Determinants and Performance Mapping of Income Inequality Before and During Pandemic Covid-19 in Sumatra, Indonesia

(Penentu dan Pemetaan Prestasi Ketidaksamaan Pendapatan Sebelum dan Semasa Pandemik Covid-19 di Sumatera, Indonesia)

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ABSTRACT

This study aims to examine the determinants of income inequality and to map the performance of each province based on the interaction among variables before and during the Covid-19 pandemic. It employs panel data regression analysis and applies the IPA quadrant method for two observation periods, 2015-2019 and 2020-2022. Data were sourced from the Central Bureau of Statistics and the Ministry of Environment. The findings suggest that improvements in democracy, environmental quality, and real GRDP per capita can help reduce income inequality, whereas the industrial sector appears to exacerbate it. Real output per capita exerts the strongest influence in reducing inequality. The quadrant analysis results show that Aceh Province experienced worsening inequality performance compared to the pre-pandemic period, while inequality in other provinces has generally stabilised. No high-income province was found to have low inequality status. Democracy performance across Sumatera Island was more volatile. In the industrial sector, only North Sumatra recorded weaker performance. Careful fiscal, monetary, and microeconomic policy consideration are thus required, especially regarding real output per capita growth and industrial sector expansion to prevent further widening of the income gap.

Keywords: Income inequality; democracy; environmental; industry; importance performance analysis; pandemic covid-19

ABSTRAK

Kajian ini bertujuan untuk menilai penentu ketidaksamaan dan memetakan prestasi setiap wilayah terhadap interaksi antara pembolehubah sebelum dan semasa pandemik Covid-19. Kajian ini menggunakan kaedah analisis regresi data panel dan menggunakan kuadran daripada kaedah IPA dalam dua tempoh pemerhatian iaitu 2015-2019 dan 2020-2022. Data dari Biro Perangkaan Pusat dan Kementerian Alam Sekitar. Kajian menunjukkan bahawa penambahbaikan dalam demokrasi, kualiti alam sekitar, dan KDNK sebenar per kapita boleh mengurangkan ketidaksamaan pendapatan. Sementara itu, sektor perindustrian meningkatkan ketidaksamaan. Keluaran sebenar per kapita mempunyai pengaruh paling kuat dalam mengurangkan ketidaksamaan. Keputusan kuadran menunjukkan bahawa wilayah Aceh mempunyai prestasi ketidaksamaan yang semakin buruk berbanding dengan tempoh sebelum-pandemik, manakala prestasi ketidaksamaan di wilayah lain secara relatifnya perlahan. Penulis tidak menemui mana-mana wilayah berpendapatan tinggi yang mempunyai status ketidaksamaan yang rendah. Prestasi demokrasi di Pulau Sumatera lebih tidak menentu. Dalam sektor perindustrian, hanya wilayahi Sumatera Utara yang berprestasi lebih buruk. Pertimbangan dasar yang teliti diperlukan, termasuk dasar fiskal, monetari, dan mikro, terutama berkaitan peningkatan keluaran per kapita dan sektor perindustrian agar peningkatan itu tidak melebarkan jurang pendapatan.

Kata kunci: Ketidaksamaan pendapatan; demokrasi; alam sekitar; industri; analisis prestasi kepentingan; wabak covid-19

INTRODUCTION

Income inequality remains one of the major issues in the world today. Approximately 60% of countries with loans from the IMF and World Bank have experienced rising inequality. No region has successfully transitioned from middle-income to high-income status while maintaining high inequality levels (World Bank 2023). Income inequality is influenced by various factors, such as democratic development, environmental quality, industrialization and per capita income (Acheampong et al. 2023; Rahman et al. 2023; Rauf et al. 2021).

Indonesia's current condition suggests that income and purchasing power are increasingly concentrated among a small segment of the population (Sulistyaningrum & Tjahjadi 2022). The democratic reforms intended to achieve social justice during the Reform Era, are often limited to procedural practices, lacking meaningful participation from community groups (Rajab 2022). This situation constrains efforts to reduce inequality, raising challenges to fiscal redistribution following democratization (Albertus & Menaldo 2018). Inclusive institutions, in the long term, promote more equitable income distribution of income (Acemoglu et al. 2015). However, Bahamonde & Trasberg (2022) and Piketty (2015) argue that increasing inequality observed in both developed and developing countries reflects a fundamental tendency within capitalism to concentrate wealth among a limited elite.

Kuznets (1955) described how inequality tends to increase in the early stages of development before declining once income levels reach a turning point. Industrialization is one of the key indicators of progress towards high-income status (Rostow 1959). Recent studies reaffirm this phenomenon, emphasizing industrialization as a path towards high income, and its dynamic impact on inequality (Mehic 2018; Zhang et al. 2023). Ali et al. (2022) further demonstrate that in upper middle-income countries, industrialization increases inequality, whereas in lower middle-income countries, the effect is insignificant.

Growing concerns of income inequality and climate-related disasters reveal stark projections: within fifty years, 30% of the world's population could live in regions with average temperatures exceeding 29° Celsius unless large-scale displacement is mitigated. The poorest 50% contribute only 12% of global emissions, while the wealthiest 10% drive much of the environmental instability, leaving the poor disproportionately vulnerable (Tooze 2023).

The relationship between environment conditions and income inequality has been widely studied though findings remain mixed. Rahman et al. (2023) found that improving environmental quality can reduce income inequality, while Khan et al. (2023) reported the opposite among Belt and Road Initiative (BRI) countries. Conversely, Ali (2023) who examined 42 middle-income countries, concluded that income inequality and environmental degradation are mutually reinforcing.

Figure 1 shows that all provinces in Sumatra experienced a decline in inequality between 2015-2022. Bangka Belitung province recorded the lowest level of inequality, with its index value declining from 28.30 to 23.60. Bengkulu and Lampung provinces had the highest level of inequality in 2015, both at 37.60, but by the end of 2022, they were surpassed by the Riau Islands. Several provinces including Aceh, South Sumatra, and Riau Island, experienced renewed inequity pressures since 2020, coinciding with the Covid-19 pandemic.

Figure 2 presents the development of real GRDP per capita across Sumatra. The Riau Islands had the highest real GRDP per capita, averaging IDR 82.34 million, followed by Riau at IDR 73.78 million. Bengkulu recorded the lowest at IDR 22.50 million. Based on the geometric mean, the real GRDP per capita for Sumatra during 2015-2022, amounted to IDR 37.11 million. A pronounced gap persists between Riau Island and Riau compared with other provinces. A total of five provinces - North Sumatra, West Sumatra, Bengkulu, Lampung and Bangka Belitung - experienced a decline in real GRDP per capita in 2020, coinciding with the onset of the pandemic. Interestingly, these five provinces also recorded a lower income inequality in the same year.

In terms of real GRDP, North Sumatra and Riau provinces dominate other provinces. The real GRDP of North Sumatra averaged IDR 512.43 trillion, while Bengkulu showed the lowest at IDR 44.35 trillion. All provinces experienced a decline in real GRDP in 2020, with recovery beginning in 2021, exceeding 2019 levels in all except for the Riau Island.
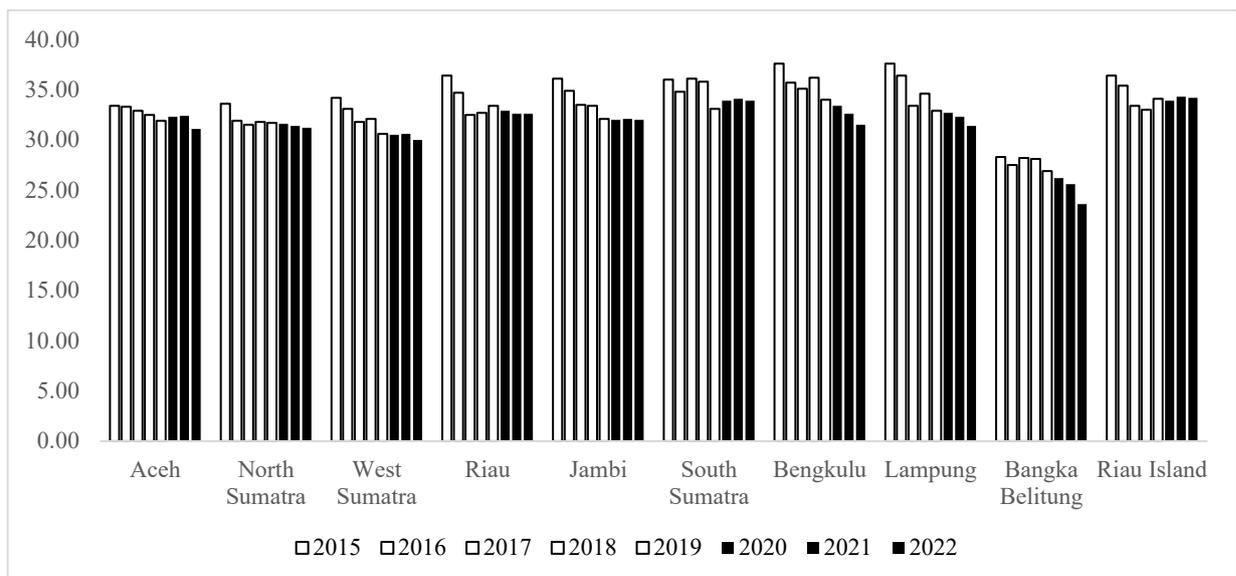

FIGURE 1. Development of Gini ratio of each province in Sumatra 2015-2022
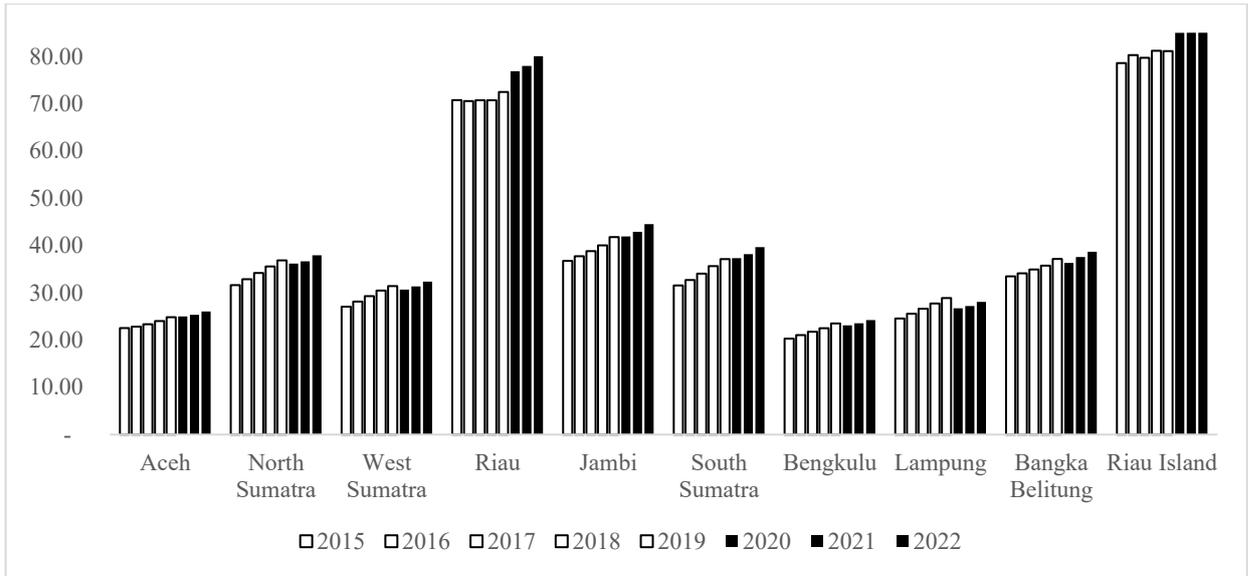*Source*: (BPS-Statistics Indonesia, 2023b)

FIGURE 2. Development of real GRDP per capita of each province in Sumatra 2015-2022 (IDR Million)
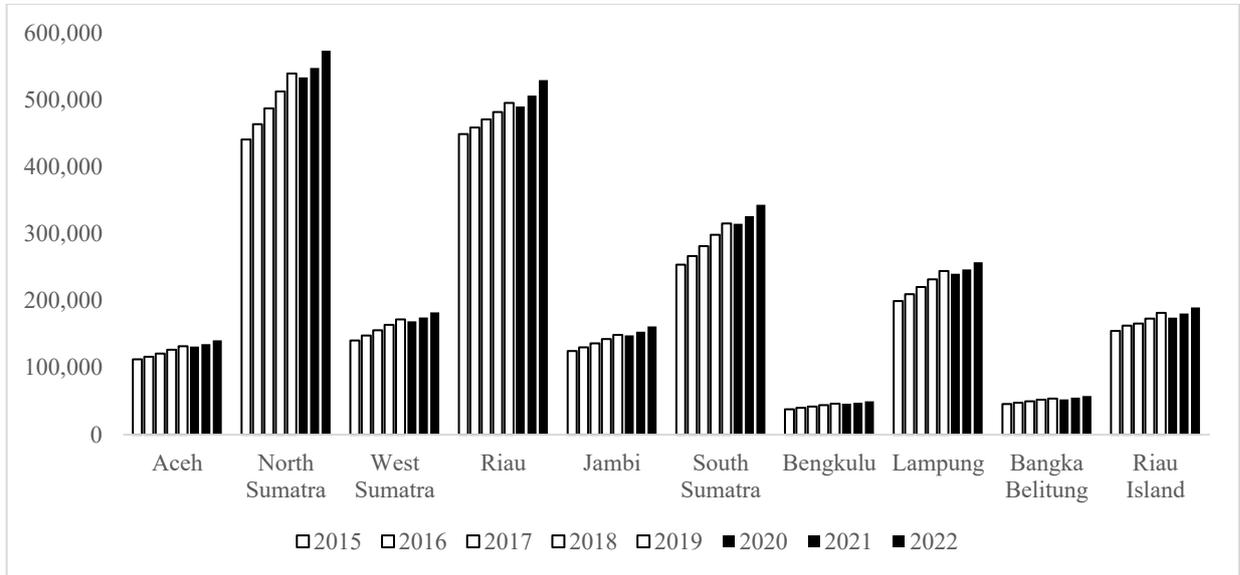*Source*: (BPS-Statistics Indonesia, 2023b)

FIGURE 3. Development of real GRDP of each province in Sumatra 2015-2022 (IDR Billion)
Source: (BPS-Statistics Indonesia, 2023b)

This study aims to examine the effects of democracy, environmental quality, industrialization, and real GDP per capita on inequality across Sumatra, and to map provincial inequality performance and its determinants before and during the Covid-19 pandemic. Panel data regression analysis was applied for the 2015-2022 period, complemented by quadrant analysis using the Importance-Performance Analysis (IPA) method, divided into two observation periods, namely 2015-2019 and 2020-2022. Previous studies have examined economic inequality utilizing the IPA framework, but with the use of different variables (Arno et al. 2019). Sari & Kurniawati (2018) conducted a similar study at the subdistrict with alternative variables and methods.

This study contributes to the understanding of income inequality and its determinants before and during the Covid-19 pandemic. It demonstrates how these determinants were affected during the pandemic and reveals changes in the observed variables across province. Additionally, the study adapts the IPA approach by incorporating the geometric mean as a measure of performance between two variables. In this adaptation, the vertical axis that usually represent expectations is replaced by the Gini ratio, with values above the horizontal line of the quadrant (Sumatra average) interpreted as worse performance. The horizontal line represents each determinant variable, where values to the right of the vertical line (Sumatra's average) indicate better performance. The study indicates that no province with a high real income per capita exhibited low or below-average inequality status. This paper is structured as follows: introduction, literature review, methodology, result and discussion, and conclusion.

LITERATURE REVIEW

Previous studies have examined the relationship between income inequality and various factors such as environmental quality, democracy, the industrial sector, and per capita income. Some of these studies report consistent findings, while others present contrasting results. Such variations may arise from differences in models, methods, sample groupings, regional characteristics, and observation periods. This study examines the interaction of these variables under both normal and pandemic conditions. By employing relatively different conditions and methodologies, this study aims to complement previous findings and provide an additional perspective on the relationship between inequality and its determinants.

DEMOCRACY WITH INCOME INEQUALITY

Przeworski et al. (2000) found that democracy is much more vulnerable when income inequality is high, especially when workers receive a smaller share of income generated by the manufacturing sector. They also observed that democracy tends to be less stable in more unequal societies, as measured by the Gini coefficient and the distribution of workers' share of income. Boix (2003) also argued that higher inequality reduces the likelihood of democratization. Similarly, Alesina et al. (1996) found that greater inequality leads to greater political instability. Kotschy and Sunde (2021) examined the impact of income inequality on democracy and reported that negative income shocks positively affect democracy in highly unequal countries, and vice versa.

Bahamonde and Trasberg (2022) argued that democratic governance and strong state capacity jointly result in higher income inequality over time, as such contexts attract foreign direct investment and foster financial development. Conversely, Shaheen and Amjad (2023) revealed that democracy, and income inequality are associated with higher corruption levels, while effective control of corruption, rule of law, and economic growth contribute to reducing income inequality.

Findings of Bahamonde and Trasberg (2022) and Shaheen and Amjad (2023) highlight varying interactions depending on the democratic components and the transmission channels influencing inequality. Previous studies have also revealed a bidirectional relationship between democracy and inequality. This study focuses on the role of democracy in explaining inequality in Sumatra, which is relatively more equal than Java, Sulawesi and Papua. Democracy is treated as an exogenous variable to explain inequality, given its function as a mechanism to achieve Sustainable Development Goals (SDGs), one of which is to reduce inequality. Based on previous studies, we hypothesize that democracy has a negative effect on income inequality.

ENVIRONMENTAL QUALITY WITH INCOME INEQUALITY

Empirical evidence from 2015-2019 suggests that improved environmental quality reduces income inequality (Rahman et al. 2023). Similar findings were reported by Khan et al. (2023) and Wu & Id (2020).

Xiao et al. (2022) demonstrated an inverse U-shaped relationship between income inequality and environmental quality, whereby pollution increases with inequality but decreases with higher per capita income. Che et al. (2023) who conducted a cross-country study of 65 countries, found little differences between developing and developed countries regarding the impact of inequality on environmental quality. Generally, the impact of inequality tends to exacerbate environmental degradation, with more significant results observed in developed countries.

Wang et al. (2021), in a study on China, found that greater income inequality reduces public support for environmental improvements, and vice versa. However, this study found no evidence on the role of per capita income in accelerating environmental inequality. Conversely, Grunewald et al. (2017) found that the relationship between inequality and carbon emissions differs by developmental levels: in developing countries, higher inequality is associated with lower carbon emissions, while in developed countries, it leads to higher per capita emissions. Based on previous literature, we expect that environmental quality will reduce income inequality in Sumatra.

Our earlier research limited the observation period to 2019, due to concerns that the Covid-19 pandemic in 2020 could distort the findings. However, this study extends the period to 2022 to capture potential pandemic-related effects and test the consistency of the results. Accordingly, we hypothesise that environmental quality continues to reduce income inequality in Sumatra.

INDUSTRY SECTOR WITH INCOME INEQUALITY

Rauf et al. (2021) examined inequality in Morowali and Banggai districts, Indonesia, and discovered that the commencement of large-scale mining operations led to rapid economic growth accompanied by increased income inequality. Morsy et al. (2023) concluded that increasing value-added in agriculture contributes to inter-country inequality, while sustainable structural transformation can mitigate it. Similarly, Zhang et al. (2023) observed an inverse U-shaped relationship between industrial agglomeration and income inequality in China - inequality initially rises with industrial clustering but declines once a threshold is reached.

Ha et al. (2019) associated urbanization with industrial expansion, observing that while it raises inequality in the short term, it reduces it over the long term. Ali et al. (2022) categorized countries by income level and revealed that in high-income countries, industrialization reduces inequality across most lower and middle quantiles. In upper middle-income

4

countries, however, industrialization tends to increase inequality, while in lower middle-income countries, the effect is not significant. Based on these findings and in the economic context of Sumatra, we posit that industrial expansion will increase income inequality.

INCOME PER CAPITA WITH INCOME INEQUALITY

Hassan (2021), in a study on India, discovered that higher economic growth can be achieved without worsening income inequality; broadly shared growth patterns, lead to decline in inequality. Ali et al. (2022) identified an inverted Kuznets curve relationship in lower middle- and upper middle-income countries. In Malaysia Fatimah et al. (2017) found that real GDP per capita reduces income inequality in the short run, but has a weaker effect in the long run

Our previous study covered the period up to 2019, focusing on the effect of real GRDP per capita on income inequality under normal conditions. The current study however extends the timeframe to 2022 to account for the pandemic's impact and assess the robustness of earlier findings. We hypothesise that higher real GDP per capita reduces income inequality.

METHODOLOGY

This study employs a descriptive quantitative analysis with two main objectives. First, it examines the extent to which democracy, environmental quality, industrial sector, and real income per capita influence income inequality across ten provinces in Sumatra. The observation period spans from 2015 to 2022. Second, it maps the performance of each province in terms of inequality trends and their determining factors. The analysis divides performance into two subperiods: namely, 2015-2019 (as the pre-covid-19 pandemic), and 2020-2022 (post- pandemic conditions).

In this study, income inequality is proxied by Gini ratio, democracy by provincial democracy index, environmental quality by the Environmental Quality Index (IKLH), the industrial sector by its share of GRDP, and real income per capita by GRDP at constant prices divided by the mid-year provincial population. Gini ratio data, democracy index, industrial sector contribution, and real income per capita are sourced from the Central Bureau of Statistics, while IKLH data are sourced from the Indonesian Ministry of Environment.

PANEL DATA REGRESSION

To address the first objective, a panel data regression approach was employed. This approach offers several regression models, including pooled OLS, fixed effects (least-squares dummy variable), and random effects models.

Model selection was guided by a series of specification tests. The Breusch–Pagan Lagrange Multiplier (LM) test was first conducted to examine whether the pooled OLS or random effects model was more appropriate. The null hypothesis assumes zero variances across cross-sectional units, indicating that the pooled OLS model is sufficient. A significant LM statistic indicates that the random effects model provides preferable, as it captures unobserved heterogeneity across entities.

Subsequently, the Hausman test was used to choose between the fixed effects and random effects estimators. The null hypothesis assumes that there is no correlation between the individual-specific effects and the explanatory variables, implying that the random effects estimator is both consistent and efficient. A significant Hausman test statistic (p-value < 0.05) supports the fixed effects model, while a non-significant value favours the random effects model.

Additionally, diagnostic tests were conducted to ensure that the residuals satisfy the assumptions of normality, homoscedasticity, no autocorrelation, and no cross-section dependence, thereby confirming model robustness.

Based on these specification and diagnostic tests, the random effects model was determined to be the most appropriate and robust for this study. The estimated relationship between inequality and its determinant variables is expressed through the following equation (Gujarati & Porter 2009):

$$gini_{it} = \beta_1 - \beta_2 democracy_{it} - \beta_3 iklh_{it} + \beta_4 industry_{it} - \beta_5 percapita_{it} + w_{it} \qquad (1)$$

where $gini$ is the Gini ratio, $iklh$ is the Environmental Quality Index, $democracy$ is the democracy index of each province, $industry$ is the distribution of the industrial sector to GRDP, $percapita$ is the real GRDP per capita, i indicates province, t refers to the period 2015-2022, and w is the composite error term comprising individual-specific and idiosyncratic errors.

QUADRANT ANALYSIS

To achieve the second objective, quadrant analysis was conducted using Importance-Performance Analysis (IPA) as a tool to map inequality performance against its determinant variables - democracy, environmental quality, industrial sector, and real income per capita. This method, introduced by Martilla & James (1977), was initially developed to evaluate consumer responses to marketing programs and has since been adapted in various empirical studies (Aghajanzadeh et al. 2022; Babalola 2023; Esmailpour et al. 2020; Suhardono et al. 2024).

The IPA approach was adopted to map the relationship between income inequality and its determinants, and the performance gap among provinces. The mean inequality scores and the scores of each determinant variable were calculated,

serving as reference scores for mapping the quadrants into four categories. We divide the curve into two lines, the horizontal line representing the Gini ratio and the vertical line being the determinant variables. The quadrants are interpreted as follows:

a. Quadrant 1: Provinces with below-average Gini ratios, and above-average determinant variable values – indicating low inequality and strong determinant performance.
b. Quadrant 2: Provinces with below-average Gini ratio, and below-average determinant variable values, indicating low inequality but poor determinant performance.
c. Quadrant 3: Above-average Gini ratio and below-average determinant variable values, reflecting high inequality despite strong determinant performance.
d. determinant performance.
e. Quadrant 4: Above-average Gini ratio and below-average determinant variable values, indicating high inequality and weak determinant performance.

DATA

GINI RATIO

Income inequality, measured by the Gini Ratio, is based on expenditure data sourced from the National Socioeconomic Survey (Susenas) conducted by the Central Bureau of Statistics. The formula as follows:

$$GR = 1 - \sum_{i=1}^{N} F_{pi}(F_{ci} + F_{ci-1}) \qquad (2)$$

where
F_{pi} = Frequency of population in the i-th class
F_{ci} = Cumulative frequency of total expenditure in class i
F_{ci-1} = Cumulative frequency of total expenditure in class $(i-1)$

REAL GRDP PER CAPITA

Real Gross Regional Domestic Product (GRDP) per capita is calculated using 2010 constant prices to measure real output per person (BPS-Statistics Indonesia 2023a; Mankiw 2016). The formula as follows:

$$Real\ GRDP\ per\ capita = \frac{GRDP\ at\ constant\ prices_t}{\Sigma\ Population\ in\ the\ middle\ of\ the\ year\ of\ counting_t} \qquad (3)$$

ENVIRONMENTAL QUALITY INDEX (IKLH)

IKLH captures water (IKA), air (IKU) and land cover (IKTL) quality across Sumatra.

$$IKLH\_province = (30\%\ x\ IKA) + (30\%\ x\ IKU) + (40\%\ x\ IKTL) \qquad (4)$$

DEMOCRACY

The democracy index measures three components: Civil Liberty, Political Rights, and Institutions of Democracy. The IDI is based on four data sources, namely: (1) review of local newspapers, (2) review of documents (local regulations, Pergub, etc.), (3) Focus Group Discussions (FGDs), and (4) in-depth interviews. The measurement scale ranges from 0 to 100. Data are obtained from the Central Bureau of Statistics, and transformed into natural logarithms.

INDUSTRY SECTOR DISTRIBUTION

The industrial sector's contribution is the share of value-added generated by the industrial sector in GRDP. Data are sourced from the Central Bureau of Statistics and transformed into natural logarithm. The formula is as follows:

$$Industry\ sector\ distribution = \frac{Industry\ sector\ value\ added_t}{GRDP\ at\ current\ prices_t}\ x\ 100\% \qquad (5)$$

RESULTS AND DISCUSSION

PANEL DATA REGRESSION

The F-Restricted and Hausman test values are 0.000 and 0.0013, respectively, both below 5% significance level. However, the fixed effect regression model exhibits autocorrelation, as indicated by the Durbin Watson value of 0.963, which is lower than the Durbin Lower (DL) limit of 1.534. The Glejser test further indicates the presence of heteroscedasticity, with

probability value of logindustry on the absolute residual model being 0.024, which is lower than the 5% threshold. On this basis, the random effect model is adopted, since it is more efficient than the fixed effects estimator (Wooldridge 2020). Using the Generalized Least Squared (GLS) method ensures minimum variance and helps address the heteroscedasticity issue in the model (Gujarati & Porter 2009).

Residuals from the random effects regression are normally distributed, as shown by the Jarque-Bera probability value of 0.062 which exceeds the 5% confidence level. The heteroscedasticity test results using the Glejser method indicate that the probability values of logdemo, logiklh, logindustry and logperkap on the absolute residuals are 0.354, 0.739, 0.234, and 0.265, respectively – all above the 5% level. This suggests that the variances in the models tend to be constant throughout the observation. The probability value of the Pesaran CD test is 0.104, indicating the absence of spatial dependence. Correlation tests among predictor variables are still within acceptable levels.

TABLE 1. Result of random effect model regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGDEMOCRACY**	-0.135	0.061	-2.203	0.031
LOGIKLH**	-0.131	0.056	-2.352	0.021
LOGINDUSTRY***	0.143	0.041	3.49	0.001
LOGPERCAPITA***	-0.309	0.051	-6.115	0.000
C***	2.875	0.481	5.980	0.000
Weighted Statistics				
R-squared	0.511	Mean dependent var		-0.125
Adjusted R-squared	0.485	S.D. dependent var		0.043
S.E. of regression	0.031	Sum squared resid		0.071
F-statistic	19.564	Durbin-Watson stat		0.739
Prob(F-statistic)	0.000			

Source: Data Processing Results

The regression results show that democracy, environmental quality, industrial sector and real GRDP per capita have a significant effect on income inequality represented by the Gini ratio. Their probability values - 0.031, 0.021, 0.001 and 0.000, respectively – are all below the 5% level.

An increase in the democracy index by 1% reduces income inequality by 0.135%. The democracy index used in this study follows the previous methodology, which comprises three aspects: namely, civil liberties, political rights, and democratic institutions. It reflects the overall performance of democratic actors, including the government, society, legislature, political parties, judiciary, and law enforcement. The fluctuating scores of these indicators across provinces highlight the ongoing challenge of strengthening and sustaining democratic performance. For instance, disparities in civil liberties across Sumatran provinces remain substantial (BPS-Statistics Indonesia 2020). A convergence in these scores is expected to contribute to reduced inequality across the island.

Environmental quality negatively affects income inequality. Findings from this study aligns with those by Rahman et al. (2023) and Wu and Id (2020), but contrasts with Khan et al. (2023), who observed an opposing relationship. The results further strengthens the importance of integrating economic, social and environmental aspects within developmental strategies. Persistent environmental degradation risks exacerbating income inequality. Hence, collective efforts from the government, academia, philanthropic bodies, and the private sector are essential to mitigate environmental degradation.

The results also strengthen the relationship between productivity and income inequality. An increase in real GRDP per capita reduces income inequality, with a coefficient of -0.309, representing the strongest effect among all explanatory variables. This result is in line with Rahman et al. (2023), who identified real GRDP per capita converging among Sumatran provinces. Similarly, Fatimah et al. (2017) found that in Malaysia, real GDP per capita has a short-run effect on reducing inequality, while the Sumatran context reflects a longer-term interaction. Balanced development between advanced and underdeveloped regions can promote equitable income distribution thus reducing income inequality in Sumatera. Large-scale infrastructure projects enhancing mobility across Sumatera are strongly suspected to have accelerated the "catch-up effect", alongside strong institutional roles in income redistribution, support for micro-enterprises, and technology diffusion.

Industrial sector distribution has a positive effect on income inequality. A 1% increase in the share of the industrial sector in the economy can increase income inequality by 0.143%. This phenomenon occurs because large industries still dominate the aggregate value added, where they are synonymous with high-tech business practices. Automation in these industries further limits expansion of employment, which would normally accompany economic growth. Conversely, the growth of low-tech industries – often represented by small enterprises - has not been able to match the value added generated by medium and large industries, thereby widening the income gap among workers. These findings align with Ali et al. (2022), who reported similar patterns in industrial activity across upper middle-income regions. Several provinces such as Riau and the Riau Island, are classified into this category. This result is moreover consistent with Zhang et al. (2023), who identified the inverted-U relationship between industrialisation and inequality, although expected turning point has yet to occur in Sumatra.

The constant value of 2.875, significant at the 1% level, indicates that if the effects of the model variables are removed, income inequality would increase by 2.87%. This confirms the importance of the variables included in the model to reduce inequality and to guide policy interventions. The constant value is in line with the adjusted R-squared value of 0.485, suggesting that 48.5% of the variation in income inequality can be explained by the predictor variables.

QUADRANT ANALYSIS

The performance tabulations in Tables 1 and 2 are derived from mapping the initial position (2015-2019) of inequality performance with its determinants, as well as their changes in the subsequent period (2020-2022), across the provinces under observation. Columns two to five in Tables 1 and 2 present the tabulated quadrant positions of each province for each comparison, while the seventh column shows the average. The average reflects each province's overall position in addressing inequality based on all predictor variables. A value closer to 1 indicate better performance in addressing inequality and improving environmental quality, income, democracy, and industrial development, whereas a value closer to 4 indicates poorer performance.

TABLE 2. Achievement of income inequality and its determinant variables in Sumatera Island 2015-2019

Province	Income Inequality and Environment	Income Inequality and Real GRDP per Capita	Income Inequality and Democracy	Income Inequality and Industry	Total	Average (Quadrant)
Aceh	1	2	1	2	6	1.5
North Sumatra	2	2	2	1	7	1.75
West Sumatra	2	2	2	2	8	2
Riau	4	3	3	3	13	3.25
Jambi	4	4	4	4	16	4
South Sumatra	4	4	3	3	14	3.5
Bengkulu	3	4	3	4	14	3.5
Lampung	4	4	4	3	15	3.75
Bangka Belitung	1	2	1	1	5	1.25
Riau Island	3	3	3	3	12	3

Source: Data processing results

TABLE 3. Achievement of income inequality and its determinants in Sumatera Island 2020-2022

Province	Income Inequality and Environment	Income Inequality and Real GRDP per Capita	Income Inequality and Democracy	Income Inequality and Industry	Total	Average (Quadrant)
Aceh	3	4	3	4	14	3.5
North Sumatra	2	2	2	2	8	2
West Sumatra	1	2	1	2	6	1.5
Riau	4	3	4	3	14	3.5
Jambi	4	3	4	4	15	3.75
South Sumatra	4	4	3	3	14	3.5
Bengkulu	4	4	4	4	16	4
Lampung	4	4	3	3	14	3.5
Bangka Belitung	1	2	2	1	6	1.5
Riau Island	3	3	3	3	12	3

Source: Data processing results

The results show that from the period 2015-2019 to 2020-2022, several provinces generally showed improved performance. For instance, West Sumatra recorded an average value of 2 in 2015-2019 which declined to 1.5 in 2020-2022, indicating improvement. Environmental quality and democracy in West Sumatra has notably progressed. The province's civil liberties and equality indices increased from 52.99 and 69.77 in 2015 to 78.01 and 79.85 in 2022, respectively (BPS-Statistics Sumatera Barat Province 2024). The increasing number of community groups actively involved in environmental rescue programs has also contributed to the enhanced environmental quality (West Sumatra Provincial Environment Agency 2022). However, more attention should be given to improving the performance of real GRDP per capita, and the contribution of the industrial sector. Policy measures need to be implemented judiciously to ensure that economic growth does not widen income disparity, while maintaining environmental sustainability.

Other provinces showing improved performance include Jambi, with its average value decreasing from 4.00 to 3.75, and Lampung from 3.75 to 3.50. These two provinces still face challenges in reducing inequality. Jambi, in particular, requires stronger interventions to improve environmental quality, democracy, and its industrial performance. The province's reliance on agriculture, forestry and fisheries, especially the plantation subsector, is slowing down the process of economic transformation towards higher value-added activities. Although the expansion of forest cover and increased community access to sustainable forest management are commendable, the mining and quarrying sector, which accounted for approximately 15.87% of Jambi's economy in 2022, poses risks to environmental improvements. Meanwhile, the industrial sector in Lampung is relatively dominant, but still face challenges in improving environmental quality and real GRDP per capita. Waste pollution incidents between 2020-2022 have further reduced environmental quality in the province (Jaya & Susanti 2022).

South Sumatra and the Riau Islands recorded no change in quadrant position, maintaining average scores of 3.5 and 3.0 respectively. Both provinces still experience higher income inequality than the national average until the most recent period. In addition, South Sumatra faces challenges in enhancing democratic and industrial performance, whereas the Riau Islands demonstrate stronger outcomes in environmental quality, real GDP per capita, democracy, and the industrial sector development.

Conversely, five provinces - namely Aceh, North Sumatra, Riau, Bengkulu, and Bangka Belitung – recorded declining performance. Their average scores increased compared to the initial observation period. Aceh's average rose from 1.5 to 3.5, indicating worsening income inequality. Although environmental quality and democracy improved, the performance in real GRDP per capita and the industrial sector declined. Inflation during the pandemic (2020-2021) reached 3.59%, particularly in personal care, other services and health groups (Kanwil Ditjen Perbendaharaan Provinsi Aceh 2020), eroding purchasing

power. Combined with high poverty rates, these factors increased vulnerability to economic shocks during the pandemic, thus widening inequality and lowering overall welfare.

North Sumatra experienced a slowdown in industrial activity but maintained income inequality below the Sumatra average. Riau consistently recorded higher-than-average inequality from the initial to the most recent period, accompanied by a weakening democracy index, drifting away from quadrant 3 to quadrant 4. Bengkulu has also showed no improvement in inequality, alongside slowdowns in environmental and democracy index performance across all four quadrant indicators in the current period. Bangka Belitung, which initially showed basically good performance with an average score of 1.25, declined in democratic performance, shifting away from quadrant 1 to quadrant 2. In general, the pandemic has not caused significant deterioration in income inequality across Sumatra. The dominance of the agriculture, forestry and fisheries sectors in supporting the economies of nine provinces, except for the Riau Islands, help cushion against the economic shocks following the Covid-19 pandemic.

INCOME INEQUALITY AND ENVIRONMENTAL QUALITY

Quadrant 1 represents the ideal condition, characterized by low income inequality followed by high environmental quality. Quadrant 2 indicates low inequality but poor environmental quality, while quadrant 3 reflects high inequality alongside high environmental quality. Quadrant 4 is the least desirable condition, where both inequality and environmental degradation are high.

As presented in Figure 1, during 2015-2019, only two provinces, namely Aceh and Bangka Belitung, were classified under quadrant 1. Although Aceh exhibited greater inequality than Bangka Belitung, it achieved superior environmental quality. North Sumatra and West Sumatra fall into quadrant 2, displaying similar conditions of inequality and environmental quality. Quadrant 3 included the Riau Islands and Bengkulu, while the majority of provinces, Riau, Jambi, South Sumatra, and Lampung, are located in quadrant 4, reflecting both high inequality and low environmental quality.
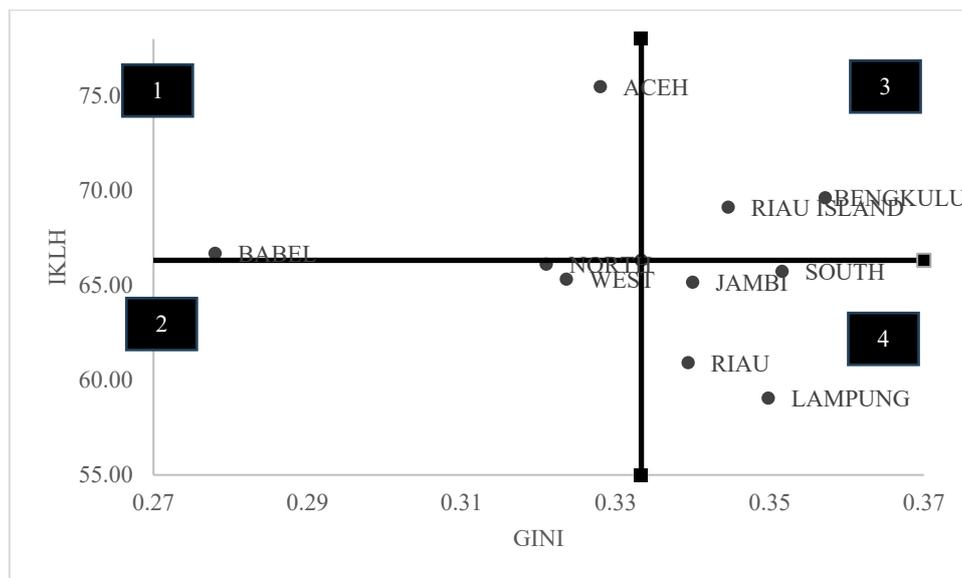

FIGURE 4. Conditions of income inequality and environmental quality 2015-2019
Source: Data processing results

In the 2020-2022 period, there was a shift in quadrant 1, as Aceh Province, previously included in this category, moved to quadrant 3. Conversely West Sumatra exhibited improved performance, moving from quadrant 2 to quadrant 1. North Sumatra moved closer to the average line, although it still remain in quadrant 2. Meanwhile, Bengkulu declined from quadrant 1 to quadrant 4. The provinces that were already in quadrant 4, namely Jambi, South Sumatra, Riau, Lampung, and Bengkulu, retained their positions.
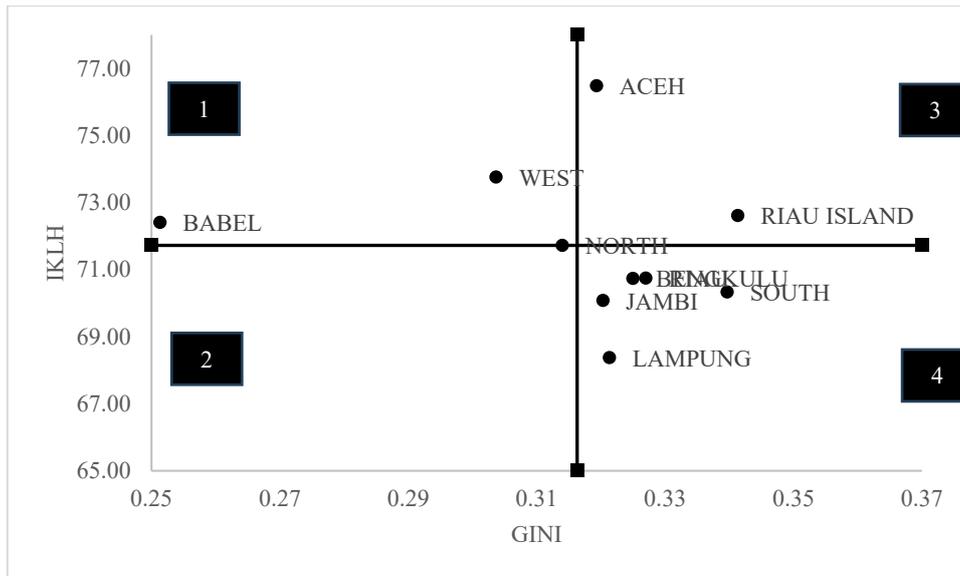
FIGURE 5. Conditions of income inequality and environmental quality 2020-2022
Source: Data processing results

INCOME INEQUALITY AND REAL GRDP PER CAPITA

Figure 3 below shows an interesting pattern. During the 2015-2019 period, none of the provinces in Sumatra were positioned in quadrant 1, which represents the ideal condition of low inequality followed by high real GRDP per capita. Provinces such as Bangka Belitung, North Sumatra, West Sumatra, and Aceh exhibited inequality below the Sumatra average but also recorded real GRDP per capita below the regional mean. In contrast, Riau and the Riau Islands recorded the highest real GDP per capita, but had inequality levels exceeding the Sumatra average. Other regions, such as Jambi, South Sumatra, Lampung, and Bengkulu, all showed high inequality combined with low real GRDP per capita.
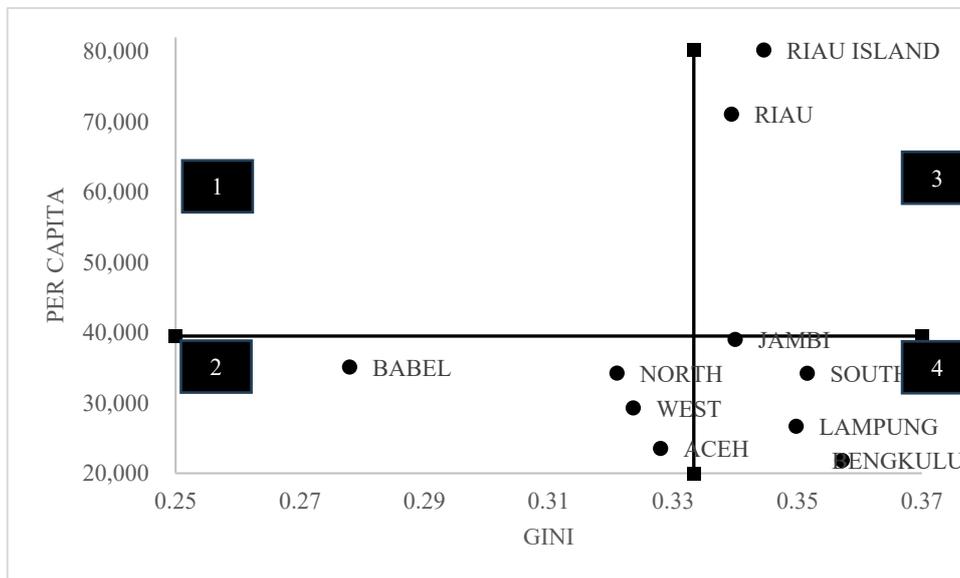
FIGURE 6. Income inequality condition and real income per capita 2015-2019
Source: Data processing results

In the 2020-2022 period, Riau and the Riau Islands still remain in quadrant 3, with the addition of Jambi, which moved up from quadrant 4 to quadrant 3. Aceh however declined from quadrant 2 to quadrant 4, reflecting a deterioration in inequality achievement, which shifted from below to above the regional average. This outcome is in line with the findings of Ali (2023), who observed that development processes in upper middle-income regions tend to increase inequality. Both Riau and the Riau Islands were classified as upper middle-income provinces during the observation period, based on the World Bank classification.

The Kuznets curve, which postulates that inequality declines as per capita income rises, has not been reflected in the quadrant analysis. Although some provinces experienced simultaneous increases in real GRDP and inequality reductions, several instances demonstrated the opposite trend. These include Riau (in 2015-2016 and 2018-2019), West Sumatra (2017-

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2018), North Sumatra (2017-2018), and the Riau Islands (2016-2017). Thus, the turning points depicted in the Kuznets hypothesis appear inconsistent across provinces.
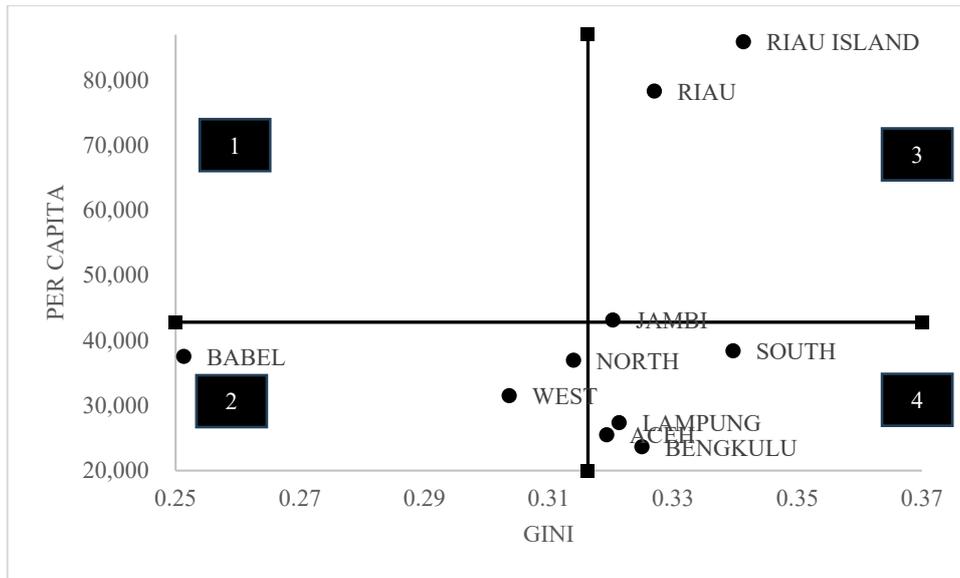

FIGURE 7. Income inequality condition and real income per capita 2020-2022
Source: Data processing results

INCOME INEQUALITY AND DEMOCRACY

During 2015-2019, two provinces, namely Bangka Belitung and Aceh, performed well in terms of income inequality and democracy. Both provinces recorded inequality levels below the average for Sumatra, while their democracy indices were above the national average. North Sumatra and West Sumatra were positioned in quadrant 2, with low inequality performance and accompanied by modest democracy scores. Most provinces, including South Sumatra, the Riau Islands, Bengkulu, and Riau, were positioned in quadrant 3, characterized by strong democratic performance but higher income inequality. Meanwhile, Jambi and Lampung recorded poor outcomes in both inequality and democracy.
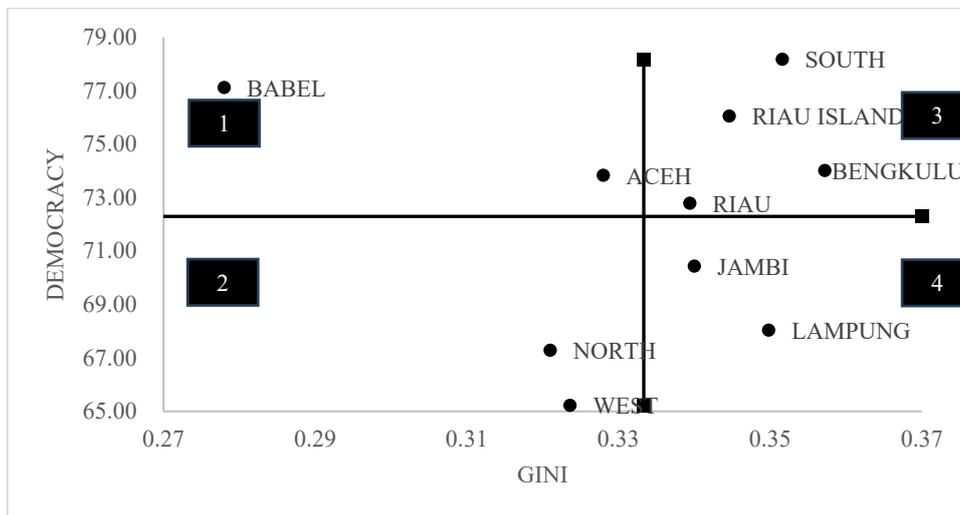

FIGURE 8. Conditions of income inequality and democracy index 2015-2019
Source: Data Processing Results

A significant shift in provincial performance occurred during the 2020-2022 period. Bangka Belitung shifted from quadrant 1 to quadrant 2 as its average democracy index declined from 77.12 (2015-2019) to 76.05. Aceh meanwhile, shifted to quadrant 3, with inequality rising above the Sumatra average. Conversely, Lampung experienced improvements in both democracy and inequality, moving from quadrant 4 to quadrant 3, closer to the regional average for inequality. The Riau Islands and South Sumatra remained in quadrant 3.

Two provinces, Riau and Bengkulu dropped from quadrant 3 into quadrant 4. Riau's democracy index improved slightly compared to the 2015-2019 period, but lagged behind other provinces, falling below the national average. In contrast

however, Bengkulu's democracy score declined from 74.01 (2015-2019) to 72.72 (2020-2022) below Sumatra's average of 76.17. Jambi also remained in quadrant 4.
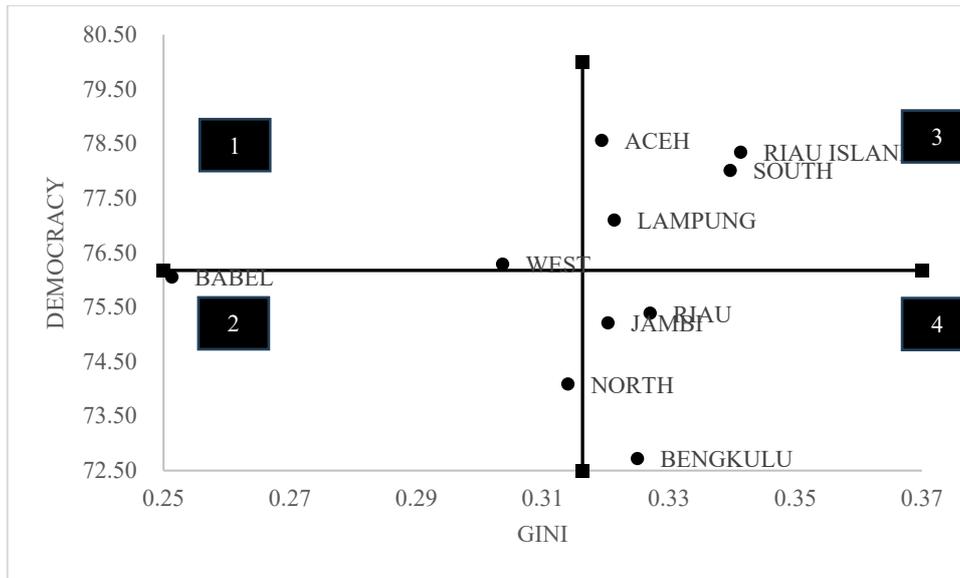

FIGURE 9. Conditions for income inequality and democracy index 2020-2022
Source: Data processing results

INCOME INEQUALITY AND INDUSTRY

Figure 7 illustrates the relationship between income inequality and industrial performance for the 2015-2019 period. Two provinces, Bangka Belitung and North Sumatra, were positioned in quadrant 1, indicating relatively strong performance in both inequality and industrial development. West Sumatra was in quadrant 2, while Aceh recorded the lowest industrial performance among all provinces. Quadrant 3, comprising Riau Islands, Riau, South Sumatra, and Lampung, displayed high inequality alongside strong industrial achievements. Jambi and Bengkulu, in quadrant 4, showed poor outcomes in both inequality and industrial performance.
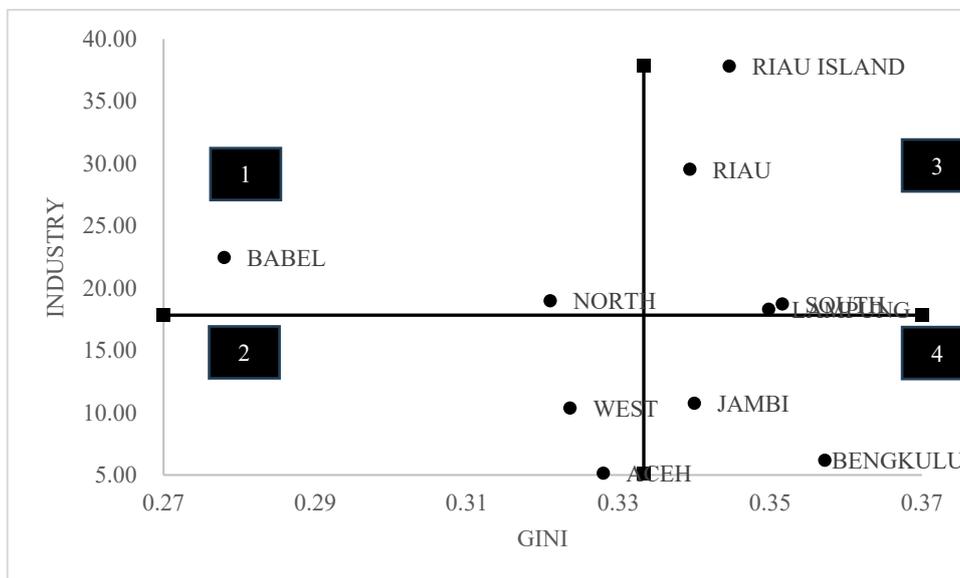

FIGURE 10: Income inequality and distribution in the industrial sector 2015-2019
Source: Data processing results

In the 2020-2022 period, Bangka Belitung remained in quadrant 1. However, North Sumatra shifted to quadrant 2, as its industrial sector achievement declined slightly below the Sumatra average. West Sumatra also remained in quadrant 2, but its industrial achievement decreased. Lampung, located in quadrant 3, moved closer to the regional average due to improved inequality performance. Aceh shifted from quadrant 2 to quadrant 4, reflecting worsening inequality performance compared to other provinces.
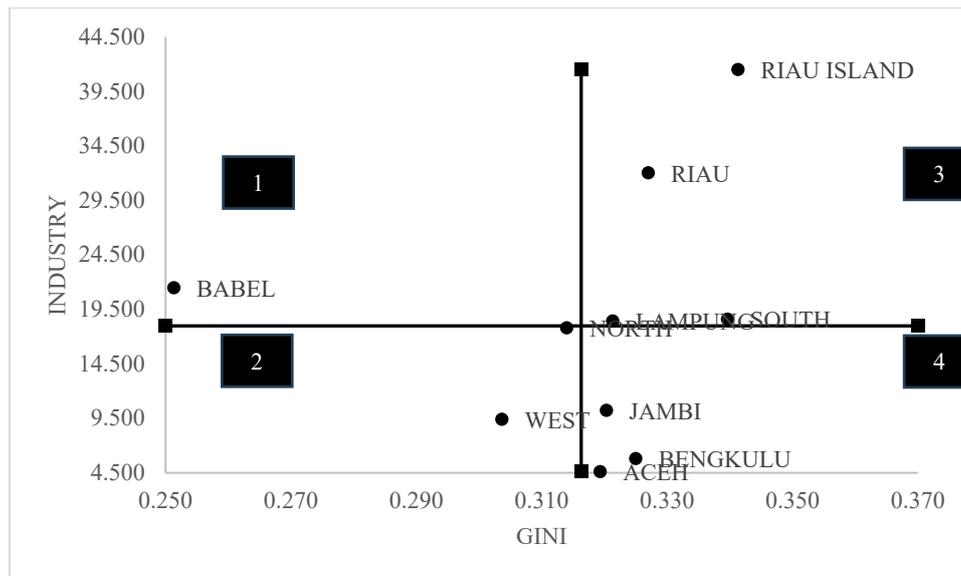
FIGURE 11. Income inequality and distribution in the industrial sector 2020-2022
Source: Data processing results

CONCLUSION

This study demonstrates that increases in the democracy index, environmental quality, and real GDP per capita contribute to reducing income inequality. Among these factors, real output per capita exerts the greatest influence in narrowing inequality across Sumatera Island. In contrast, an increase in the industrial sector distribution tends to exacerbate income inequality.

Aceh Province recorded worsening inequality compared to the pre-Covid-19 period, while inequality levels in other provinces remained relatively unchanged. Bengkulu experienced a decline in environmental quality, whereas West Sumatra showed improvement. North Sumatra's environmental quality performance moved closer to the national average. Notably, Jambi performed well in terms of its per capita output. Meanwhile, the democracy index across Sumatra Island displayed greater volatility, with declines observed in Bangka Belitung, Riau, and Bengkulu, but improvements in West Sumatra and Lampung. In the industrial sector, only North Sumatra showed a deterioration, while performance in other provinces remained largely stable.

In overall performance, three provinces, West Sumatra, Jambi and Lampung, showed improvement. South Sumatra and the Riau Islands showed little change, while five provinces, namely Aceh, North Sumatra, Riau, Bengkulu and Bangka Belitung, experienced declines in performance.

The study implies that balanced and coordinated efforts are required to enhance the democratic climate, environmental quality, income levels and industrial sector development simultaneously. Such effort should not rely solely on government initiatives but also involve broader collaboration with academia, philanthropic organizations, and the private sector. Policymakers should exercise prudence in promoting per capita output growth and industrial expansion to ensure that the resulting gains are equitably distributed, thereby preventing wider income disparities. Fiscal policies that reinforce these developmental dimensions should be further strengthened.

ACKNOWLEDGEMENT

REFERENCES

Acemoglu, D., Naidu, S., Restrepo, P . & Robinson, J. A. 2015. Democracy, redistribution, and inequality. In *Handbook of Income Disribution. Vol 2B* (1st ed., Vol. 2). Elsevier B.V.

Acheampong, A.O., Dzator, J . & Abunyewah, M. 2023. Sub - Saharan Africa ' s tragedy : Resource curse , democracy and income inequality. In *Social Indicators Research* (Vol. 168, Issue 1). Springer Netherlands.

Aghajanzadeh, M., Aghabayk, K., Esmailpour, J . & Gruyter, C. De. 2022. Importance – Performance Analysis (IPA) of metro service attributes during the COVID-19 pandemic. *Case Studies on Transport Policy* 10(3): 1661–1672.

Albertus, M . & Menaldo, V. 2018. *Authoritarianism and the Elite Origins of Democracy*. Cambridge University Press

Alesina, ALberto, & Perotti, R. 1996. Income distribution, political instability, and investment. *European Economic Review* 40: 1203–1225.

Ali, I.M. 2023. Income inequality and environmental degradation in middle-income countries: A test of two competing hypotheses. *Social Indicators Research* 166: 299–321.

Ali, I.M., Attiaoui, I., Khalfaoui, R . & Tiwari, A.K. 2022. The effect of urbanization and industrialization on income inequality: An analysis based on the method of moments quantile regression. *Social Indicators Research* 161: 29–50.

Arno, A.K., Fasiha, Abdullah, M.R . & Ilham. 2019. An analysis on pverty inequality in South Sulawesi Indonesia by using importance performance analysis (IPA). *I-Finance* 05(02).

Babalola, T.O. 2023. Adopting Importance-Performance Analysis (IPA) model to assess land governance in the peri-urban areas of Ibadan, Nigeria. *Land Use Policy* 133.

Bahamonde, H . & Trasberg, M. 2022. Inclusive institutions , unequal outcomes: Democracy , state capacity , and income inequality. *European Journal of Political Economy* 70.

Boix, C. 2003. *Democracy and Redistribution*. New York: Cambridge University Press.

BPS-Statistics Indonesia. 2020. *Indeks Demokrasi Indonesia (IDI) 2019* (Issue 62). https://www.bps.go.id/id/pressrelease/2020/08/03/1756/idi-nasional-2019-mengalami-peningkatan-dibandingkan-dengan-idi-nasional-2018.html

BPS-Statistics Indonesia. 2023a. *[Seri 2010] Produk Domestik Regional Bruto Per Kapita*. Indonesian Central Bureau of Statistics. https://www.bps.go.id/indicator/52/288/2/-seri-2010-produk-domestik-regional-bruto-per-kapita.html

BPS-Statistics Indonesia. 2023b. *Provider of Quality Statistical Data For Advanced Indonesia*. BPS-Statistics Indonesia. https://www.bps.go.id/en

BPS-Statistics Sumatera Barat Province. 2024. *[New Method] Aspects of the Indonesian Democracy Index (IDI) of West Sumatra Province, 2021-2023*. BPS-Statistics Sumatera Barat Province. https://sumbar.bps.go.id/id/statistics-table/2/NTM4IzI=/indeks-demokrasi-indonesia--idi--provinsi-sumatera-barat-menurut-aspek.html

Che, C., Li, S., Yin, Q., Li, Q., Geng, X . & Zheng, H. 2023. Does income inequality have a heterogeneous effect on carbon emissions between developed and developing countries ? Evidence from simultaneous quantile regression. *Frontiers in Environmental Science 2023*: 1–13.

Esmailpour, J., Aghabayk, K., Vajari, M.A . & Gruyter, C. De. 2020. Importance – Performance Analysis (IPA) of bus service attributes: A case study in a developing country. *Transportation Research Part A: Policy and Practice* 142: 129–150.

Fatimah, N., Sulaiman, C., Yussof, I., Azlan, M., Zaidi, S . & Sulaiman, N. 2017. Long run relationship between income inequality and economic growth : Evidence from Malaysia. *International Journal of Academic Research in Business and Social Sciences* 7(6): 73–88.

Grunewald, N., Klasen, S., Martinez-Zarzoso, I . & Muris, C. 2017. The trade-off between income inequality and carbon dioxide emissions. *Ecological Economics* 142: 249–256.

Gujarati, D.N . & Porter, D.C. 2009. *Basic Econometrics* (5th Editio). McGraw-Hill.

Ha, N.M., Le, N.D . & Trung-kien, P. 2019. The impact of urbanization on income inequality : A study in Vietnam. *Journal of Risk and Financial Management* 12(146): 1–14.

Hassan, M. 2021. Inequality adjusted per capita income of Indian States in 2004-05 and 2011-12. *The Journal of Development Practice* 7: 29–34.

Jaya, T.P . & Susanti, R. 2022. *Walhi Beberkan 4 Pencemaran Limbah di Lampung Selama 2020-2022*. Kompas. https://regional.kompas.com/read/2022/07/19/095856178/walhi-beberkan-4-pencemaran-limbah-di-lampung-selama-2020-2022

Kanwil Ditjen Perbendaharaan Provinsi Aceh. 2020. *Kajian Fiskal Regional Triwulan III 2020*.

Khan, I., Han, L., Zhong, R., Bibi, R . & Khan, H. 2023. Income inequality, economic growth, renewable energy usage, and environmental degradation in the belt and road initiative countries: Dynamic panel estimation Title. *Environmental Science and Pollution Research* 30: 57142–57154.

Kotschy, R . & Sunde, U. 2021. Income shocks , inequality , and democracy. *Scandinavian Journal of Economics* 123(1): 295–326.

Kuznets, S. 1955. Economic growth and income inequality. *The American Economic Review XLV:* 1–28.

Mankiw. 2016. *Macroeconomics Ninth Edition*.

Martilla, J.A . & James, J.C. 1977. Importance-performance analysis. *Journal of Marketing* 41(1): 77–79.

Mehic, A. 2018. Industrial employment and income inequality: Evidence from panel data. *Structural Change and Economic Dynamics* 45: 84–93.

Morsy, H., Shimeles, A . & Nabassaga, T. 2023. Structural change and inequality in Africa. *Journal of African Economies*, 32(2018): 228–245.

Piketty, T. 2015. *The Economics of Inequality*. The Belknap Press of Harvard University Press.

Przeworski, A., Alvarez, M., Cheibub, J . & Limongi, F. 2000. *Democracy and Development: Political Institutions and Well-Being in the World, 1950–1990*. Cambridge University Press.

Rahman, A., Andrasari, M . & Sirojuzilam. 2023. Economic development and convergence in sumatra island , Indonesia ecces : Economics social and development studies. *Ecces: Economics Social and Development Studies* 10(1): 23–47.

Rahman, A., Sirojuzilam, Lubis, I . & Pratomo, W.A. 2023. Income inequality between provinces in Indonesia. *Jurnal*

Ekonomi Malaysia 57(3): 1-16.

Rajab, B. 2022. Otoritarianisme-birokratik orde baru, krisis ekonomi dan politik, dan demokrasi formal masa reformasi. *Indonesian Journal of Politics* 8(1): 59–78.

Rauf, R.A., Husnah, Halwi, M.D., Pratama, M.F., Mayapada, A.G . & Arsyad, M. 2021. Industrialization and regional income inequality: Agriculture transformation. *IOP Conference Series: Earth and Environmental Science* 681(2021): 1-11.

Rostow, W.W. 1959. The Stages of economic growth. *The Economic History Review* 12(1): 1–16.

Sari, V.K . & Kurniawati, F. 2018. Income inequality in Surakarta. *Journal of Applied Economics in Developing Countries* 3(2) 86–92.

Shaheen, R . & Amjad, M. H. 2023. Nexus between democracy , corruption , and income inequality in South Asia. *Journal of Development Policy, Research, & Practice* 7: 73–92.

Suhardono, S., Fitria, L., Yenis, I., Mutiara, M., Ulhasanah, N . & Suryawan, K. 2024. Trees , forests and people community-centric importance and performance evaluation of human-orangutan conflict management in Aceh , Indonesia. *Trees, Forests and People* 15.

Sulistyaningrum, E . & Tjahjadi, A. M. 2022. Income inequality in Indonesia: Which aspects cause the most? *Journal of Indonesian Economy and Business* 37(3): 229–253.

Tooze, A. 2023. *The Climate Emergency Really is a New Type of Crisis – Consider the 'Triple Inequality' at the Heart of it*. The Guardian.

Wang, F., Yang, J., Shackman, J . & Liu, X. 2021. Impact of income inequality on urban air quality : A game theoretical and empirical study in China. *International Journal of Environmental Research and Public Health* 18(6): 1-17.

West Sumatra Provincial Environment Agency. 2022. *Employee Performance Accountability Report (LAKIP) 2021 West Sumatra Provincial Environment Agency*.

Wooldridge, J.M. 2020. *Introductory Econometrics: A Modern Approach, Seventh Edition*. Cengange Learning Inc.

World Bank. 2023. 2023 in nine charts: A growing inequality. *World Bank*. https://www.worldbank.org/en/news/feature /2023/12/18/2023-in-nine-charts-a-growing-inequality?qterm_test1=income+inequality

Wu, J . & Id, Y.P. 2020. Air pollution, general government public- health expenditures and income inequality : Empirical analysis based on the spatial Durbin model. *PLoS ONE* 15(10): 1–24.

Xiao, D., Yu, F . & Yang, H. 2022. The impact of urban-rural income inequality on environmental quality in China. *Complexity 2022*: 1–14.

Zhang, S., Bani, Y., Selamat, A.I . & Ghani, J.A. 2023. Exploring the effect of industrial agglomeration on income inequality in China. *PLoS ONE* 18(6): 1-20.

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