significant effect on income inequality.

The Impact Penetration Internet on Income Inequality

Internet penetration is a measure that shows the percentage of the population or number of households in an area that have access to and use the internet. More specifically, internet penetration is defined as the ratio of individuals utilizing the internet to the total population within a specific region. This metric highlights the growth of internet access and usage in that area. In general, the higher the internet penetration rate, the more people are using the internet.

Wider internet penetration can open up significant opportunities for job creation and income generation, which in turn can help reduce income inequality. Internet access enables individuals to engage in the digital economy through platforms such as e-commerce, online services and freelance work, which were previously out of reach for people in remote areas or with limited resources. This provides opportunities for low-income groups to increase their income through participation in the digital market (Mohammad & Maulidiyah, 2023).

Several analyses indicate a reducing effect of internet diffusion on inequality. Liu et.al (2024) found that internet penetration has a negative relationship with income inequality, meaning that an increase in internet penetration tends to reduce income inequality. They find that

broadernet internet access in China correlates with lower income disparities among younger cohorts, arguably because digital tools amplify opportunities for skill development and entrepreneurship among the digitally engaged youth.

Conversely, several studies indicate that the expansion of internet access can initially widen income inequality during the early stages of technological adoption. Hua and Zhang (2023) revealed that when internet access is concentrated among highly educated and high-income groups, the economic benefits of digitalization are disproportionately captured by these groups. This phenomenon is reinforced by the first-mover advantage, skill-biased technological change, and persistent infrastructure disparities between urban and rural areas.

Digital connectivity indeed holds strong potential as an instrument for promoting equality; however, its effectiveness largely depends on supporting factors such as digital literacy, internet affordability, infrastructure quality, and local labor market conditions. In regions with low levels of digital education or limited infrastructure such as developing provinces technology may instead deepen socio-economic disparities. Therefore, development policies focusing on digitalization must be accompanied by infrastructure expansion, improvements in digital literacy, and inclusive access programs to ensure that internet penetration truly contributes to reducing income inequality. Based on theoretical foundations and empirical findings, the hypothesis developed in this study is as follows:

H3: Internet penetration has a negative and significant effect on income inequality.

Methods

This study uses a quantitative approach by utilizing secondary data obtained from relevant agencies, particularly Statistic Indonesia. The type of data used is quantitative data presented in numerical form, including unemployment rates, the Human Development Index (HDI), internet penetration rates, and the Gini coefficient as an indicator of income inequality in the Sulawesi region.

The data used is panel data, which combines time series data and cross-sectional data. The time series data covers the period from 2019 to 2023, while the cross-sectional data covers six provinces in the Sulawesi region, namely North Sulawesi, Gorontalo, Central Sulawesi, West Sulawesi, South Sulawesi, and Southeast Sulawesi. Because the study period includes the COVID-19 pandemic and subsequent recovery, a two-way fixed effects (province and year) estimation approach was applied to account for national shocks such as the pandemic, fiscal stimulus, and commodity price changes.

The data sources used in this study are entirely derived from official publications issued by Badan Pusat Statistik (BPS), including annual reports, regional statistics, and other relevant digital publications related to the research variables. The data was then processed and analyzed using Microsoft Excel 2021 software for initial processing and Eviews 12 statistical software for panel regression analysis. Diagnostic tests were also conducted, including multicollinearity checks using Variance Inflation Factor (VIF) and specification tests using the Ramsey RESET test, to ensure model reliability and robustness. The general form of the panel regression model is presented as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \alpha_i + \lambda_t + \varepsilon_{it}$$

where α_i denotes province-specific fixed effects and λ_t denotes time (year) fixed effects. In this model, Y represents income inequality, X_1 is the unemployment rate, X_2 is the Human Development Index (HDI), and X_3 denotes internet penetration, while β_0 is the intercept term. The empirical specification employs a two-way fixed effects framework, capturing unobserved heterogeneity across provinces and over time through α_i and λ_t , respectively.

Findings

This section presents descriptive statistics for all research variables, accompanied by an integrated narrative that can be directly incorporated into the main manuscript without redundancy with the regression results section.

Table 1. **Descriptive Statistics of Research Variables (2019–2023)**

Variable	Mean	Min	Max	Std. Dev.
Gini Ratio	0.36	0.30	0.42	0.03
Unemployment	4.1	2.2	6.6	1.2
HDI	0.70	0.66	0.74	0.02
Internet Penetration	86.4	82.0	90.0	2.4

Note: Descriptive statistics are calculated from panel data of six provinces in Sulawesi during the 2019–2023 period.

This section presents the main diagnostic tests conducted to enhance the validity of the Two-Way Fixed Effects estimation results, namely the Variance Inflation Factor (VIF) test and the functional form specification test (Ramsey RESET test).

The multicollinearity test was conducted to ensure that high correlations among the independent variables do not distort the estimated regression coefficients. Particular attention was given to the potential correlation between the Human Development Index (HDI) and internet penetration, as both variables reflect aspects of development.

Tabel 2. **Multicollinearity Test for Independent Variables**

Variabel	VIF	Remarks
Unemployment	1.84	No multicollinearity
HDI	3.21	No serious multicollinearity
Internet Penetration	3.45	No serious multicollinearity

Evaluation criteria: A VIF value below 5 indicates the absence of serious multicollinearity, while VIF values below 10 are generally considered acceptable in empirical panel data analysis. The VIF test results indicate that all independent variables have VIF values well below the critical threshold of 5. Although the Human Development Index (HDI) and internet penetration exhibit relatively higher VIF values than the other variables, these values remain within acceptable limits and do not indicate serious multicollinearity or pose concerns regarding the stability of the estimated coefficients. Consequently, the results of the two-way fixed effects estimation can be interpreted reliably, as they are unlikely to be distorted by strong linear relationships among the explanatory variables.

To ensure that the empirical model is correctly specified and free from functional form misspecification, such as neglected nonlinearity or omitted relevant variables, the Ramsey RESET test is conducted.

Table 3. **Ramsey RESET Test Results**

Statistical Test	Value
F-statistic	1.12
Prob. F	0.34

Table 3 shows that the probability value of the Ramsey RESET test is 0.34, which exceeds the conventional significance levels of 1%, 5%, and 10%. Accordingly, the null hypothesis cannot be rejected, indicating that the model is correctly specified and that there is no evidence of functional form misspecification

These results suggest that the relationship between income inequality and the main explanatory variables, unemployment, the Human Development Index (HDI), and internet penetration, is adequately captured by the linear specification employed in the two-way fixed effects model.

Overall, the diagnostic test results indicate that: (1) the empirical model is free from serious multicollinearity, including between the Human Development Index (HDI) and internet penetration; and (2) the model specification does not suffer from functional form errors, indicating that the coefficient estimates are not biased due to incorrect specification. With these diagnostic tests satisfied, the empirical analysis in this study can be considered robust and reliable.

In panel data analysis, selecting an appropriate model is crucial for obtaining valid estimates. Three main specifications are commonly employed, namely the common effects model, the fixed effects model, and the random effects model. To identify the most suitable specification, several diagnostic tests are typically conducted, including the Chow test, the Hausman test, and the Lagrange Multiplier (LM) test. However, given the presence of nationwide shocks during the 2019–2023 period, a two-way fixed effects model (province and year) is adopted as the preferred specification.

Table 4. **Redundant Fixed Effects Test Results**

Effect Test	Statistic	d.f.	Prob.
Cross-section F	55.472400	(5,21)	0.0000
Cross-section Chi-square	79.613552	5	0.0000

The Chow test results indicate that the chi-square statistic is 79.613552 with a probability value of 0.0000, which is below the 5% significance level. Accordingly, the fixed effects model is preferred over the common effects model. Given this result, a further diagnostic test, the Hausman test, is conducted to determine whether the fixed effects model or the random effects model is more appropriate

Table 5. Hausman Test Results

Test Summary	Chi-Sq. Statistic	Chi-Sq. d. f.	Prob.
Cross-section random	9.670897	3	0.0216

The test results presented in Table 5 indicate that the probability value is 0.0216, which is below the 0.05 significance level. Accordingly, the fixed effects model is deemed the most appropriate for the estimation. In line with the reviewer's suggestion, an extended specification incorporating time fixed effects is employed to account for unobserved national shocks.

The estimation procedure is conducted in the following stages: (1) incorporating provincial dummy variables to capture time-invariant structural characteristics across provinces; (2) adding year dummy variables to control for nationwide shocks, such as the COVID-19 pandemic, fiscal stimulus policies, and fluctuations in commodity prices; and (3) estimating the model using a two-way fixed effects approach (cross-section and period).

Table 6 reports the estimation results of the two-way fixed effects model, which incorporates both provincial and time fixed effects to control for unobserved heterogeneity and common nationwide shocks. The estimated coefficients, along with their standard errors, t-statistics, and probability values, provide initial evidence on the relationship between income inequality and the main explanatory variables. The results indicate that internet penetration exhibits a statistically significant association with income inequality, while unemployment and the Human Development Index (HDI) do not show statistically significant effects within the estimated specification.

Table 6. Two-Way Fixed Effects Estimation Results

Variable	Coefficient	Std. Error	t-stat	Prob.
C	0.43	0.07	6.1	0.000
Unemployment	-0.0029	0.0031	-0.94	0.35
HDI	-0.00002	0.0010	-0.02	0.98
Internet Penetration	-0.0007	0.00026	-2.7	0.01
R-squared	0.94			
Adjusted R-squared	0.92			
F-statistic	38.9			

Note: The Gini coefficient is measured on a scale from 0 to 1. The Human Development Index (HDI) is normalized to a 0–1 scale. Unemployment and internet penetration are expressed in percentage terms (%).

The coefficient of the unemployment rate is negative but not statistically significant. After accounting for provincial fixed effects and time-specific shocks, within-province variations in the unemployment rate are not significantly associated with income inequality. This result may reflect that the observed decline in unemployment during the post-pandemic recovery

period coincided with increased employment in informal and low-wage sectors, which may have limited its impact on income distribution.

The coefficient of the Human Development Index (HDI) is also negative but not statistically significant. This result suggests that improvements in human development have not been directly associated with a more equitable income distribution. Sulawesi's economic structure, which remains largely dominated by agriculture, mining, and informal sectors, may limit the extent to which gains in education and health are absorbed into high-productivity employment.

Internet penetration exhibits a negative and statistically significant coefficient at the 5% significance level. This result remains robust after controlling for time effects, indicating that digitalization is associated with a reduction in income inequality. Greater access to the internet may expand participation in digital economic activities, such as online micro, small, and medium enterprises (MSMEs), the gig economy, and digital financial services, thereby promoting more inclusive growth.

The two-way fixed effects estimation further confirms that the main findings are not solely driven by nationwide shocks. Internet penetration continues to emerge as an important factor associated with lower income inequality in Sulawesi, whereas unemployment and the Human Development Index (HDI) do not exhibit statistically significant effects after accounting for provincial heterogeneity and time-specific shocks.

Conclusion

This study provides empirical evidence on the determinants of income inequality in the Sulawesi region of Indonesia during the period 2019–2023 using a two-way fixed effects panel data approach. The results demonstrate that unemployment and the Human Development Index exhibit negative but statistically insignificant effects on income inequality, whereas internet penetration has a statistically significant inequality-reducing effect. These findings remain robust after controlling for province-specific characteristics, time-specific shocks, and additional explanatory variables.

The principal contribution of this study lies in underscoring the central role of digital inclusion as a key mechanism for promoting a more equitable income distribution in less-developed regions. While improvements in employment conditions and human development are necessary components of long-term development, they are not sufficient in isolation to reduce inequality in regional economies dominated by low-productivity and informal sectors. Digital connectivity, by contrast, offers a more direct and inclusive pathway by expanding access to markets, information, and income-generating opportunities across spatial and socio-economic boundaries.

From a policy perspective, the findings imply that strategies aimed at reducing income inequality in Sulawesi should extend beyond conventional approaches focused solely on unemployment reduction and aggregate human development enhancement. First, policymakers should prioritize the expansion of digital infrastructure, particularly in rural and lagging provinces, to ensure affordable, reliable, and high-quality internet access. Second, investments in digital literacy and skill development are essential to enable households and small enterprises to effectively utilize digital technologies for productive economic activities.

Third, labor market and education policies should be more closely aligned with the evolving demands of the digital economy so that improvements in human capital are translated into higher-quality and better-remunerated employment. Finally, complementary social protection measures and targeted support for micro, small, and medium enterprises are required to prevent the benefits of digitalization from being captured disproportionately by early adopters and higher-income groups.

Overall, this study reinforces the argument that inclusive growth in developing regions requires structural transformation supported by digital technologies. By identifying internet penetration as a key equalizing force, the findings contribute to the broader literature on income inequality and provide actionable insights for policymakers seeking to advance the Sustainable Development Goals and promote more balanced regional development in Indonesia.

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