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Economic Growth as a Moderator in the Nexus between Public Finance, Human Development, and Income Inequality in Aceh

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Abstract

Income inequality continues to pose a significant economic challenge in Indonesia, particularly at the regional level. Although economic growth is regarded as a pathway to improved public welfare, it can either alleviate or exacerbate existing income disparities. This study investigates the moderating role of economic growth in the relationship between public finance, human development, and income inequality, using panel data from 23 districts and cities in Aceh Province over the period 2017-2023. Employing panel data regression with the Moderated Regression Analysis (MRA) technique, the analysis focuses on three key independent variables: local tax revenue, village funds, and the Human Development Index (HDI). The results show that local tax revenue is positively associated with income inequality, while village funds have no statistically significant effect. The HDI, on the other hand, is significantly and negatively associated with inequality. However, economic growth does not moderate the effects of local tax revenue or village funds on income inequality. Notably, it does moderate the relationship between HDI and inequality, with the effect of HDI turning positive when interacted with economic growth. These findings highlight the need for local governments to prioritize inclusive development through strengthened fiscal management, more targeted village fund allocations, and sustained investment in human capital.

Introduction

Income inequality remains a central concern for the Indonesian government, as it does for governments around the world, both in developed and developing countries. The issue is complex and persistent, and it often intensifies alongside economic growth. As the economy expands, the benefits are not always evenly distributed, which can lead to a widening gap between high- and low-income groups [1,2]. Per capita income, commonly measured by dividing gross domestic product (GDP) by the total population, is often used as a proxy for welfare, but it tends to mask disparities in income distribution. Febriana & Ariani [3] highlights that development imbalances are particularly pronounced in the South-West and Central-South regions of Indonesia, due in part to geographical constraints. The classic Kuznets hypothesis further suggests that in the early stages of development, economic growth may worsen inequality, which may decline only as the economy becomes more mature [4,5].

Disparities in income are driven by several structural factors, including demographic composition, geographic isolation, uneven distribution of natural resources, and variations in regional economic capacity. As Chayyani [6] emphasizes, Indonesia's diverse geography and social structure pose challenges for achieving equitable development. Regional inequalities have therefore become a key focus in both governmental and societal agendas. Empirical findings from Ridho & Wijayanti [7] show that local tax revenues can enhance regional investment, stimulate growth, and reduce inequality by expanding employment opportunities.

The findings from another study indicate that GDP per capita initially increases income inequality, consistent with the Kuznets Curve hypothesis, although this effect tends to diminish as the economy reaches a more advanced stage of development [8]. Additionally, the results show that both gross and net capital flows have a positive impact on income inequality in emerging market economies, whereas the effect is not statistically significant in advanced economies [9].

Despite these potential benefits, recent data from the Statistics Indonesia indicate a rise in income inequality, with the Gini ratio increasing from 0.402 in 2022 to 0.409 in 2023. This trend suggests that high economic growth in certain areas has not been accompanied by proportional improvements in income distribution. As Rambe & Febriani [10] observes, Indonesia continues to face persistent income inequality, especially between affluent and low-income populations. Aceh Province demonstrates a particularly high inequality rate compared to the national average, reinforcing the need for tailored regional policy interventions.

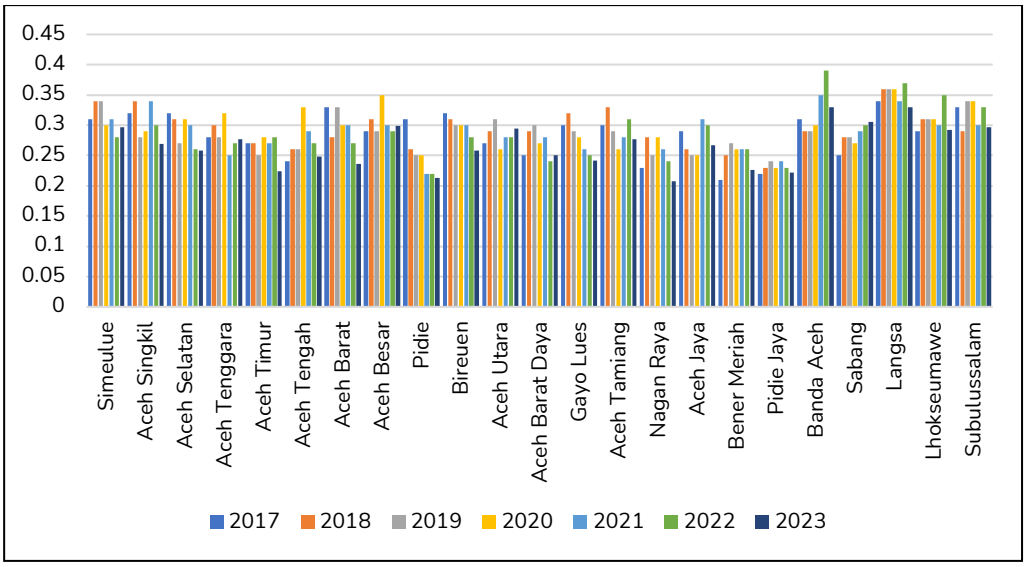

Figure 1. Gini Ratio of Aceh Province 2017-2023 Percent (Source: Statistics Aceh Province [11])

Figure 1 shows that income inequality in Aceh Province fluctuated from 2017 to 2023, as reflected in the varying Gini ratios across districts and cities. Most regions exhibit Gini ratios between 0.25 and 0.35, with some areas maintaining relative stability and others showing notable volatility. Urban areas such as Banda Aceh consistently record higher inequality levels, with Gini ratios approaching or exceeding 0.35 in 2020 and 2021, followed by Lhokseumawe and Langsa. In contrast, rural districts like Pidie and Pidie Jaya report lower inequality levels. This disparity suggests that economic development in Aceh has not been evenly distributed across regions. Despite receiving Special Autonomy Fund allocations from the central government intended to reduce such disparities, the uneven development pattern remains evident. While economic growth signals an improvement in overall welfare, Aceh's growth rate remains below the national average, highlighting the need for more effective and equitable development strategies.

Figure 2 illustrates the variation in economic growth across districts and cities in Aceh Province from 2017 to 2023. Most regions experienced positive growth throughout the period, with the exception of 2020 when the COVID-19 pandemic led to economic contractions in areas such as Banda Aceh, Lhokseumawe, and Sabang. Notably, Aceh Barat recorded a sharp growth surge of approximately 10 to 13 percent in 2017-2018, likely driven by large-scale projects or a temporary boom in local commodities. In 2023, Nagan Raya posted the highest growth rate at 6.83 percent, while East Aceh recorded the lowest at 2.09 percent. Overall, the growth trajectory has remained relatively stable, reflecting a pattern of modest but steady economic

expansion. However, Aceh's growth continues to lag behind the national average, pointing to structural limitations that may require targeted policy interventions.

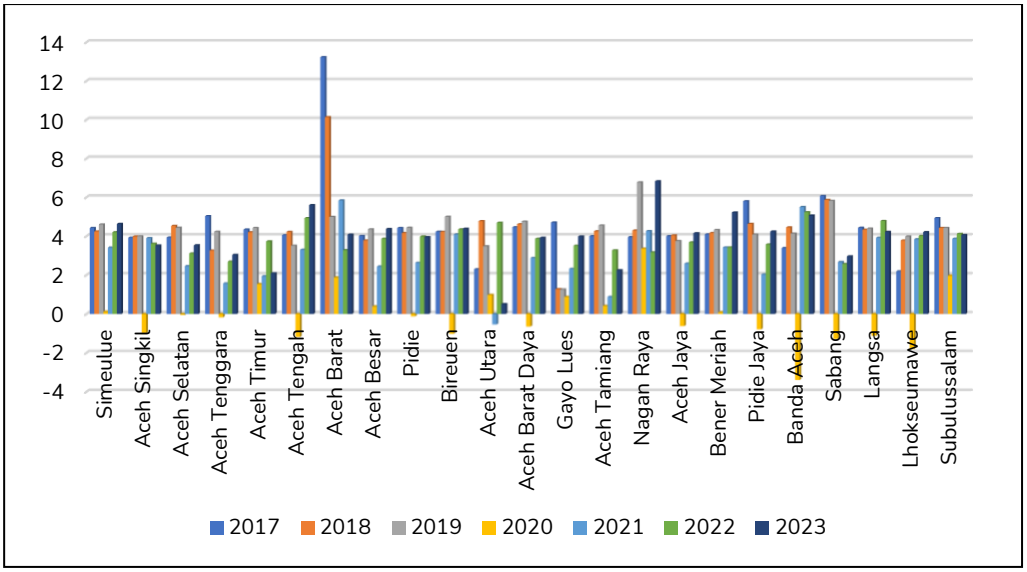

Figure 2. Gross Regional Domestic Product Per Capita at Constant Prices of Aceh Province 2017-2023 Percent (Source: Statistics Aceh Province [12])

According to Kuznets' theory, income distribution tends to worsen in the early stages of economic growth but improves as development progresses. This relationship is illustrated by the Kuznets curve, which takes the form of an inverted U and reflects the structural transformation from traditional to modern economic sectors [13,14]. As the economy grows and the modern sector expands, income inequality initially rises before declining in later stages [15]. In addition to Kuznets' framework, this study draws on several other theoretical perspectives. Kaasa [16] highlights the role of government transfers, such as village funds, in influencing inequality. If such funds are not allocated effectively and equitably, they may fail to achieve their redistributive goals. The vicious circle of poverty further explains that poverty and inequality are interlinked in a self-reinforcing cycle, where low income leads to low investment in human capital and infrastructure, thereby perpetuating underdevelopment and continued inequality [17,18]. Bajja et al. [19] finds that technological innovation and urbanization contribute to economic growth while simultaneously creating employment opportunities.

Economic growth serves a critical role in moderating the relationship between various determinants of income inequality. Consistent with the Kuznets hypothesis, inequality tends to rise during the early stages of development but may decline as economies advance and structural transformations take hold. In the case of Aceh, however, economic growth remains uneven and heavily reliant on low-productivity primary sectors such as agriculture and fisheries. This sectoral dependence limits the capacity of growth to deliver broad-based benefits, leading to unequal outcomes across segments of society. To address these disparities, the government promotes sustainable development policies aimed at enhancing overall welfare and reducing income gaps. Development financing is primarily facilitated through the national and regional budgets (APBN and APBD), with local tax revenue serving as a key fiscal instrument to mobilize domestic resources in support of region-specific development priorities. Heterogeneity analysis reveals that the digital economy's positive effect on regional tax revenues varies significantly across three dimensions: innovation capacity, types of taxes, and the timing of policy implementation [20].

Taxes are an essential policy instrument for supporting regional economic development. According to Law Number 34 of 2000 concerning Regional Taxes and Levies, as amended by Law Number 28 of 2009, local taxes are defined as mandatory contributions to regional

governments, owed by individuals or entities under legal obligation, without direct compensation, and allocated for the greatest welfare of the people. In both the short and long term, taxes have a measurable impact on economic growth [21]. Data on Aceh's local tax revenue between 2017 and 2023 highlight significant disparities across districts. Although tax revenue generally increased over the period, the distribution remains highly uneven. Banda Aceh recorded the highest and most stable revenue, reaching 104.64 billion rupiah in 2023, followed by Aceh Besar with 95.44 billion. In contrast, Bener Meriah, Sabang, and Subulussalam reported the lowest local tax revenues, with 6.26 billion, 6.25 billion, and 5.86 billion respectively [22]. Toussaint et al. [23] find that while the current generation benefits from an average income tax reduction of 47 percent, the resulting decline in tax revenue disproportionately burdens future generations.

This gap underscores structural challenges in maximizing local tax potential, which may stem from regional dependence on narrow economic sectors, limited diversification, or underdeveloped tax administration systems. From a policy perspective, these disparities highlight the urgency of implementing fiscal reforms aimed at broadening the tax base, enhancing tax collection efficiency, and strengthening financial governance. Such reforms are crucial not only to boost regional revenue capacity but also to promote fiscal autonomy and reduce reliance on transfers from the central government. A simpler and more proportional tax system, one that is easier for the general public to understand, with transparent redistribution mechanisms and efficient enforcement, can significantly enhance overall tax morale [24]. In addition, Lartey [25] finds that non-resource tax revenues tend to rise both in the period following resource discovery and after the commencement of production.

One form of government support for rural development was the enactment of Law No. 6 of 2014 on Villages. This law introduced the Village Fund program, launched in 2015, as a mechanism to reduce inequality by increasing village-level fiscal capacity. The Village Fund is sourced from the State Budget (APBN) and is intended to finance rural development, community empowerment, and efforts to address socioeconomic disparities (Ministry of Finance, 2019). Hilmawan et al. [26] state that village funds have a positive and significant impact on rural development, as measured by the Village Development Index. Priority is given to funding locally tailored programs that aim to improve rural welfare, enhance quality of life, and reduce poverty. These funds are directed toward initiatives in community empowerment based on each village's specific needs and potential, aligned with the Village Medium-Term Development Plan (RPJMDes) and the Village Government Work Plan (RKPDes). The fund also supports the development of local economic potential to foster entrepreneurship, raise household income, and expand rural economic activity. Over the past seven years, the distribution of village funds across districts and cities in Aceh has generally corresponded to the number of villages within each region. North Aceh District consistently received the highest allocation, reaching 639.06 billion rupiah in 2023, followed by Bireuen, Pidie, Aceh Besar, and East Aceh, each receiving between 450 and 550 billion annually. The lowest allocations were recorded in Sabang, Banda Aceh, Langsa, and Lhokseumawe, areas with relatively few villages [22]. Smas et al. [27] show that Village Funds significantly contribute to reducing extreme poverty by enhancing access to basic services and promoting community economic empowerment.

Many government funds, including the Special Autonomy Fund, are often not managed effectively. A large portion of these funds is allocated to major infrastructure projects that have limited direct impact on poverty alleviation or the reduction of inequality [28,29]. Watts et al. [30] argue that additional funding should be allocated alongside the existing Village Fund and may be sourced from separate mechanisms, including REDD+ funds. This approach differs from other proposed fiscal transfers between local governments. Government spending tends to concentrate in urban centers such as Banda Aceh, while remote and inland areas receive significantly smaller allocations. Moreover, numerous reports highlight issues such as project

delays and substandard implementation, which diminish the intended benefits of public investment. Another key factor influencing income inequality is the Human Development Index (HDI), which reflects the overall standard of living through indicators of education, health, and income. Regional disparities in HDI contribute to differences in labor productivity and, by extension, income levels. Lower HDI scores are typically associated with lower productivity and limited economic opportunities. Conversely, improvements in HDI can enhance community productivity and drive increases in household income. However, because HDI levels vary widely across regions, these differences continue to contribute to spatial income inequality.

Indonesia's Human Development Index (HDI) has shown a consistent upward trend from 2017 to 2023. Within Aceh Province, Banda Aceh consistently recorded the highest HDI, approaching 90 points, which places it in the high category at the national level. This is expected given its status as the provincial capital. Other areas with relatively high HDI scores include Langsa, Lhokseumawe, East Aceh, and Aceh Besar, each ranging between 70 and 75 points. In contrast, districts such as Aceh Singkil, Gayo Lues, and Subulussalam reported the lowest HDI levels, falling between 65 and 68 points [31]. These figures reflect broader national progress in human development, particularly in education, health, and living standards, with growth remaining relatively stable across years. Dey et al. [32] state that the proportion of the population in the lowest social class and the level of urbanization are key factors influencing regional patterns of human development. Although Aceh's HDI remained slightly below the national average, the trajectory of improvement mirrored national trends, indicating that human development efforts in the province have broadly aligned with national progress, despite regional differences in outcomes.

Sulistyaningrum [33] found that the Human Development Index (HDI) has a negative and significant effect on income inequality. Nasution [34] shows that government spending is positively correlated with inequality, based on an analysis using the Williamson index. Sanjaya & Anis [35] emphasize the fiscal linkage between tax revenue and government spending, where public funds collected through taxation are directly used to implement government programs. Similarly, Rambe & Febriani [10] found that both government spending and tax revenues have a significant positive effect on economic growth. Roy et al. [36] further support the view that local taxes are instrumental in boosting local investment, promoting economic growth, and expanding employment opportunities.

Sarkodie & Adams [37] argue that effective labor market promotion and stronger socioeconomic capacity to address unemployment and disability can reduce income inequality and promote human development. Mwakalila & Muba [38] find that improved access to finance enhances the HDI by enabling individuals to invest in education, health, and productive economic activities, ultimately reducing poverty. Cerqueira-Silva et al. [39] state that women who migrate to cities with higher HDI typically experience worse socioeconomic conditions prior to migration compared to those who move to cities with lower HDI or remain non-migrants. Anwar & Sun [40] show that income inequality and related factors have asymmetric effects on the energy rebound effect. Karim et al. [41] report that the Village Fund was instrumental in meeting community economic needs during the COVID-19 pandemic.

This study offers several important contributions to the literature. First, it simultaneously examines the effects of local tax revenue, village funds, and the Human Development Index on income inequality within the context of Aceh Province, which operates under Special Autonomy status. Second, by introducing economic growth as a moderating variable, the study adopts a more comprehensive analytical framework that captures the dynamic interactions between development indicators and inequality. Third, the research is situated within the broader context of fiscal decentralization and the expanded allocation of Village Funds following the implementation of special autonomy, an area that remains underexplored in empirical studies on Aceh. As such, this study aims to provide a more contextualized and analytical understanding

of income inequality, with findings that can inform more equitable and pro-people policy interventions.

Materials and Methods

This study uses secondary data in the form of panel data covering the period from 2017 to 2023 across 23 districts and cities in Aceh Province. The dataset includes variables such as local tax revenue, village funds, the Human Development Index (HDI), and Gross Regional Domestic Product (GRDP) at constant 2010 prices. The data were obtained from the Statistics Aceh Province (BPS Aceh) [11,12,31] and the Ministry of Finance [22]. The analysis involves five variables: three independent variables: local taxes (PD), village funds (DS), and HDI, one dependent variable: income inequality (GR), and one moderating variable: economic growth (PE).

Table 1. Operational definition of variables.

Status	Variable (Symbol)	Measurement Unit	Data Source
Dependent	Income Inequality (GR)	Percent	Statistics Aceh Province
Independent	Local Tax (PD)	Billion Rupiah	Ministry of Finance
	Village Fund (DS)	Billion Rupiah	Ministry of Finance
	Human Development Index (HDI)	Points	Statistics Aceh Province
Moderation	Economic Growth (PE)	Percent	Statistics Aceh Province

Methods

This study employs two main analytical techniques: panel data regression and Moderated Regression Analysis (MRA). The panel data regression is used to assess the effect of each independent variable on income inequality, while MRA is applied to examine whether economic growth moderates these relationships. Prior to the regression analysis, classical assumption tests, such as tests for multicollinearity and heteroscedasticity, are conducted to ensure the validity and reliability of the model. The data are processed using statistical software to generate accurate and robust findings relevant to income inequality in Aceh Province.

Panel data regression is selected for its ability to capture heterogeneity across districts and cities in Aceh Province while also controlling for unobserved factors that may influence income inequality. This method enables a more reliable estimation of the effects of local tax revenue, village funds, and the Human Development Index on inequality, and it facilitates the assessment of economic growth as a moderating variable. The model selection process involves comparing the Fixed Effect Model (FEM) and the Random Effect Model (REM), with the Hausman test applied to determine the most appropriate specification. Panel data, also known as longitudinal data, combine cross-sectional observations, data collected from multiple units at a single point in time, with time series data, which track the same units over multiple periods [42]. This structure allows for a more dynamic and comprehensive analysis of socio-economic phenomena by simultaneously capturing both temporal changes and inter-regional differences.

The MRA framework is used to test whether economic growth functions as a moderating variable in the relationship between local taxes, village funds, and the Human Development Index with income inequality [43,44]. This is done by introducing interaction terms between each independent variable and economic growth. The general specification of the panel data regression model is presented as follows:

$$GR_{it} = \beta_0 + \beta_1 PD_{it} + \beta_2 DS_{it} + \beta_3 HDI_{it} + \varepsilon_{it} \quad (1)$$

$$GR_{it} = \beta_0 + \beta_1 PD_{it} + \beta_2 DS_{it} + \beta_3 HDI_{it} + \beta_4 PE_{it} + \beta_5 PD \times PE_{it} + \beta_6 DS \times PE_{it} + \beta_7 HDI \times PE_{it} + \varepsilon_{it} \quad (2)$$

Where, GR represents income inequality (Gini ratio), β_0 is the constant, β_1 to β_7 is the regression coefficient, PD denotes local tax, DS refers to village fund, HDI is the Human Development Index, PE represents economic growth, ε is the error term, i is the cross-sectional unit, and t is the time period.

Results and Discussion

Descriptive Statistics

Based on Table 2, the descriptive statistics are derived from 161 observations for each variable, covering districts and cities in Aceh Province from 2017 to 2023. The average value of income inequality, measured by the Gini ratio, is 0.28, with a maximum of 0.39 and a minimum of 0.20, indicating considerable variation across regions. The average value of local tax revenue is 2.08 billion rupiah, ranging from 1.14 billion to 3.62 billion. Aceh Besar recorded the highest average local tax allocation at 90.25 billion, while Bener Meriah had the lowest at 5.45 billion. The average value of village funds is 2.1 billion rupiah, with the highest allocation at 6.39 billion and the lowest at 1.42 billion. North Aceh received the largest village fund allocation at 617 billion, while Sabang received the smallest at 19 billion. The Human Development Index (HDI) averaged 71.23 points over the seven-year period, with a maximum of 86.69 and a minimum of 62.88; Banda Aceh recorded the highest HDI. The moderating variable, economic growth, had an average rate of 3.43 percent, with a maximum value of 13.2 percent and a minimum of -3.39 percent.

Table 2. Descriptive statistics.

Statistic	GR	PD	DS	HDI	PE
Mean	0.2856	2.08E+10	2.10E+11	71.237	3.4362
Median	0.2900	1.32E+10	1.66E+11	70.360	3.9800
Max.	0.3900	1.14E+11	6.39E+11	86.690	13.230
Min.	0.2074	3.62E+09	1.42E+10	62.880	-3.3900
Obs.	161	161	161	161	161

Panel Model Selection

The Chow test is used to determine the more suitable model between the Common Effect Model (CEM) and the Fixed Effect Model (FEM) for panel data estimation. Based on Table 3, the model 1 probability value of the cross-section Chi-square is 0.000, which is below the 5 percent significance level (α = 0.05), indicating that the null hypothesis is rejected and FEM is preferred over CEM. The Hausman test further evaluates the selection between FEM and the Random Effect Model (REM). The probability value is 0.005, also below 0.05, leading to the rejection of the null hypothesis and confirming FEM as the more appropriate model. However, model 2 presents different results. While the Chow test again favors FEM over CEM (probability = 0.000 < 0.05), the Hausman test indicates that REM is more appropriate, with a probability value of 0.0982, exceeding the 5 percent threshold. Additionally, the Lagrange Multiplier test supports the REM over the CEM, as the probability value (0.000) is below 0.05.

Table 3. Results of Chow, Hausman, and Lagrange multiplier tests.

Model	Test	Effects Test	Statistic	d.f.	Prob.	Conclusion
Model 1	Chow Test	Cross-section F	7.8191	(22,135)	0.0000	FEM
		Cross-section Chi-square	132.28	22	0.0000	
	Hausman Test	Cross-section random	7.6692	3	0.0053	FEM

Model	Test	Effects Test	Statistic	d.f.	Prob.	Conclusion
Model 2	Chow Test	Cross-section F	7.8111	(22,134)	0.0000	FEM
		Cross-section Chi-square	132.86	22	0.0000	
	Hausman Test	Cross-section random	7.826157	4	0.0982	REM
	Lagrange Multiplier Test	Breusch-Pagan	73.78438	n/a	0.0000	REM

Note: 'n/a' indicates not applicable.

Classical Assumption Tests

This study applies classical assumption tests, specifically the multicollinearity and heteroscedasticity tests. A normality test is not required, as both the Fixed Effect Model (FEM) and Random Effect Model (REM) are capable of producing consistent estimates even when the error terms are not normally distributed, particularly in large samples. Autocorrelation is also less relevant in this context, as the panel data used are more cross-sectional in nature than time-series.

To detect the presence of multicollinearity, the analysis examines the magnitude of the correlation coefficients between independent variables. Multicollinearity is considered to exist if the pairwise correlation coefficient between any two variables exceeds 0.80. Conversely, if all correlation values remain below this threshold, the model is deemed free from multicollinearity. As shown in Table 4, all pairwise correlation coefficients among the independent variables are below 0.80, indicating no signs of high multicollinearity in the model.

Table 4. Multicollinearity test results.

Independent Variable	PD	DS	HDI	PE	PD×PE	DS×PE	HDI×PE
PD	1						
DS	0.299	1					
HDI	0.554	-0.169	1				
PE	0.007	-0.076	-0.010	1			
PD×PE	0.746	0.171	0.438	0.485	1		
DS×PE	0.217	0.666	-0.123	0.546	0.430	1	
HDI×PE	0.068	-0.090	0.098	0.091	0.551	0.522	1

Based on the heteroscedasticity test results shown in Table 5, all variables have probability values above the 0.05 significance level, indicating the absence of heteroscedasticity. This suggests that the variance of the residuals is constant and randomly distributed, which supports the reliability of coefficient estimates and the validity of hypothesis testing.

Table 5. Heteroscedasticity test results.

Model	Variable	Coef.	Std. Er.	t-stat.	Prob.
Model I	PD	6.16E-05	0.000173	0.355636	0.7227
	DS	9.52E-05	9.65E-05	0.986642	0.3256
	HDI	-0.000264	0.001120	-0.236097	0.8137
Model II	PD	3.50E-05	0.000123	0.284274	0.7766
	DS	-4.59E-06	1.46E-05	-0.314699	0.7534
	HDI	-0.000562	0.000612	-0.917497	0.3603
	PE	-0.013711	0.011215	-1.222561	0.2234
	PD×PE	1.65E-06	3.28E-05	0.050208	0.6600
	DS×PE	-4.81E-07	3.99E-06	-0.120464	0.7043
	HDI×PE	0.000194	0.000157	1.240102	0.2168

The Results of Panel Data Regression (Model 1)

The panel data regression results for Model 1, as presented in Table 6, indicate that local taxes (PD) have a significant positive effect on income inequality in Aceh Province. The t-statistic value

of 2.731980 exceeds the critical value, and the corresponding probability of 0.0071 is below the 5 percent significance level, confirming the variable's statistical significance. The coefficient for the village fund variable (DS) is -9.68E-06, suggesting a potential reduction in income inequality with a 1 percent increase in village funds. However, the t-statistic of -0.055969 and probability of 0.9554 indicate that this effect is statistically insignificant. The Human Development Index (HDI) has a coefficient of -0.007416, meaning a 1 percent increase in HDI is associated with a 0.007 percent decrease in income inequality. With a t-statistic of -3.694352 and a probability of 0.0003, the HDI effect is both negative and statistically significant.

Furthermore, the joint effect of PD, DS, and HDI on income inequality is statistically significant, as reflected in the F-statistic value of 9.734 and its corresponding probability of 0.000, which is well below the 5 percent threshold. The R-squared value of 0.643 indicates that 64.3 percent of the variation in income inequality is explained by the model, while the remaining 35.7 percent is attributed to other unobserved factors. The Adjusted R-squared value of 0.577 further supports the robustness of the model after adjusting for the number of predictors.

Table 6. Panel Data Regression results for model 1.

Variable	Coef.	Std. Er.	t-stat.	Prob.
C	0.7983***	0.1388	5.7514	0.0000
PD	0.0008***	0.0003	2.7319	0.0071
DS	-9.68E-06	0.0002	-0.0559	0.9554
HDI	-0.0074***	0.0020	-3.6944	0.0003
R-squared	0.6432			
Adj. R-squared	0.5771			
F-stat.	9.7343			
F-stat. (Prob.)	0.0000***			

Note: *** indicates significant level at 1%.

The Results of Moderated Regression Analysis (Model 2)

The Moderated Regression Analysis results for model 2 presented in Table 7 show that local taxes (PD) and the Human Development Index (HDI) continue to have statistically significant effects on income inequality, with positive and negative coefficients, respectively. In addition, economic growth (PE) itself has a significant but negative direct effect on income inequality. Regarding moderation effects, the interaction term PD×PE has a coefficient of -2.29E-05 with a probability value of 0.14 (> 0.05), indicating that economic growth does not significantly moderate the effect of local taxes on income inequality. Similarly, the interaction term DS×PE has a coefficient of 8.18E-07 with a probability of 0.75 (> 0.05), showing that economic growth does not significantly moderate the relationship between village funds and income inequality. However, the interaction term HDI×PE has a coefficient close to zero but a probability value of 0.0017 (< 0.05), suggesting that the interaction between HDI and economic growth has a statistically significant positive effect on income inequality in Aceh Province.

In terms of overall model fit, the F-statistic value of 10.148 with a Prob. of 0.00 is well below the 5 percent significance level, indicating that the independent and interaction variables jointly have a significant effect on income inequality. The R-squared value of 0.6920 suggests that 69.2 percent of the variation in income inequality is explained by the model, while the remaining 30.8 percent is attributed to factors outside the model. The Adjusted R-squared value of 0.6238 represents an improvement over the previous model, indicating that including economic growth and interaction terms enhances the model's explanatory power. However, economic growth does not significantly moderate the effects of local taxes or village funds, and its moderating effect on HDI, while statistically significant, is minimal due to the very low coefficient value.

Table 7. Moderated Regression Analysis results for model 2.

Variable	Coef.	Std. Er.	t-stat.	Prob.
C	1.0092***	0.2443	4.1316	0.0001
PD	0.0014**	0.0006	2.3367	0.0210
DS	-5.05E-05	0.0002	-0.2659	0.7907
HDI	-0.0095***	0.0036	-2.6737	0.0085
PE	-0.0260***	0.0078	-3.3244	0.0011
PD×PE	-2.29E-05	1.55E-05	-1.4774	0.1420
DS×PE	8.18E-07	2.67E-06	0.3068	0.7595
HDI×PE	0.0003***	0.0001	3.2057	0.0017
R-squared	0.6920			
Adj. R-squared	0.6238			
F-stat.	10.148			
F-stat. (Prob.)	0.0000***			

Note: *** and ** indicate significant levels at 1% and 5%, respectively.

Discussion

In Model 1, local tax revenue (PD) has a positive and significant effect on income inequality in Aceh Province, with a coefficient of 0.000. This finding aligns with Eydam & Qualo [45], whose study in Germany confirmed a statistically significant negative relationship between personal income tax progressivity and income inequality. Similarly, Duncan & Sabirianova Peter [46] found that local taxes can significantly reduce income inequality. Drieandita & Santoso [47] shows that social assistance expenditure and local taxes have a negative and significant relationship with income inequality in Indonesia, both individually and jointly..

The Village Fund (DS) has a negative but statistically insignificant effect on income inequality, with a coefficient of -9.6. This implies that a 1 percent increase in the composition of village funds relative to regional income could reduce inequality by 9.6 points, although the relationship is not statistically significant. This finding is consistent with Salsabila & Arcana [48], who analyzed rural Indonesia from 2015-2022, as well as Yasni & Yulianto [49], both of whom reported similar trends in the redistributive role of village funds.

The Human Development Index (HDI) demonstrates a negative and significant effect on income inequality at the 1 percent significance level, with a coefficient of -0.007. This result supports Kusuma et al. [50], who found that HDI significantly influenced income inequality in Yogyakarta, and Lala et al. [51], who reported similar findings in North Sulawesi. The negative relationship suggests that improvements in HDI can contribute to reducing inequality, consistent with Asman et al. [52]. Farhan & Sugianto [53] also identify HDI as a key determinant of income inequality, while Randa [54] emphasizes the importance of equitable economic development to improve human development and reduce disparities.

In Model 2, using the Moderated Regression Analysis (MRA), the interaction between local tax revenue and economic growth (PD×PE) has no significant effect on income inequality in Aceh, as indicated by a probability value of 0.1420. This suggests that economic growth does not moderate the relationship between local taxes and income inequality. However, economic growth alone has a significant negative effect on income inequality at the 1 percent significance level, implying that it functions as a pure moderator variable. Similarly, the interaction between village funds and economic growth (DS×PE) also has no significant effect on income inequality, with a probability value of 0.7595. This finding suggests that economic growth does not moderate the relationship between village funds and inequality.

According to Kuznets' theory, inequality may initially rise during the early stages of growth but will eventually decline as income levels increase and human development improves. In this context, if economic growth strengthens the relationship between HDI and income inequality, it may suggest that a growing economy provides the conditions for improved income distribution

through better access to services and opportunities. Liyana et al. [55] found that economic growth moderates the influence of HDI and unemployment on poverty in Indonesia. The current study supports this claim, as the interaction term HDI×PE shows a significant positive effect on income inequality in Aceh, with a probability value of 0.0017. While HDI alone reduces inequality, the interaction suggests that higher economic growth in regions with higher HDI may initially exacerbate inequality, potentially due to unequal access to the benefits of growth. Nevertheless, economic growth continues to show a significant negative direct effect, confirming its role as a pure moderator in this study.

Conclusions

Based on the analysis of panel data from 2017 to 2023 across 23 districts and cities in Aceh Province, this study examined the effects of local tax revenue, village funds, and the Human Development Index (HDI) on income inequality, using economic growth as a moderating variable. Employing Panel Data Regression and Moderated Regression Analysis, the results indicate that local taxes have a positive and significant effect on income inequality, while village funds have a negative but statistically insignificant effect. The HDI shows a negative and significant relationship with income inequality, suggesting that improvements in human development contribute to reducing disparities. Economic growth does not moderate the effects of local taxes or village funds on inequality but does significantly moderate the relationship between HDI and income inequality in the province.

The Aceh Provincial Government is advised to implement more targeted and intensive policies to increase local tax revenues and ensure that village funds are allocated and utilized effectively and efficiently. Efforts should also be directed toward enhancing human development progress to support broader regional development goals. For future researchers examining similar issues, it is recommended to include additional variables not covered in this study to gain a more comprehensive understanding of the factors influencing income inequality and human development from alternative perspectives.

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