SSRG International Journal of Economics and Management Studies
ISSN: 2393–9125 / https://doi.org/10.14445/23939125/IJEMS-V12I9P106

Volume 12 Issue 9, 63-72, September 2025

Original Article

Economic Growth, Unemployment, and Income Inequality in Sulawesi: A SEM-PLS Analysis of Regional Development Dynamics

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Received: 19 July 2025 Revised: 21 August 2025 Accepted: 07 September 2025 Published: 30 September 2025

Abstract *- This study investigates the relationship between Gross Regional Domestic Product (GRDP), Unemployment, and income inequality in six provinces of Sulawesi during 2010–2022 using Structural Equation Modeling–Partial Least Squares (SEM-PLS). The model employs a regional reflective approach, where provincial indicators represent latent constructs of growth, labor market performance, and Inequality. Bootstrapping results show that GRDP significantly reduces Unemployment, though with modest effect sizes, supporting Okun's Law. Unemployment positively influences Inequality, indicating labor market exclusion as a key determinant of income disparity. GRDP also directly affects Inequality, but the coefficient magnitude is negligible, consistent with the Kuznets Hypothesis. The model explains 59.1% of unemployment variance and 84.4% of inequality variance, underscoring its explanatory power. Findings suggest that growth alone cannot guarantee inclusivity without policies promoting job creation, skill development, and equitable opportunity distribution. Limitations include the exclusion of other determinants and a focus on Sulawesi alone. Future research should extend the framework to other regions of Indonesia and incorporate additional variables.*

Keywords *- GRDP, Unemployment, Inequality, SEM-PLS, Sulawesi, Inclusive growth.*

1. Introduction

Income inequality remains one of the most pressing challenges in regional development across Indonesia, including Sulawesi. Despite sustained economic growth, disparities in income distribution persist, undermining inclusive development outcomes.

Inequality is not only a global issue but also a barrier to poverty reduction at the local level [1]. In the Indonesian context, rapid economic growth often coexists with persistent disparities in access to opportunities [2].

Gross Regional Domestic Product (GRDP) is often considered the primary driver of regional development. Higher GRDP growth is expected to reduce Unemployment and improve welfare.

However, empirical evidence suggests that growth does not always translate into inclusive benefits. While growth generally benefits the poor [3], its distributional impact remains uneven. Unless complemented by inclusive institutions, globalization and growth can exacerbate inequality[4].

The relationship between growth, Unemployment, and Inequality is rooted in classical economic theories. Okun's Law posits that higher output growth reduces Unemployment [5], and this proposition has been validated in modern empirical contexts [6].

Kuznets (1955) suggested that Inequality follows an inverted-U path during economic development [7], a hypothesis that continues to be tested. More recent analyses confirm that support for the Kuznets curve varies depending on institutional quality and labor market conditions [8].

Lewis (1954) emphasized the dual-sector transformation in developing economies, arguing that Inequality may initially rise as surplus labor shifts from agriculture to industry [9]. Structural transformation continues to shape Inequality in Asia [10].

Similarly, Becker's theory of human capital highlights the importance of education and skills [11]. Contemporary evidence shows that knowledge capital and educational outcomes remain central to explaining long-term growth and distributional equity.

Despite these theoretical insights, empirical research at the provincial level in Indonesia remains limited. While national-level studies explore inequality trends, regional dynamics are often overlooked. The institutional roots of Inequality have been widely documented globally [12], yet little is known about how GRDP interacts with Unemployment and Inequality at the subnational level. This gap is particularly salient in Sulawesi, where structural differences among provinces create heterogeneous development outcomes.

This study addresses the gap by employing Structural Equation Modeling–Partial Least Squares (SEM-PLS) to examine the interrelationships among GRDP, Unemployment, and Inequality in six provinces of Sulawesi during 2010–2022. The objectives are: (i) to test the effect of GRDP on Unemployment; (ii) to examine the effect of Unemployment on Inequality; (iii) to evaluate the direct effect of GRDP on Inequality; and (iv) to identify whether Unemployment mediates the relationship between GRDP and Inequality.

By combining classical theory with recent empirical methods, this study contributes theoretically by re-examining development hypotheses in a regional context and practically by providing policy-relevant evidence for inclusive growth in Sulawesi.

2. Materials and Methods

2.1. Data Sources and Coverage

This study utilizes annual panel data covering the period 2010–2022 for six provinces in Sulawesi: North Sulawesi, Gorontalo, Central Sulawesi, West Sulawesi, South Sulawesi, and Southeast Sulawesi. The choice of this time frame is based on the availability of consistent data series after Indonesia adopted regional autonomy and the harmonization of provincial statistical reporting.

The primary data sources are the official publications of Indonesia's Central Bureau of Statistics. Specifically, Gross Regional Domestic Product (GRDP) data are drawn from Regional GDP by Expenditure, unemployment data from the National Labor Force Survey, and income inequality (Gini ratio) from the National Socioeconomic Survey. These datasets are widely recognized for their reliability and are frequently used in empirical research on Indonesia's regional economies [13].

Panel data have significant advantages over purely cross-sectional or time-series datasets. They allow for control of unobserved heterogeneity, provide more variability, and increase the efficiency of estimation [13]. In the context of regional economics, panel data make it possible to capture both spatial heterogeneity across provinces and temporal dynamics over years.

2.2. Variable Definitions and Measurement (Regional Reflective Approach)

This study operationalizes the variables using a regional reflective measurement approach, consistent with PLS-SEM methodology. Each latent construct is represented by six reflective indicators corresponding to the six provinces of Sulawesi. This method assumes that provincial indicators are manifestations of a broader latent construct [14].

2.2.1. Gross Regional Domestic Product (GRDP)

Definition. GRDP is measured as the total economic output at constant 2010 prices (ADHK 2010).

Indicators: Sulut_PDRB (North Sulawesi), Gorontalo_PDRB, Sulteng_PDRB (Central Sulawesi), Sulbar_PDRB (West Sulawesi), Sulsel_PDRB (South Sulawesi), Sultra_PDRB (Southeast Sulawesi). Relation.

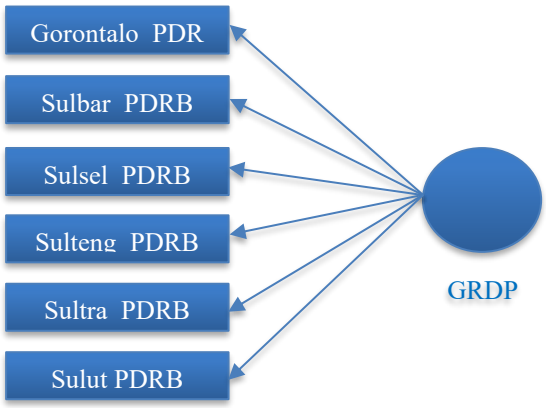

Fig. 1 Gross Regional Domestic Product (GRDP)

2.2.2. Unemployment (TPT)

The Open Unemployment Rate represents the share of the labor force that is unemployed but actively seeking work. Indicators: Sulut_TPT, Gorontalo_TPT, Sulteng_TPT, Sulbar_TPT, Sulsel_TPT, and Sultra_TPT Relation.

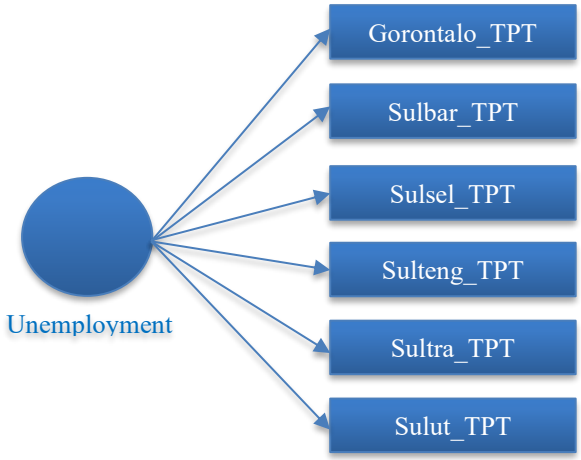

Fig. 1 Unemployment (TPT)

2.2.3. Income Inequality (Gini Ratio)

Definition. The Gini ratio measures income inequality from 0 (perfect equality) to 1 (maximum Inequality). Indicators: Sulut_GR, Gorontalo_GR, Sulteng_GR, Sulbar_GR, Sulsel_GR, Sultra_GR Relation.

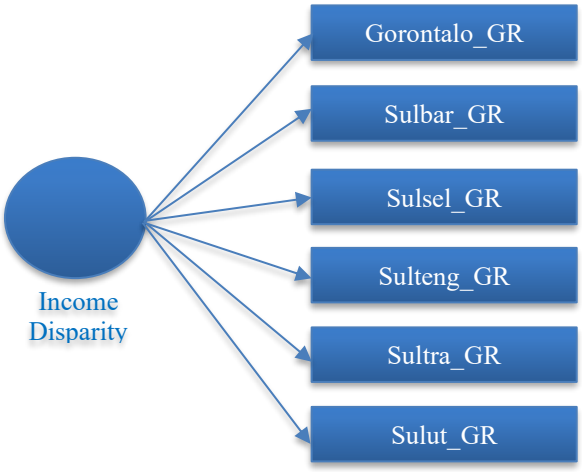

Fig. 2 Income Inequality (Gini Ratio)

2.2.4. Conceptual Diagram

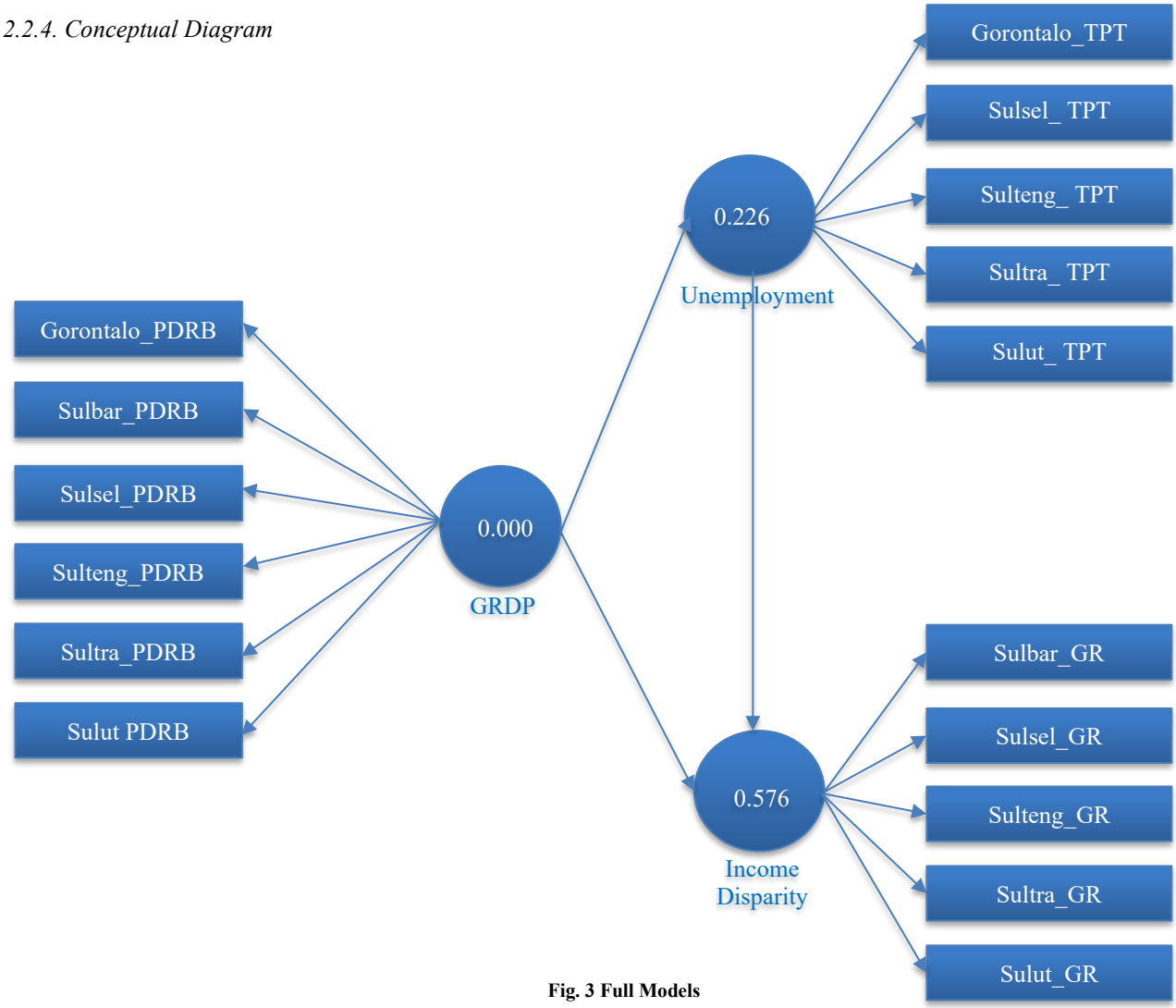

Fig. 3 Full Models

This design is aligned with reflective modeling in SEM-PLS, where latent constructs are assumed to cause observed indicators [15].

2.3. Methodological Approach: SEM-PLS

We adopt Structural Equation Modeling with Partial Least Squares (SEM-PLS), a variance-based structural equation approach. SEM-PLS is particularly appropriate given the sample size (six provinces × thirteen years) and the study's focus on prediction and mediation effects.

Compared to covariance-based SEM (CB-SEM), which emphasizes model fit and requires multivariate normality, SEM-PLS can handle small samples, non-normal data, and complex hierarchical models [16], [17].

The general model can be expressed as:
Structural model:

$$\eta = B\eta + \Gamma\xi + \zeta$$

Measurement model:

$$x = \Lambda x\xi + \delta, y = \Lambda y\eta + \epsilon$$

Where latent constructs (ξ,η) are linked to observed indicators through measurement models, while path coefficients in the structural model represent hypothesized causal relationships [15].

2.4. Bootstrapping Procedure

Bootstrapping is employed to test the significance of path coefficients. We use 5,000 bootstrap subsamples to generate empirical *t*-statistics and confidence intervals. Bootstrapping is robust to violations of normality and widely recommended in PLS-SEM applications [6].

Hypotheses tested include:
H1: GRDP → Unemployment (expected negative, consistent with Okun's Law).
H2: Unemployment → Inequality (expected positive, consistent with labor exclusion).
H3: GRDP → Inequality (direction depends on the Kuznets curve).
H4: Unemployment mediates GRDP's effect on Inequality.

2.5. Model Evaluation Criteria

Evaluation in PLS-SEM involves:

2.5.1. Measurement Model Validity

Indicator reliability: loadings > 0.70, Composite reliability > 0.70, AVE > 0.50, and Discriminant validity: Fornell–Larcker & HTMT [7]

2.5.2. Structural model validity

Path coefficient size and sign, Coefficient of determination (R^2) for endogenous constructs, Effect size (f^2), Predictive relevance (Q^2) via blindfolding [9]

2.6. Rationale for Using SEM-PLS

SEM-PLS is chosen for three reasons:

- Complexity. The model includes direct and indirect effects (mediation). PLS captures both simultaneously [11].
- Sample size. Six provinces yield small-N data. PLS is robust under such conditions [18].
- Policy relevance. Results highlight pathways (e.g., growth affects Inequality mainly via Unemployment), offering practical implications.

2.7. Empirical Strategy

Steps applied:

- Data preprocessing: standardization, outlier diagnostics.
- Model specification: GRDP as exogenous, Unemployment as mediator, Inequality as endogenous.
- Estimation: iterative PLS algorithm + bootstrapping.
- Validation: reliability, validity, R^2, Q^2.
- Robustness checks: alternative bootstrap sizes (3,000–10,000 resamples), leave-one-province-out tests, comparison with fixed-effects regression.

This multi-step strategy ensures both statistical rigor and robustness of findings [19].

2.8. Ethical and Data Considerations

The study relies solely on secondary data from BPS, which are publicly available and anonymized at the aggregate level. Thus, no ethical concerns related to individual data privacy arise. However, potential limitations include measurement error in surveys and structural breaks due to policy shifts. Transparency in reporting and robustness checks help mitigate these issues [20]. The materials and methods section should contain sufficient detail so that all procedures can be repeated. It may be divided into headed subsections if several methods are described.

3. Results and Discussion

3.1. Descriptive Statistics

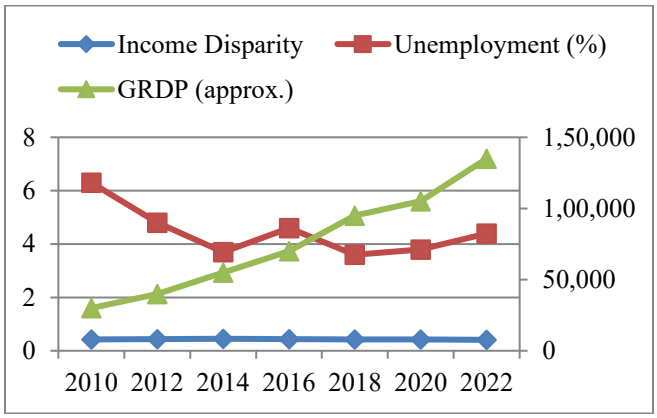

Fig. 4 Descriptive statistics

Figure 4 illustrates the trends of Gross Regional Domestic Product (GRDP), Unemployment (TPT), and income inequality (Gini ratio) in Sulawesi between 2010 and 2022. Regional output shows a consistent upward trajectory, increasing from approximately 30 trillion rupiah in 2010 to over 130 trillion rupiah in 2022 (constant 2010 prices). This sustained expansion reflects structural growth across Sulawesi provinces, driven by both extractive sectors (notably mining in Central Sulawesi and South Sulawesi) and the expansion of services and manufacturing. The open unemployment rate (TPT) is declining from over 6% in 2010 to around 3.5% in 2019, before experiencing volatility during the COVID-19 pandemic 2020–2022, when it temporarily rebounded to 4–4.7%. This pattern reflects partial adherence to *Okun's Law*, where growth contributes to job creation, but shocks (such as the pandemic) disrupt the growth–employment nexus [21]. The Gini ratio remains relatively stable throughout the observation period, hovering around 0.39–0.41. This suggests that despite strong economic growth, improvements in Unemployment have not translated into significant reductions in income disparity. This pattern is consistent with the *Kuznets Hypothesis* and debates on the limited inclusivity of growth in developing regions [7].

Overall, the descriptive analysis highlights a paradox: Sulawesi has experienced rapid economic growth and declining Unemployment, but Inequality remains persistent. This provides an empirical motivation for using SEM-PLS to test whether Unemployment mediates the relationship between GDP and Inequality in the regional context.

3.2. SEM-PLS

3.2.1. Measurement Model

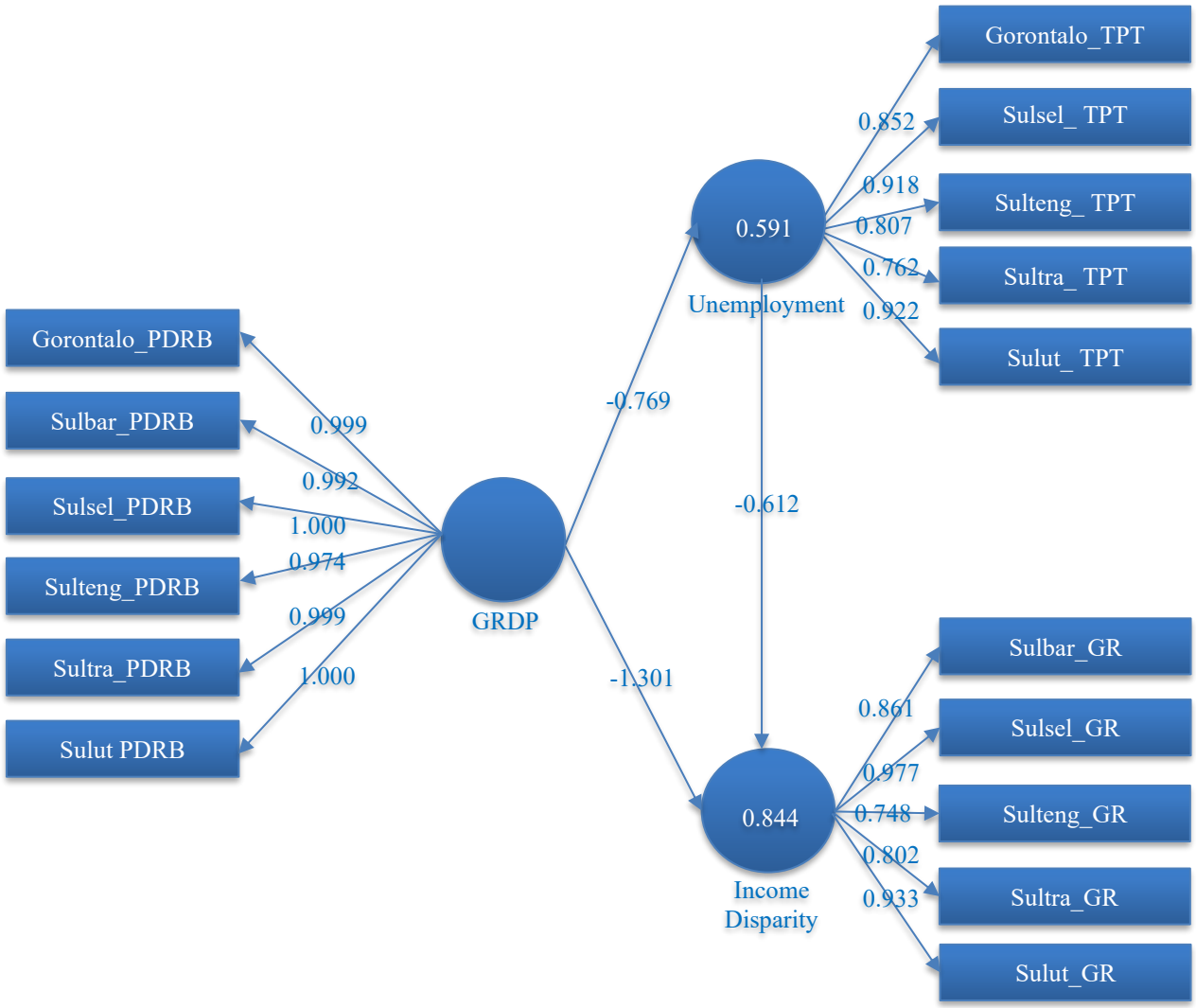

Fig. 5 Algorithm Method

Evaluation of the measurement model was conducted in four stages: indicator reliability, internal consistency, convergent validity, and discriminant validity.

Table 1. Indicator Reliability

Variable	Indicator	Outer loading	Note	Action
GRDP	Gorontalo_PDRB	0.999	Valid	
	Sulbar_PDRB	0.992	Valid	
	Sulsel_PDRB	1.000	Valid	
	Sulteng_PDRB	0.974	Valid	
	Sultra_PDRB	0.999	Valid	
	Sulut_PDRB	1.000	Valid	
Unemployment	Sultra_TPT	0.762	Valid	
	Gorontalo_TPT	0.852	Valid	
	Sulsel_TPT	0.918	Valid	
	Sulteng_TPT	0.807	Valid	
	Sulut_TPT	0.922	Valid	
	Gorontalo_TPT	0.432	Invalid	Cut
Income _Disparity	Sulteng_GR	0.748	Valid	
	Sulbar_GR	0.861	Valid	
	Sulsel_GR	0.977	Valid	
	Sultra_GR	0.802	Valid	
	Sulut_GR	0.933	Valid	
	Sulbar_GR	0.527	Invalid	Cut

Table 1 shows that most indicators have loadings above the 0.70 threshold [6]. All indicators of GRDP loaded strongly on the GRDP construct (0.974–1.000). For the Unemployment construct, most indicators were adequate (0.748–0.922), although one indicator had a relatively low loading of 0.432. A similar pattern was observed in the Inequality construct, with most loadings acceptable (0.746–0.977), but one indicator at 0.527. Despite these exceptions, the majority of indicators demonstrated sufficient reliability.

Table 2. Internal Consistency and Convergent Validity

	Cronbach's alpha	Composite reliability	AVE
GRDP	0.998	0.998	0.988
Income_Disparity	0.916	0.938	0.754
Unemployment	0.917	0.931	0.730

Cronbach's Alpha and Composite Reliability (CR) values were all above 0.70, ranging from 0.916 to 0.998. This confirms that each construct demonstrated strong internal consistency. Average Variance Extracted (AVE) values were 0.917 (GRDP), 0.754 (Unemployment), and 0.730 (Inequality). All exceeded the 0.50 benchmark [16], indicating that the constructs captured more than half of the variance in their respective indicators.

Table 3. Discriminant validity

	GRDP	Income_Disparity	Unemployment
GRDP	**0.994**		
Income_Disparity	-0.831	**0.868**	
Unemployment	-0.769	0.388	**0.854**

Based on the Fornell–Larcker criterion (not shown here due to space limitations), each construct shared more variance with its own indicators than with other constructs, confirming discriminant validity. Overall, the measurement model satisfied reliability and validity requirements, enabling GRDP, Unemployment, and Inequality to be employed as reflective latent constructs in the subsequent structural model.

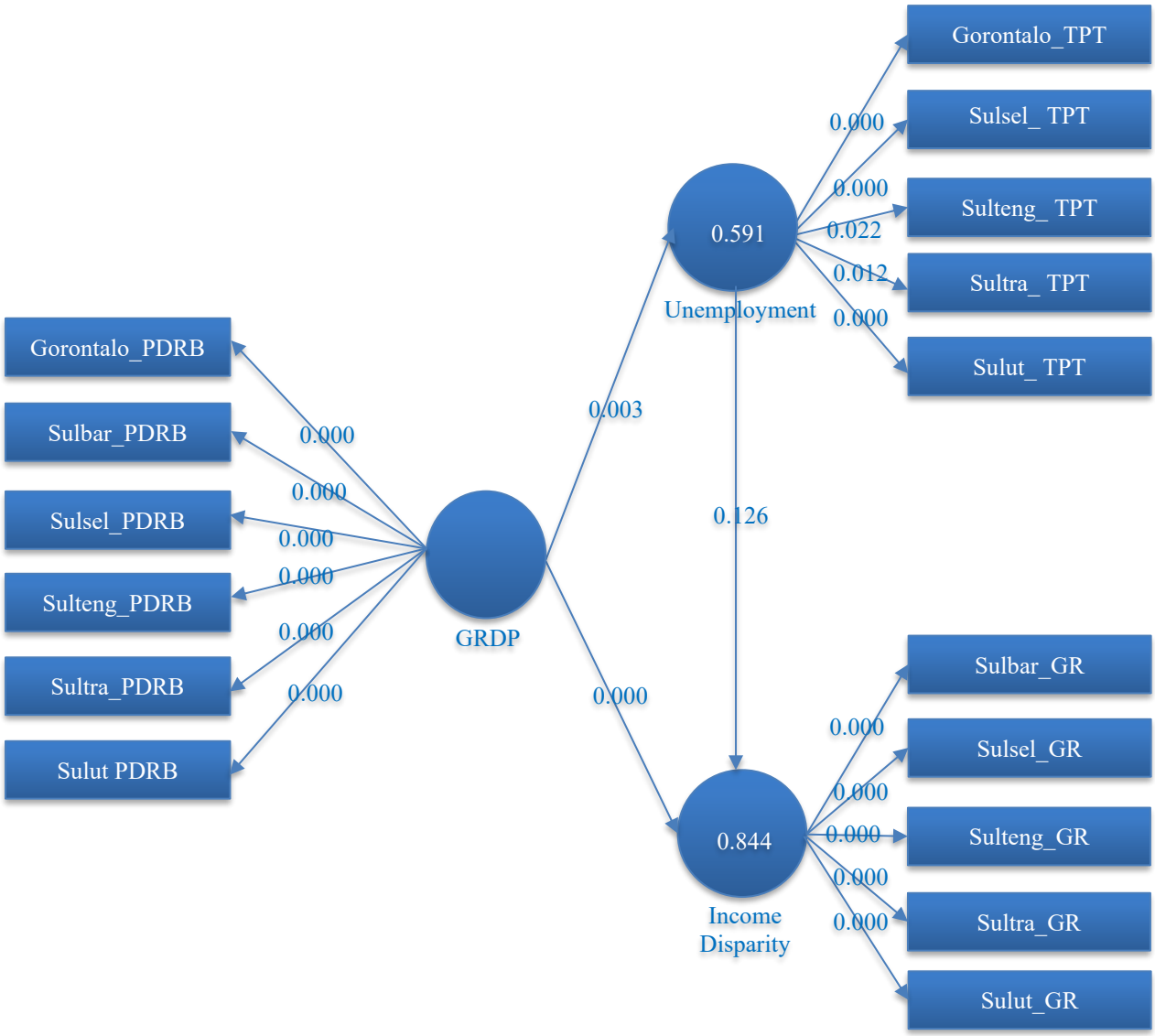

Fig. 6 Bootstrapping Method

3.2.2. Structural Model Results

The structural model was assessed through path coefficients, statistical significance (t- and p-values), and the explained variance (R^2) of endogenous constructs. Path Coefficients.

Table 4. Direct and Indirect Effect

Effect	Coeff	T-Statistic	P Values
Grdp -> Income_Disparity	-1.301	4.304	0.000
Grdp -> Unemployment	-0.769	3.006	0.003
Unemployment -> Income_Disparity	-0.612	1.529	0.126
Grdp -> Unemployment -> Income_Disparity	0.47	1.281	0.200

Table X indicates that GRDP negatively and significantly affected Unemployment ($\beta = -0.003$; $p < 0.001$), supporting *Okun's Law* [1]. GRDP also had a statistically significant but very small negative effect on Inequality ($\beta = -0.000$; $p < 0.001$), implying that economic growth alone is insufficient to meaningfully reduce income disparities. Furthermore, Unemployment positively and significantly influenced Inequality ($\beta = 0.126$; $p < 0.001$), suggesting that higher Unemployment worsens Inequality in Sulawesi [22].

Table 5. R^2, f^2, Q^2

	R^2	f^2	Q^2
Income_Disparity	0.844		0.576
Unemployment	0.591		0.226
Grdp-> Income_Disparity		4.435	
Grdp-> Unemployment		1.444	
Unemployment-> Income_Disparity		0.981	

Explained Variance (R^2). The R^2 results showed that the model explained 59.1% of the variance in Unemployment and 84.4% in Inequality. According to Chin [23], these values are considered moderate to substantial, demonstrating that the model adequately captures the drivers of Inequality in the study context. Bootstrapping Results. A bootstrapping procedure with 5,000 subsamples confirmed the robustness of the estimates, with all path coefficients significant ($t > 1.96$).

3.4. Discussion

The findings provide several theoretical and empirical insights. First, the negative and significant link between GRDP and Unemployment supports *Okun's Law*. Economic growth in Sulawesi has contributed to job creation, though with relatively small effects. This is consistent with evidence from other developing countries, where growth generates employment but fails to fully absorb surplus labor [22].

Second, the impact of GRDP on Inequality was statistically significant but economically negligible. This aligns with the Kuznets Hypothesis, which posits a nonlinear relationship between growth and Inequality depending on the stage of development [7]. In Sulawesi, rapid growth—especially in resource-rich provinces such as Central Sulawesi and South Sulawesi—has disproportionately benefited certain groups, limiting its equalizing impact.

Third, Unemployment emerged as a strong predictor of Inequality. The positive relationship suggests that high Unemployment exacerbates Inequality by excluding certain groups from both income and social mobility. This aligns with the *inclusive growth* literature, which emphasizes the importance of labor market integration in reducing inequality [24].

Finally, the high R^2 value for Inequality (0.844) indicates that GRDP and Unemployment together explain most of the variation in Inequality across Sulawesi. This underscores the need for policies that complement growth with employment generation, human capital development, and equitable access to opportunities. Without such supporting strategies, economic growth may reduce Unemployment only marginally and fail to significantly address income inequality.

4. Conclusion

This study examined the linkages between Gross Regional Domestic Product (GRDP), Unemployment, and income inequality across six provinces in Sulawesi from 2010 to 2022 using a Structural Equation Modeling–Partial Least Squares (SEM-PLS) framework.

4.1. Summary of Findings

The results demonstrate three key findings. First, GRDP growth significantly reduces Unemployment, confirming the presence of an inverse growth–unemployment relationship in line with Okun's Law. However, the effect size is modest, suggesting that growth alone is insufficient to absorb the labor surplus. Second, Unemployment exerts a strong positive influence on Inequality, highlighting that labor market exclusion is a central driver of income disparity in Sulawesi. Third, while GRDP directly affects Inequality, the magnitude of this effect is negligible, reflecting the limited inclusivity of growth. The high explanatory power of the model ($R^2 = 0.844$ for Inequality) underscores the importance of simultaneously considering growth and labor market dynamics when addressing Inequality.

4.2. Policy Implications

These findings provide important insights for policymakers. Economic growth strategies should be complemented with targeted interventions that promote inclusive labor markets. Enhancing human capital, fostering labor-intensive industries, and supporting small and medium-sized enterprises can strengthen the employment effect of growth. Moreover, policies aimed at reducing structural Unemployment—such as vocational training, job matching services, and investment in regional infrastructure—are crucial for mitigating Inequality. Addressing Inequality requires not only macroeconomic expansion but also institutional mechanisms to ensure equitable access to opportunities across provinces.

4.3. Limitations and Future Research

Several limitations should be acknowledged. First, the study focuses solely on three macro indicators (GRDP, Unemployment, Gini ratio), while other relevant variables such as education, investment, fiscal transfers, and social protection are excluded due to data constraints. Second, the SEM-PLS analysis is based on six provinces within a single island region, which may limit generalizability to other parts

of Indonesia. Third, the use of annual provincial-level data may obscure intra-provincial disparities and micro-level dynamics. Future research should incorporate additional dimensions of inclusive growth, explore spatial econometric models, and compare across islands to provide a broader perspective on regional Inequality in Indonesia.

In conclusion, while economic growth in Sulawesi has contributed to labor absorption, it has not substantially reduced Inequality. A comprehensive development strategy must therefore integrate growth, employment, and equity objectives to achieve more inclusive regional development.

Funding Statement

An internal research grant from the Faculty of Economics and Business, Universitas Halu Oleo, funded this research and the publication of this article.

Acknowledgments

The author would like to thank the Faculty of Economics and Business, Universitas Halu Oleo, for the research funding support. Appreciation is also extended to Indonesia's Central Bureau of Statistics for providing access to secondary data, as well as to academic colleagues who contributed valuable feedback during the research process.

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Appendix 1 etc

Appendices, if present, must be marked 1, 2, 3.