HDI's Role in Moderating Economic Growth, Poverty, and Unemployment Effects on Income Inequality in North Sumatra

Abstract

This study investigates the impact of economic growth, poverty, unemployment, and the Human Development Index (HDI) on income inequality in North Sumatra during 2019–2023. Using panel data regression with the Fixed Effect Model (FEM), selected for its ability to control unobserved district-specific factors, the study identifies significant relationships. Poverty and unemployment show a positive and significant effect on income inequality, indicating that higher poverty and unemployment levels exacerbate disparities in income distribution. In contrast, HDI has a significant negative effect, demonstrating that improvements in education, healthcare, and living standards mitigate inequality. Interestingly, economic growth does not significantly affect income inequality, challenging conventional assumptions about its equitable benefits. The findings suggest that growth alone cannot ensure equity without targeted interventions. The study recommends enhancing HDI through education reforms, improved healthcare systems, and social welfare initiatives. Additionally, efforts to alleviate poverty and reduce unemployment, such as job creation, skills training, and MSME development, are essential for achieving inclusive economic growth. By addressing these structural inequalities, policymakers can foster a more equitable income distribution across districts. This research offers theoretical insights into inequality determinants and practical guidance for regional development, filling a gap in understanding how socio-economic factors and human capital interact to influence income disparities.

Keywords: Income Inequality, Economic Growth, Poverty Rate, Unemployment Rate, Human Development Index, Panel Data Regression.

I. INTRODUCTION

Income inequality is a global issue that affects various social, economic, and political aspects. In developing countries like Indonesia, income inequality is one of the main problems in economic development. This inequality refers to the uneven distribution of income among community groups, which can be measured using the Gini Ratio. The Gini Ratio ranges from 0 to 1, where a higher value indicates greater inequality. High inequality can trigger social problems such as reduced social stability, weakened community solidarity, and economic inefficiency (Sukirno, 2012; Todaro & Smith, 2014). Therefore, controlling income inequality has become one of the focal points of national economic development policy (Rodionov et al., 2018).

North Sumatra is one of the regions that experiences significant income inequality. Based on data from the Central Bureau of Statistics (BPS), the Gini Ratio in North Sumatra during the 2019 to 2023 period remained in the moderate inequality

category, increasing from 0.315 in 2020 to 0.329 in 2023 (BPS, 2023). This upward trend indicates that, despite economic recovery after the COVID-19 pandemic, income distribution has not been evenly distributed. While Kuznets' (1955) theory suggests that long-term economic growth reduces inequality, this study finds that in North Sumatra, economic growth does not significantly affect income inequality. This challenges the prevailing notion that growth inherently leads to equitable income distribution, highlighting the need for complementary policies to ensure inclusivity.

Income inequality is a critical issue that affects socio-economic stability and development, particularly in regions like North Sumatra, where disparities in income distribution persist. Traditional theories, such as Kuznets' hypothesis, suggest that economic growth reduces inequality over time; however, this relationship is not universally observed. Recent studies emphasize the role of Human Development Index (HDI) components—education, health, and standard of living—as pivotal factors in addressing inequality. For instance, Tlemsani et al. (2023) highlight that HDI improvements, driven by advancements in digitalization and socio-economic reforms, significantly mitigate income disparities, particularly in emerging economies. Similarly, Anderson and Hao (2022) underscore the multidimensional nature of HDI, showing how its health and education components can act as catalysts for equitable development in regions with entrenched inequalities.

Moreover, within the Southeast Asian context, variations in HDI components illustrate significant challenges in achieving equitable development. For example, Kamaruddin and Rogers (2020) identify Malaysia's progress in reducing income inequality through targeted HDI-driven initiatives, contrasting this with regions where institutional support is lacking. Febrianti and Indriyati (2020) explore the effects of poverty and investment on sustainable development in Kalimantan, revealing how disparities in HDI metrics—such as education access—exacerbate inequality. These findings reinforce the importance of tailoring HDI-based interventions to regional dynamics, making them particularly relevant for addressing North Sumatra's unique socio-economic landscape.

Economic growth is one of the factors predicted to influence income inequality. Economic growth reflects an increase in the capacity to produce goods and services, which should be accompanied by increased community income. However, in reality, economic growth does not always impact the equitable distribution of income. BPS data shows that the GRDP of North Sumatra increased from IDR 539.51 trillion in 2019 to IDR 602.23 trillion in 2023. However, this increase was not accompanied by a reduction in income inequality (BPS, 2023). This indicates that not all community groups benefit from economic growth. Kuznets' (1955) theory explains that in the early stages of development, economic growth tends to increase inequality, but over time, inequality decreases. This phenomenon was not observed in North Sumatra, where inequality increased along with economic growth (Masruri, 2016; Jhingan, 2018).

In addition to economic growth, poverty is another factor influencing income inequality. Poverty refers to the condition where individuals or community groups cannot meet basic needs such as food, education, and health (Marianti & Munawar, 2006). In North Sumatra, the poverty rate fluctuated from 8.75% in 2019 to 9.01% in

2021, and then declined to 8.15% in 2023 (BPS, 2023). Although the poverty rate has decreased, the poverty disparity between regions remains high. For instance, West Nias Regency had a poverty rate of 22.81% in 2023, much higher than the provincial average. This condition indicates disparities in development between regions, which affects the uneven distribution of income (Maipita, 2014; Utami, 2020).

Another factor influencing income inequality is unemployment. Unemployment refers to the situation where individuals do not have a job despite having the desire to work. Unemployment directly impacts household income, especially for low-income groups (Sjafrizal, 2012). High unemployment increases the proportion of the population without income, thereby widening income distribution disparities (Sukirno, 2016). BPS data shows that the unemployment rate in North Sumatra increased from 5.41% in 2019 to 6.91% in 2020 due to the COVID-19 pandemic, then declined to 5.89% in 2023 (BPS, 2023). The high unemployment rate in North Sumatra presents a significant challenge in creating inclusive and high-quality jobs. According to Keynes (1936), increasing aggregate demand can create new jobs and reduce unemployment, thereby making income distribution more equitable (Utami, 2020; Todaro & Smith, 2012).

To strengthen the influence of socio-economic factors on income inequality, this study also uses the Human Development Index (HDI) as a moderating variable. HDI measures three main dimensions: health (life expectancy), education (mean years of schooling), and a decent standard of living (per capita income) (Becker, 1964; Al & Subrata, 2018). BPS data shows that the HDI of North Sumatra in 2023 was 73.37, lower than neighboring provinces such as Riau (74.04) and West Sumatra (73.75) (BPS, 2023). Becker's (1964) Human Capital Theory states that improving human quality can increase productivity and income, thereby reducing income inequality. HDI is expected to strengthen the influence of economic growth, poverty, and unemployment on income inequality (Rodionov et al., 2018; Jhingan, 2018).

Previous studies indicate that socio-economic variables and HDI play an essential role in determining income inequality. Oksamulya and Anis (2020) found that education and migration significantly influence income inequality in Indonesia. Rodionov et al. (2018) showed that HDI negatively affects inequality, where an increase in HDI reduces income inequality. Masruri (2016) revealed that economic growth and unemployment have a positive impact on inequality, while HDI has a negative effect. This study aims to fill the research gap regarding the role of HDI as a moderating variable in the influence of socio-economic factors on income inequality.

This study is expected to provide theoretical and practical contributions. Theoretically, it provides empirical evidence on the influence of economic growth, poverty, and unemployment on income inequality, moderated by HDI. Practically, the findings can serve as policy recommendations for the government to reduce income distribution inequality through human development, poverty alleviation, and the creation of quality employment opportunities.

II. RESEARCH METHODS

This study aims to analyze the effect of economic growth, poverty, and unemployment on income inequality in North Sumatra Province, with the Human

Development Index (HDI) as a moderating variable. This research employs a quantitative design using panel data analysis. Panel data is chosen because it improves the degree of freedom, reduces collinearity issues, and allows for a more precise examination of variable effects compared to cross-sectional or time-series data alone. The research methods include the following elements:

Research Location The study is conducted in North Sumatra Province, focusing on 33 districts/cities from 2019 to 2023. North Sumatra's socio-economic disparities provide a relevant case for examining HDI's moderating effects. Similar studies, such as those by Kamaruddin and Rogers (2020) in Malaysia, have highlighted how tailored HDI-focused strategies can address regional disparities effectively. This location is selected due to its status as one of the provinces with the highest income inequality on Sumatra Island, as reflected in its Gini Ratio consistently being above 0.3 during this period (BPS, 2023). Hence, North Sumatra serves as a relevant case for examining the impact of economic growth, poverty, and unemployment on income inequality, as well as the role of HDI as a moderating variable.

Sample Determination Method The sample is selected using purposive sampling, a non-probability sampling method that selects units based on specific criteria relevant to the research objectives (Ansori, 2020). This approach ensures the selection of samples that meet the research criteria, resulting in more accurate data. The sample consists of 33 districts/cities in North Sumatra from 2019 to 2023, combining cross-sectional (33 districts/cities) and time-series data (5 years) for a total of 165 samples (33 districts/cities × 5 years = 165 observations). The sample size determination follows Roscoe's (1975) rule, which recommends a minimum of 10 samples per independent variable in quantitative research. With five independent variables (economic growth, poverty, unemployment, HDI, and the interaction of HDI with other variables), the minimum required sample size is 50 (5 variables × 10 = 50 samples). The 165 total observations meet this requirement, ensuring sufficient sample size for analysis.

Data and Data Sources This study employs secondary data collected and published by third parties. Data is obtained using documentation methods, which involve gathering official documents and publications from credible institutions (Siyoto et al., 2015). The primary data source is the Central Bureau of Statistics (BPS), the official statistical agency of Indonesia. Data includes the Gini Ratio, economic growth, poverty rate, open unemployment rate (TPT), and the Human Development Index (HDI).

Data Used

- **Income Inequality (Y)**: Measured using the Gini Ratio, where 0 indicates perfect equality and 1 indicates perfect inequality.
- **Economic Growth (X1)**: Measured by the annual percentage growth of GRDP.
- **Poverty (X2)**: Measured as the percentage of the population classified as poor relative to the total population in a district/city.
- **Unemployment (X3)**: Measured using the Open Unemployment Rate (TPT),

representing the percentage of the unemployed in the total labor force.

- **Human Development Index (HDI) (Z)**: Measured using a composite index based on three dimensions: health (life expectancy), education (mean years of schooling and expected years of schooling), and a decent standard of living (expenditure per capita).

Data Analysis Methods The study employs panel data regression analysis, which combines cross-sectional and time-series data, providing more robust results than traditional regression models. This method accounts for individual heterogeneity and allows for the separation of individual effects from time effects (Widarjono, 2007). The regression model used in this study is:

$$Y = \beta_0 + \beta_1 PE + \beta_2 KN + \beta_3 PR + \beta_4 IPM$$

Where:

- **Y**: Income Inequality (Gini Ratio)
- **PE (X1)**: Economic Growth (%)
- **KN (X2)**: Poverty (%)
- **PR (X3)**: Unemployment (%)
- **IPM (X4)**: Human Development Index (HDI)

Panel Data Model Selection The study utilizes three approaches to determine the best model for the panel data regression:

1. **Common Effect Model (CEM)**: Assumes uniform behavior for all cross-sectional units with a single intercept.
2. **Fixed Effect Model (FEM)**: Allows for different intercepts across cross-sectional units, but the slope remains constant.
3. **Random Effect Model (REM)**: The Fixed Effect Model (FEM) was chosen based on Chow and Hausman tests. FEM accounts for unobserved variables specific to each district that remain constant over time, ensuring a robust estimation of the effects of socio-economic factors on income inequality. Assumes that intercept differences across cross-sectional units are random.

To choose the best model, three tests are conducted:

- **Chow Test**: To select between CEM and FEM.
- **Hausman Test**: To select between FEM and REM.
- **Lagrange Multiplier (LM) Test**: To select between CEM and REM.

Classical Assumption Tests To ensure the model's reliability, the following tests are conducted:

- **Multicollinearity Test**: Ensures no high linear correlation among independent variables (Basuki, 2014).
- **Heteroscedasticity Test**: Verifies that the residuals' variance remains constant across observations.

Model Fit Tests (Goodness of Fit) The model's suitability is tested through:

- **Coefficient of Determination (R^2)**: Measures how well the independent variables explain variations in the dependent variable.
- **F-Test**: Tests the simultaneous effect of independent variables on the dependent variable.
- **t-Test**: Tests the individual effect of each independent variable on the dependent variable.

Moderated Regression Analysis (MRA).

The inclusion of HDI as a moderating variable is grounded in its ability to encapsulate key dimensions of human well-being, such as education, health, and living standards. As demonstrated by Tlemsani et al. (2023), HDI improvements can significantly mediate the effects of socio-economic factors like poverty and unemployment on income inequality, promoting more inclusive development. By leveraging HDI in the moderated regression analysis, this study extends the existing body of work by examining its interactive effects within North Sumatra's unique socio-economic context. The study employs MRA to examine HDI's role as a moderating variable. The MRA model is:

$$Y = \alpha + b_1X_1 + b_2X_2 + b_3X_3 + b_4Z + b_5X_1Z + b_6X_2Z + b_7X_3Z + e$$

The regression equation incorporates interaction terms between HDI and other independent variables to capture the moderating effects on income inequality. This approach builds on methodologies discussed by Ghozali (2016) who employed moderation analysis to explore the interplay between environmental and socio-economic factors on HDI outcomes.

Where:

Y = Income Inequality (Gini Ratio)
α = Constant
b_1 = Regression coefficient for X1
b_2 = Regression coefficient for X2
b_3 = Regression coefficient for X3
b_4 = Regression coefficient for the interaction of HDI with X1, X2 dan X3
X_1 = Economic Growth
X_2 = Poverty
X_3 = Unemployment
Z = Human Development Index (HDI)

This method enables researchers to assess how HDI strengthens or weakens the effects of economic growth, poverty, and unemployment on income inequality.

III. RESULTS AND DISCUSSION

3.1 Results

Descriptive Statistics of Research Variables

This study uses five variables: Income Inequality (Y), Economic Growth (X1), Poverty (X2), Unemployment (X3), and Human Development Index (HDI) (Z) as a moderating variable. Descriptive statistics are used to provide an overview of the characteristics of the research data.

Table 1. Descriptive Statistics of Research Variables

Variable	N	Minimum	Maximum	Mean	Standard

					Deviation
Gini Ratio (Y)	165	0.194	0.402	0.272	0.045
Economic Growth (X1)	165	-1.98	6.05	3.42	1.89
Poverty (X2)	165	3.44	26.42	9.18	4.92
Unemployment (X3)	165	0.19	11.50	5.42	2.78
Human Development Index (HDI) (Z)	165	61.14	82.19	71.04	5.14

Based on Table 1, the Gini Ratio (Y) has an average value of 0.272, with a minimum value of 0.194 and a maximum value of 0.402, indicating the variation in income inequality levels across districts/cities in North Sumatra. The Economic Growth (X1) variable shows an average of 3.42%, with a minimum of -1.98% and a maximum of 6.05%, where negative growth occurred at the start of the COVID-19 pandemic in 2020. The Poverty (X2) variable has an average of 9.18%, with a minimum of 3.44% and a maximum of 26.42%. The Unemployment Rate (X3) has an average of 5.42%, with a minimum of 0.19% and a maximum of 11.50%, while the Human Development Index (HDI) (Z) has an average of 71.04, with a minimum of 61.14 and a maximum of 82.19.

Panel Data Regression Analysis

The Fixed Effect Model (FEM) was selected based on the results of the Chow and Hausman tests, confirming its suitability for this study. FEM effectively controls for unobserved heterogeneity that is unique to each district, ensuring robust estimation of the relationship between income inequality and socio-economic factors. This approach aligns with methodologies highlighted by Pinar et al. (2022), who demonstrate the utility of FEM in analyzing HDI's role in moderating economic and institutional impacts on inequality.

Selection of Panel Data Regression Model

Panel data is a combination of time-series and cross-sectional data. According to Gujarati (2003), panel data has advantages over cross-section or time-series data when used separately. This study begins by testing three regression models: Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). The selection of the best model is done through three testing phases:

1. **Chow Test**: To choose between CEM and FEM.
2. **Hausman Test**: To choose between FEM and REM.
3. **Lagrange Multiplier (LM) Test**: To choose between CEM and REM.

Table 2. Results of Chow, Hausman, and Lagrange Multiplier Tests

Test	p-value	Conclusion
Chow Test	0.00	Fixed Effect Model
Hausman Test	0.00	Fixed Effect Model
Lagrange Multiplier Test	-	Not Conducted

The Chow Test indicates a p-value of 0.00, which is less than α (0.05), so H0 is rejected and H1 is accepted. Therefore, the selected model is the Fixed Effect Model (FEM). The

Hausman Test is then performed to determine whether FEM or REM is more appropriate. The p-value for the Hausman Test is 0.00, less than α (0.05), so H0 is rejected and H1 is accepted. Therefore, the model used in this study is the Fixed Effect Model (FEM).

Model Assumption Testing

The model assumption tests aim to ensure that the model meets the BLUE (Best Linear Unbiased Estimator) criteria. The assumption tests carried out in this study include:

1. **Multicollinearity Test**
2. **Heteroscedasticity Test**

Multicollinearity Test

The multicollinearity test is used to ensure that there is no perfect linear relationship between the independent variables. The multicollinearity test results are presented in Table 3.

Table 3. Multicollinearity Test Results

Variable	PE	KN	PR	HDI
PE	1.00	-0.09	-0.16	0.04
KN	-0.09	1.00	-0.10	-0.27
PR	-0.16	-0.10	1.00	0.47
HDI	0.04	-0.27	0.47	1.00

The correlation coefficients between the independent variables are all below 0.85, indicating that multicollinearity does not exist among the independent variables.

Heteroscedasticity Test

The heteroscedasticity test is used to ensure that the variance of the error term is constant. This study employs the Breusch-Pagan Godfrey test.

Table 4. Heteroscedasticity Test Results

Test	p-value
Obs*R-Squared	0.309

Since the p-value is greater than α (0.05), it is concluded that the regression model does not contain symptoms of heteroscedasticity.

Goodness of Fit and Regression Results

Table 5. Panel Data Regression Results (FEM)

Variable	Coefficient	p-value
Constant	1.042040	0.000
Economic Growth (X1)	0.080001	0.401
Poverty (X2)	0.001239	0.030
Unemployment (X3)	0.001770	0.047
Human Development Index (X4)	-0.010909	0.000

$$Y = 1{,}042040 + b + 0{,}080001X1 + 0{,}001239X2 + 0{,}001770X3 - 0{,}010909X4$$

Adjusted R^2: 0.759
F-statistic: 33.872 (p = 0.000)
The results show that the independent variables of poverty, unemployment, and HDI have significant effects on income inequality, while economic growth does not. Specifically:

- **Poverty** (X2) has a positive and significant effect on income inequality (p = 0.030), meaning that higher poverty rates lead to increased inequality.
- **Unemployment** (X3) has a positive and significant effect on income inequality (p = 0.047), indicating that higher unemployment rates increase income inequality.
- **HDI** (X4) has a negative and significant effect on income inequality (p = 0.000), implying that improvements in education, health, and living standards reduce income inequality.
- **Economic Growth** (X1) does not have a significant effect on income inequality (p = 0.401), indicating that economic growth alone does not affect income inequality.

3.2 Discussion

The Effect of Economic Growth on Income Inequality

The Effect of Economic Growth on Income Inequality
The analysis reveals that economic growth does not significantly impact income inequality (p = 0.401). This finding highlights that economic benefits are unevenly distributed across societal groups, with higher-income sectors often reaping the majority of growth benefits. Policies focusing on equitable income distribution mechanisms, such as supporting MSMEs and rural development programs, are crucial to ensuring growth reaches lower-income populations.
The insignificance of economic growth on income inequality may be due to the unequal distribution of the benefits of economic growth across all segments of society. This situation aligns with the "trickle-down effect" theory, which suggests that the benefits of economic growth are initially enjoyed by the middle and upper classes before trickling down to the lower classes. However, if the distribution mechanism does not function properly, economic growth will not have a significant impact on income inequality. Furthermore, growth in North Sumatra appears driven by industrial and financial sectors that often exclude lower-income groups, further exacerbating disparities. This aligns with findings by Anderson and Hao (2022), who highlight that economic growth alone cannot bridge income inequality without inclusive institutional frameworks.
These findings challenge traditional economic theories, such as Kuznets' curve, which assumes that growth will inherently reduce inequality over time. Instead, targeted policies that ensure inclusive benefits from growth are necessary. Examples include job creation in informal and rural sectors, as noted by Kamaruddin and Rogers (2020), to address sectoral imbalances and empower lower-income groups. Strengthening

redistribution mechanisms through MSMEs and social welfare programs will be essential for ensuring equitable economic outcomes.

The Effect of Poverty on Income Inequality

Based on the regression results, poverty has a positive and significant effect on income inequality, with a coefficient of 0.001239 and a probability value of 0.030. This indicates that as poverty increases, income inequality also worsens. Poverty limits access to education, healthcare, and decent jobs, which diminishes human capital development and perpetuates income disparities.

Communities in poverty often lack purchasing power, disrupting local economic cycles and further exacerbating inequalities between urban and rural areas. This finding aligns with studies by Febrianti and Indriyati (2020), who found that poverty in Southeast Asia significantly hinders equitable development through constrained access to resources. Therefore, poverty alleviation strategies must include expanding social protection programs, improving access to education and healthcare, and fostering community economic empowerment.

The Effect of Unemployment on Income Inequality

The regression results reveal a positive and significant relationship between unemployment and income inequality (coefficient = 0.001770, p = 0.047). Higher unemployment exacerbates disparities between employed and unemployed populations, increasing welfare inequality. People without access to stable jobs often resort to low-income informal sector activities, which widens the income gap relative to individuals in higher-paying formal sector roles.

This finding is consistent with studies by Masruri (2016) and Yusica (2018), which emphasize the disproportionate impact of unemployment on vulnerable populations. Additionally, low-quality human resources due to limited education or skills training exacerbates this issue. Addressing unemployment requires targeted initiatives such as workforce training programs, MSME development, and incentives for industries that provide stable employment for low-skilled workers.

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

HDI has a significant negative effect on income inequality (p = 0.000), highlighting its role in promoting equitable income distribution. Investments in HDI components such as education, healthcare, and living standards enable individuals to access better job opportunities and higher incomes. This reduces disparities and fosters a more inclusive economy.

The moderating effect of HDI also aligns with findings by Pinar et al. (2022), who emphasize its importance in mitigating socio-economic disparities. An improved HDI promotes productivity and innovation, particularly in regions with higher educational attainment, which supports more productive and equitable sectors. These findings are supported by Becker's (1964) Human Capital Theory, which posits that enhanced human resources contribute to reduced income inequality.

This study aligns with the works of Tlemsani et al. (2023) and Noorachmadan (2024), which highlight the multidimensional role of HDI in fostering equitable growth.

Policymakers should prioritize HDI-centered strategies to ensure long-term economic inclusivity, emphasizing investments in education and healthcare systems while promoting community-based job opportunities.

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IV. Conclusion and Recommendations

This study underscores that while economic growth in North Sumatra has not significantly influenced income inequality, improving HDI can effectively reduce it. Policies aimed at enhancing education, healthcare, and social welfare are critical in addressing poverty and unemployment, the primary drivers of inequality. Inclusive economic development strategies, such as expanding access to quality jobs and promoting MSMEs, are recommended to ensure that growth benefits all societal groups.

To reduce income inequality in North Sumatra, it is recommended that the local and central governments improve access to education and the quality of healthcare services to strengthen the Human Development Index (HDI). Governments also need to promote policies to reduce unemployment through the creation of new job opportunities, skills training programs, and the development of MSMEs. Additionally, poverty reduction efforts can be achieved through the strengthening of social protection programs, direct cash assistance (BLT), and the development of labor-intensive projects in rural areas. Inclusive economic policies are also needed to ensure that economic growth benefits all segments of society, especially the poor and vulnerable groups.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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