

Research Article

Navigating Unemployment in South Sulawesi: Interaction of Investment, Economic Growth, and Demographic Dynamics

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Abstract

This study explores the multifaceted relationship between unemployment, investment, and economic growth in South Sulawesi, Indonesia, over the period 2017–2023. Using panel data from 24 districts, the research employs fixed-effects econometric modeling to analyze how population density, gross fixed capital investment (GFCI), and economic growth influence regional unemployment rates. The empirical results demonstrate that economic growth significantly and negatively affects unemployment, underscoring its crucial role in job creation and regional development. Conversely, both GFCI and population density show statistically insignificant effects, indicating that capital investment has not effectively translated into labor absorption, likely due to the prevalence of capital-intensive rather than labor-intensive investment patterns. The findings highlight a structural mismatch between the growing youth labor force and the skills demanded by emerging industries. Despite the region's positive economic trajectory, unemployment persists, particularly among young workers, suggesting that economic expansion alone is insufficient for inclusive employment generation. The study identifies the dominance of informal sectors, urban–rural disparities, and educational inequalities as key factors constraining the full employment impact of growth and investment. Policy implications emphasize the importance of integrated strategies that combine targeted investment in labor-intensive sectors, support for micro, small, and medium enterprises (MSMEs), and alignment of vocational education with industry needs. Strengthening public–private collaboration and fostering digital and entrepreneurial competencies can further enhance employment quality and inclusivity. Overall, this study contributes to the regional labor economics literature by providing subnational evidence on the unemployment–growth–investment nexus in Indonesia. It concludes that sustainable job creation in South Sulawesi requires synchronized economic, educational, and demographic policies aimed at maximizing the region's human capital potential and ensuring that growth translates into equitable employment opportunities.

Keywords

Unemployment, Economic Growth, Investment, Panel Data, Regional Development

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1. Introduction

Unemployment remains a major concern in South Sulawesi, impacting its economic stability and development. Despite diverse economic activities and ongoing investments—both domestic and foreign—unemployment rates persist due to factors such as skill mismatches, workforce capabilities, and uneven economic growth across sectors. While investment is vital for job creation, it must align with local needs to be effective [11]. Economic growth has not consistently produced enough jobs, especially in urban areas experiencing rapid migration and labor surpluses. Addressing these challenges requires tailoring education and vocational training to better match emerging industry demands. Focusing on the region's youthful demographic and adjusting skills development can help close the gap between available jobs and workforce readiness [20].

By exploring the interconnections among investment, economic growth, and demography, this study aims to provide actionable policy recommendations for stakeholders in South Sulawesi. Understanding how these factors intersect will enable policymakers to design interventions that enhance investment flows, facilitate sustainable economic development, and align educational and vocational strategies with local labor needs. Promoting an ecosystem conducive to growth and job creation will allow South Sulawesi to effectively address the pressing issue of unemployment, benefiting both the economy and sociocultural fabric of the region.

The reviewed literature collectively addresses the interrelated dynamics of unemployment, economic growth, investment, and demographic characteristics in South Sulawesi and comparable regions. [21, 6] converge on the idea that demographic variables—particularly population growth and unemployment—negatively influence economic growth, with poverty acting as a mediating factor. While both studies rely on regional data, [6] emphasize a more integrated policy perspective, urging synchronization between demographic management and economic strategies.

In contrast, [18] extend the analysis using a vector autoregressive (VAR) model to identify bi-directional causality between economic growth, unemployment, and poverty. This suggests that not only does growth reduce unemployment, but persistent unemployment constrains sustainable economic development. [18] complements this by focusing on the micro-level determinants of unemployment, such as education and age, highlighting the necessity for demographic-sensitive labor interventions.

Provide a somewhat differing view by showing that unemployment's effect on economic growth in Sulawesi Tengah is statistically insignificant, though population and poverty remain influential [17]. This nuance may reflect the structural disparities within the region. [13, 23] underscore the role of investment and labor as key growth drivers. Notably, [23] stress investment's indirect effect on unemployment through growth, while Fitriani et al. emphasize fiscal policy and

workforce participation at the district level.

Although focused on developed countries, validate the empirical strength of Okun's Law, reaffirming that unemployment reliably responds to changes in gross domestic product (GDP). This finding supports the application of similar macroeconomic mechanisms in developing contexts [15]. [12] shifts the lens toward investment, identifying institutional quality and labor skills as prerequisites for attracting foreign direct investment (FDI). His findings imply that South Sulawesi's policy should focus on enhancing human capital to boost job-rich investments.

Finally, [2] distinguishes between public and private investment effects, finding stronger growth outcomes from public sector capital—especially when directed at infrastructure and labor-rich industries. This insight resonates with the need for targeted government expenditure in South Sulawesi to promote inclusive and employment-centered growth. Examining investment trends in South Sulawesi provides crucial insights into the complex dynamics that influence a region's unemployment rates. Investments in both public and private sectors play a fundamental role in shaping local economies. Understanding their different impacts is essential for devising effective strategies to mitigate unemployment.

Government investments in South Sulawesi have historically focused on infrastructure development, social services, and agricultural improvements. Infrastructure projects, including road construction and port improvements, aim to enhance trade and mobility, and thus, economic activities. [26] argue that these investments generate direct job opportunities during the construction phase and indirect work through increased activity in related sectors. The multiplier effect of public spending on infrastructure can lead to job creation in logistics, retail, and services, thus contributing to a reduction in the unemployment rate.

By contrast, private sector investments in South Sulawesi often target areas such as production, tourism, and agriculture. [3] note that foreign direct investments (FDI) significantly improve local industries and promote competitiveness. The presence of multinational companies capitalizing on the region's resources and strategic position can lead to technological transfers, operational efficiency improvements, and higher productivity levels. These factors contribute to job creation because new factories require workers and existing companies to expand in response to the increased demand. The diversification of economic activities through private sector investments is closely linked to fluctuations in the unemployment rate.

A comparative analysis reveals that, while government investments mainly focus on traditional sectors, private investments are more likely to innovate and diversify the labor market. However, there were disparities among the demographic groups. The youth population in South Sulawesi, which constitutes a significant part of the workforce, has

higher unemployment rates. This trend requires both government and private sector investments to prioritize skill development and professional training to meet the needs of the emerging sectors, thus improving employability.

Additionally, the nature of investments—whether capital- or labor-intensive—substantially influences job availability. Capital-intensive industries often employ fewer workers than labor-intensive sectors do, raising concerns about job creation adequacy relative to investment levels. It is vital to support a balance between attracting capital and ensuring ample job opportunities. Policymakers are encouraged to structure incentives favoring labor-intensive companies, especially considering the growing workforce seeking employment.

Ultimately, the interaction between the types of investments, demographic characteristics, and economic outcomes requires comprehensive strategies. Addressing unemployment in South Sulawesi could be achieved through better collaboration between government institutions and private stakeholders, thereby promoting an environment for strategic investments tailored to job creation. Collaborative efforts and targeted investments in key sectors can drive economic growth and reduce unemployment sustainably. Evaluating the economic growth patterns in South Sulawesi involves assessing the GDP growth rates and unemployment levels within the province. Economic growth serves as an indicator of regional economic vitality and determines the employment opportunities. Sulawesi's southern region has exhibited varying GDP growth rates over the last decade, which are influenced by investment flows, infrastructure development, and regional policies.

Reports that South Sulawesi's GDP has notably increased, particularly in agriculture, trade, and manufacturing [19]. However, this growth did not translate uniformly into job creation. Although increasing GDP usually correlates with rising employment opportunities, structural challenges prevent the direct impact of economic growth on unemployment rates. Skill mismatches between employer requirements and resident demographics have emerged as barriers. [8] indicates that growth rates favor certain sectors that do not require proportional increases in labor demand due to technological advances and capital intensity.

As the province leverages its economic potential, its demographic composition presents both opportunities and challenges. With a substantial youth population, aligning economic growth with job creation has become crucial. This demographic phenomenon suggests inclusive economic growth leveraging all residents' potential and emphasizing tailored workforce development programs. The interdependence of economic growth, demographic dynamics, and labor market results highlights the need for strategic policies that prioritize job creation along with GDP improvement. Unemployment persistence in South Sulawesi despite positive GDP growth indicates a misalignment in economic production and labor absorption capacity. [19] notes that growth-driving sectors may emphasize capital investments over labor, exac-

erbating unemployment challenges. Stimulating labor-intensive sectors aligned with local demographics is essential. Initiatives promoting entrepreneurship, strengthening SMEs, and enhancing vocational training programs are mechanisms that address these discrepancies.

Elaborates on the relationship between economic policies, growth sectors, and labor market outcomes [8]. Policymakers should implement interventions to support economic growth and increase employment. Promoting favorable investment climates that attract industries capable of generating diverse job opportunities is vital for addressing unemployment challenges. Thus, while South Sulawesi's economic growth shows promise through improved GDP metrics, its relationship with unemployment remains complex. An integrated approach that recognizes the intertwined nature of investment, demographics, and economic strategies is key to fostering sustainable job creation in the region.

South Sulawesi's demographic composition significantly influences unemployment rates, highlighting the critical intersections of age, education, and skills in the labor market. Various demographic profiles reflect different degrees of human capital, affecting employability and economic opportunities [17]. Age plays a crucial role in the understanding of South Sulawesi's unemployment dynamics. A substantial youth population faces high unemployment rates due to a gap between their skills and labor market requirements [10]. Young jobseekers compete for positions that require more experience, leading to prolonged unemployment. Conversely, older individuals with established careers may struggle to adapt to the changing requirements in a rapidly evolving economic landscape. Educational level is correlated with job possibilities. Higher education levels in South Sulawesi correlate with lower unemployment rates. Individuals with advanced education access various employment possibilities, including emerging sectors requiring higher skill levels [17]. However, disparities in educational resources, particularly in rural areas, inhibit skilled workforce development. Graduates from less-privileged backgrounds are often underprepared for employer expectations, contributing to higher unemployment rates in this demographic subset.

Skill level is increasingly important as economies shift toward knowledge-based industries. South Sulawesi's labor market demands educated individuals with practical skills for specific functions. Skill discrepancies are widespread, and many job seekers' qualifications do not align with the available job opportunities. Economic growth that promotes specific sectors, such as technology and manufacturing, exacerbates this mismatch without adequate training programs. The lack of vocational training initiatives limits employability and perpetuates unemployment. Effective strategies to reduce unemployment must consider the unique demographic characteristics of South Sulawesi. [10] Investments in improving education access and vocational training aligned with market needs are vital. Partnerships between educational institutions and local industries can help align curricula with labor market

demands, creating clearer paths for graduates into the workforce.

Therefore, targeted support initiatives for both young and older adults are crucial. Programs such as mentorship, internships, and on-the-job training can bridge the gap between academic knowledge and practical application. This strategy enhances the labor force skill set, improves economic growth prospects, and reduces unemployment across demographic groups in South Sulawesi. Investment, economic growth, and demographic characteristics collectively influence unemployment dynamics in South Sulawesi. Understanding these interdependencies is essential to creating employment opportunities. Investment catalyses economic growth, impacting unemployment levels. [1] associate FDI with expanded employment opportunities in manufacturing and agriculture. New enterprises and expansion create jobs and reduce unemployment. For example, recent capital inflows into textile and handicraft industries boosted local employment, mirroring trends in other regions like East Java [25].

The demographic variables mediate investment success in reducing unemployment. South Sulawesi's youth population could align well with market demands, depending on the education system's ability to equip young individuals with relevant skills. Studies indicate that a significant skill mismatch undermines the employment benefits of increased investment [1]. Economic growth does not ensure equitable benefit distribution. Wealth distribution inequities may intensify, worsening unemployment among marginalized populations. Urban centers, such as Makassar, experience higher investment levels and economic activity, lowering unemployment compared to rural areas. Geographic disparities present challenges that cannot be resolved by investment and economic growth alone. Cultural dynamics influence the demographic characteristics and unemployment. Traditional gender norms limit women's employment opportunities. Conservative attitudes toward female education contribute to lower female labor force participation. Regions embracing progressive gender norms report lower female unemployment rates, suggesting societal attitude shifts foster broader labor market inclusion [25].

The interplay of investment, economic growth, and demographic characteristics shapes the unemployment dynamics in South Sulawesi. Targeted interventions addressing labor force inequalities and socioeconomic conditions are needed for effective solutions. Addressing persistent unemployment in South Sulawesi requires a multidimensional strategy that integrates investment, economic policies, and education. Previous studies demonstrate the intricate interrelationship among these factors [4, 22, 24]. Targeted investment strategies should prioritize job-creating sectors that align with the regional strengths. Agriculture, tourism, and small-scale manufacturing offer employment opportunities supported by financing and infrastructure development. Investment in agri-food processing strengthens local livelihoods and drives agro-industrial growth, creating employment [5]. Local gov-

ernments can incentivize firms to hire local workers and invest in workforce development, ensuring that economic gains remain within the community.

Economic policy reforms must support micro, small, and medium enterprises (MSMEs), who are key drivers of employment for individuals with lower formal qualifications. Tax incentives, improved financial access, and streamlined regulatory frameworks can support MSMEs. Integrating digital tools into policies enhances market access and operational efficiency [22]. Tailored educational programs address South Sulawesi's demographic needs. Vocational education must reflect the competencies needed in expanding sectors. Strengthening partnerships between educational institutions and industry ensures responsive curricula [24]. Soft-skills training in entrepreneurship, leadership, and teamwork prepares individuals for diverse work environments.

Solutions must be designed that consider regional demographics and geographic diversity. Urban areas may require different strategies than rural communities. Tailoring interventions to address these disparities ensures their effectiveness. Engaging local stakeholders during the planning and implementation phases enhances the relevance and acceptance of proposed solutions. Robust monitoring and evaluation mechanisms assess long-term effectiveness, allowing the adaptive management of emerging labor market challenges. An integrated approach that combines investment, policy reform, and education can reduce unemployment in South Sulawesi. This strategy promoted social cohesion and inclusive development. Recognizing the interdependence of economic structures and human capital enables collaborative and sustainable labor market solutions.

There remains a significant research gap in understanding how investment, economic growth, and demographic dynamics interact at the subnational level in South Sulawesi. Previous studies have largely utilized national-level data to overlook regional heterogeneity. This study addresses this gap by applying panel data econometric techniques to disaggregate the effects of population density, gross fixed capital formation, and economic growth on unemployment across the 24 districts in South Sulawesi from 2017 to 2023. This study integrates demographic variables, such as youth population trends and educational disparities, into the unemployment-investment-growth model, providing a comprehensive labor market dynamics framework. Fixed-effects modeling validated through Hausman testing strengthens the robustness of the findings.

Empirically, this reveals that only economic growth significantly impacts unemployment in the regional context, while investment and population density show inconsistent impacts. Policywise, it offers insights into labor-intensive sectoral investments, education reforms, and spatially adaptive employment strategies. This study advances the academic discourse on regional unemployment in Indonesia and supports evidence-based policymaking tailored to South Sulawesi's socioeconomic conditions. Although numerous studies

have examined the relationships between unemployment, economic growth, investment, and demographic factors in Indonesia, much of the existing literature remains concentrated at the national or aggregate regional level, often overlooking subnational dynamics and heterogeneity. In the context of South Sulawesi, a region with distinct economic structures, demographic profiles, and developmental challenges, limited empirical research has been conducted to systematically assess how these variables interact across districts. Most previous studies have either analyzed these factors in isolation or failed to incorporate demographic variables, such as youth population trends and educational disparities, into quantitative models. Furthermore, the use of panel data econometrics to capture regional variations in unemployment determinants remains under-explored. This gap limits policymakers' ability to formulate evidence-based, location-specific strategies to reduce unemployment. Therefore, this study fills an important void by applying district-level panel data analysis from 2017 to 2023 and integrating economic and demographic indicators to produce a more granular and policy-relevant understanding of unemployment dynamics in South Sulawesi.

Despite the promising economic growth trends in South Sulawesi, unemployment remains a critical and persistent challenge. Investment flows, both public and private, have yet to effectively translate into broad-based job creation, especially in labor-intensive sectors. Furthermore, the region's demographic structure, characterized by a large youth population, is not adequately aligned with the skill requirements of the evolving labor market. The apparent disconnection between economic growth, investment patterns, and demographic realities suggests the presence of structural mismatches that hinder employment absorption. Therefore, a comprehensive analysis is needed to understand how the interrelationship among investment, economic growth, and demographic factors influences unemployment in South Sulawesi.

Research on unemployment in South Sulawesi reveals complex interactions between economic growth, investment, and demographic factors. Economic growth demonstrates a paradoxical relationship with unemployment - while [5] found economic growth significantly reduces unemployment, [16] discovered it positively influences unemployment due to capital-intensive development patterns that fail to create sufficient jobs. Investment consistently shows a negative relationship with unemployment, effectively reducing joblessness [16]. Demographic dynamics play crucial roles, with population growth negatively affecting both poverty and economic growth [7, 14]. Provincial minimum wages significantly reduce unemployment [7], while inflation shows positive but insignificant effects. The research indicates that South Sulawesi's economic growth has not been inclusive, failing to adequately address unemployment and poverty reduction [7]. These findings suggest the need for more employment-focused, inclusive growth strategies rather than capi-

tal-intensive development approaches.

This study investigates the complex relationship between investment, economic growth, and demographic characteristics to address unemployment in South Sulawesi. Specifically, it explores how economic growth relates to unemployment rates in the region, and examines the extent to which public and private investments contribute to employment generation. This research also aims to understand how demographic factors, particularly youth population and education levels, influence labor market dynamics and employment outcomes. Furthermore, it assesses whether a skill mismatch exists between the available workforce and the demands of emerging industries and how this mismatch contributes to persistent unemployment. To ensure methodological rigor, this study compares the performance of different panel data econometric models (Pooled OLS, Fixed Effects, and Random Effects) in capturing the effects of investment, growth, and demographic variables on unemployment across districts. Finally, the study proposes evidence-based policy recommendations by identifying strategies that align investment priorities, education systems, and the labor market needs to effectively reduce unemployment in South Sulawesi.

2. Methods

Panel data regression analysis has become an essential tool in empirical research across the economics, finance, and social sciences because of its ability to capture both cross-sectional and time-series variations in data. Panel data, also known as longitudinal data, consists of observations of multiple entities (such as individuals, firms, or regions) across multiple time periods. This structure provides richer information, more variability, and greater degrees of freedom compared to purely cross-sectional or time-series data, thereby improving the efficiency of econometric estimates [9].

There are three primary econometric models used in panel data analysis: Pooled Ordinary Least Squares (Pooled OLS), Fixed Effects (FE), and Random Effects (RE). The Pooled OLS model assumes that there are no individual-specific effects and estimates a single regression equation by ignoring the panel structure of the data. Although computationally simple, this model is often misspecified if unobserved heterogeneity exists among cross-sectional units. The Fixed Effects model accounts for unobserved heterogeneity by allowing entity-specific intercepts. This model controls for all time-invariant characteristics of individuals, thus eliminating the bias that might result from omitted variables that differ across entities but are constant over time. The FE model is particularly useful when omitted variables are correlated with explanatory variables.

Alternatively, the Random Effects model assumes that individual-specific effects are random and uncorrelated with regressors. Unlike the FE model, which uses within-entity variation, the RE model uses both within and between varia-

tions, which can increase efficiency if the underlying assumptions hold. However, if the assumption of no correlation between individual effects and regressors is violated, RE estimators become inconsistent.

The choice between the FE and RE models is typically guided by the Hausman test, which tests whether the unique errors (unobserved effects) are correlated with the regressors. A significant test result favors the FE model. Panel data regression also allows us to test dynamic relationships through models that include lagged dependent variables, known as dynamic panel models. Techniques such as the Arellano-Bond estimator are employed to address potential endogeneity in such settings. In conclusion, panel data regression analysis offers several methodological advantages such as controlling for omitted variable bias, reducing multicollinearity, and detecting dynamic effects. Appropriate model specification depends on the nature of the data and assumptions that can be reasonably justified.

Despite its strengths, panel data regression has several limitations and is a potential source of bias. A key concern is the assumption of strict exogeneity, which is often difficult to verify in practice. The violation of this assumption can lead to biased and inconsistent estimates, particularly in static models. Moreover, measurement errors, missing data, or unobserved time-varying heterogeneity can undermine the reliability of the results. In the fixed-effects model, time-invariant variables cannot be estimated directly, which may exclude important explanatory factors. In contrast, the Random Effects model, while more efficient under correct assumptions, is vulnerable to bias if the individual effects are correlated with the regressors. Furthermore, unbalanced panels, where different units are observed for different lengths of time, may introduce complexity and affect estimation precision. Finally, model specification errors, such as incorrect functional forms or omitted dynamic effects, can also distort the inference. Therefore, researchers must exercise caution in model selection, conduct robustness checks, and justify the assumptions underlying their chosen panel data models. In conclusion, panel data regression analysis offers several methodological advantages such as controlling for omitted variable bias, reducing multicollinearity, and detecting dynamic effects. However, these advantages must be weighed against the potential limitations and biases. Appropriate model specification depends on the nature of the data and assumptions that can be reasonably justified through theoretical and empirical validation.

This study adopts a quantitative approach using panel data econometric techniques to empirically investigate the impact of population density, economic growth, and gross fixed capital investment on unemployment in South Sulawesi Province. Panel data, which combine both time-series and cross-sectional dimensions, offer significant advantages such as increased degrees of freedom, improved efficiency of estimators, and the ability to control for unobserved heterogeneity that may otherwise bias results in purely cross-sectional

or time-series data.

This study utilizes secondary annual panel data covering a balanced set of provinces in Indonesia over the period 2017–2023 in 24 regions of South Sulawesi. Data were collected from official and publicly accessible sources, including the Central Bureau of Statistics (BPS). The units of analysis are the regions (cross-section units) observed over seven consecutive years (time dimension), thereby forming a panel structure that enables a robust analysis of unemployment performance.

The dependent variables in this study were as follows:

Unemployment (Y_{it}): Measured by the annual growth rate of the unemployment rate.

The independent variables were as follows:

X_{1it}: population density, in thousand

X_{2it}: economic growth, in percent

X_{3it}: gross fixed capital investment in billion Rupiah

X_{4it}: Number of Entrepreneurs proxied by the number of self-employed individuals or business owners per province.

The functional relationship between the variables is modeled using the following linear panel regression specification:

$$Y_{it} = \alpha + \beta_1 PD_{1it} + \beta_2 EG_{2it} + \beta_3 GFCI_{3it} + \varepsilon_{it} \quad (1)$$

Information:

Y_{it} = unemployment rate for region i at year t

PD_{it} = Population density for region i at year t

EG_{it} = economic growth for region i at year t

GFCI_{it} = gross fixed capital investment for region i at year t

α = Intercept term

β₁, β₂, β₃, β₄ = Coefficients estimating the effect of each independent variable

X_{1it}, X_{2it}, X_{3it}, X_{4it} = Explanatory variables for region i at time t

ε_{it} = Composite error term, which may include unobservable individual effects and idiosyncratic errors

This model is estimated using panel data regression techniques, specifically by comparing the three types of models:

Pooled Ordinary Least Squares (Pooled OLS): Assumes homogeneity across cross-sectional units without accounting for individual heterogeneity.

Fixed Effects Model (FEM): Controls for time-invariant characteristics within each province by allowing individual-specific intercepts.

Random Effects Model (REM): Assume that individual effects are random and uncorrelated with the regressors.

Several statistical tests were conducted to determine the most appropriate model. Redundant fixed effects test: To compare Pooled OLS and Fixed Effects models by testing whether fixed intercepts improve model fit. Hausman Test: To assess whether the Fixed or Random Effects model is more suitable, based on the correlation between regressors and individual effects. Following model selection, the chosen specification is subjected to classical assumption testing,

including: Multicollinearity Test: Checked using the Variance Inflation Factor (VIF) to ensure that independent variables are not highly correlated. Heteroscedasticity Test: Breusch-Pagan or White test was used to detect non-constant variance of residuals. Autocorrelation Test: Wooldridge test for autocorrelation in panel data was applied to detect the correlation of error terms across time.

The regression results were interpreted as follows:

- 1) The significance of each independent variable (p-values and t-statistics).
- 2) The magnitude and direction (positive or negative) of influence of the independent variables.
- 3) The overall fit of the model was measured using the coefficient of determination (R^2) and F-statistics.

This methodological framework allows for a nuanced understanding of how population density, economic growth, and gross fixed capital investment contribute to the unemployment rate in South Sulawesi Province. The findings are expected to provide empirical insights for policymakers, particularly in formulating labor force strategies, especially the unemployment rate, to enhance the contribution of the private sector to economic development.

3. Results

3.1. Pooled OLS

The regression output provides insights into the relationship between the dependent variable and the three independent variables: PD, EG, and GFCI. The estimated regression equation is as follows:

$$Y = -3.374 + 1.452PD - 0.077EG - 0.001GFCI$$

Table 1 shows that the intercept (C) is -3.374, which implies that when all independent variables are equal to zero, the expected value of the dependent variable is -3.374. The coefficient for PD is 1.452 and is statistically significant at the 1% level (p-value = 0.000). This indicates that a one-unit increase in PD is associated with an average increase of 1.452 units in the dependent variable, holding the other variables constant. This strong significance suggests that PD was a key explanatory variable in the model.

By contrast, the coefficients for EG and GFCF are -0.077 and -0.001, respectively, but are not statistically significant at conventional levels. EG had a p-value of 0.109, while GFCI had a p-value of 0.243. These results suggest that although the direction of the relationships is negative, there is insufficient statistical evidence to conclude that either EG or GFCI has a meaningful effect on the dependent variable within this model specification.

The overall goodness of fit of the model is reflected by the R-squared value of 0.435, which indicates that approximately 43.5% of the variability in the dependent variable is explained by the independent variables included in the model. The ad-

justed R-squared value of 0.424, which adjusts for the number of predictors, suggests that the explanatory power of the model remains relatively stable and robust after considering model complexity.

The F-statistic for the regression is 41.644 with an associated p-value of 0.000, indicating that the model is statistically significant as a whole. In other words, the independent variables collectively had a significant impact on the dependent variable.

Table 1. Polled OLS Test.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.374	0.755	-4.468	0.000
PD	1.452	0.130	11.114	0.000***
EG	-0.077	0.047	-1.610	0.109
GFCI	-0.001	0.001	-1.170	0.243
R-squared		0.435		
Adjusted R-squared		0.424		
F-statistic		41.644		
Prob (F-Statistic)		0.000		

In conclusion, the regression model was moderately strong in explaining the variation in the dependent variable, with PD emerging as a statistically significant predictor. However, the lack of significance for EG and GFCI suggests a need for further model refinement, potentially through the inclusion of alternative variables or interaction terms, to improve explanatory power and policy relevance.

3.2. Fixed Effects Model

The regression results indicate the relationship between the dependent variable and three explanatory variables: PD, EG, and GFCI. The estimated regression model can be written as

$$Y = 6.944 - 0.420PD - 0.057EG - 0.000GFCI$$

Table 2 shows that intercept (C) has a value of 6.944 and is statistically significant at the 5% level (p-value = 0.012), implying that when all independent variables are equal to zero, the dependent variable is expected to be 6.944. Among the independent variables, only EG showed statistical significance, with a coefficient of -0.057 and a p-value of 0.030. This indicates that holding other factors constant, a one-unit increase in EG is associated with a 0.057 unit decrease in the dependent variable. Statistical significance at the 5% level (indicated by **) confirms that EG has a meaningful and negative effect.

The coefficient of PD is -0.420, but its p-value is 0.391,

which is far above the common significance thresholds (e.g., 0.01, 0.05, or 0.10). This finding suggests that PD does not have a statistically significant influence on the dependent variable in this model. Similarly, the coefficient for GFCI is zero, and the corresponding p-value of 0.735 confirms the lack of statistical significance. These results imply that PD and GFCI are not reliable predictors of the dependent variable in this model specification.

An R-squared value of 0.876 indicates that 87.6% of the variance in the dependent variable is explained by the model, which is quite high and suggests a strong overall fit. The adjusted R-squared, which accounts for the number of explanatory variables, was 0.853, reinforcing the robustness of the model's explanatory power.

The F-statistic was 37.972, with an associated p-value of 0.000. This confirms that the model is statistically significant, implying that the explanatory variables jointly explain a significant portion of the variation in the dependent variable.

Table 2. Fixed Effects Test.

Variabel	Coefficient	Std. Error	t-Statistic	Prob.
C	6.944	2.738	2.536	0.012
PD	-0.420	0.489	-0.859	0.391
EG	-0.057	0.026	-2.192	0.030**
GFCI	-0.000	0.000	-0.338	0.735
R-squared		0.876		
Adjusted R-squared		0.853		
F-statistic		37.972		
Prob (F-Statistic)		0.000		

The regression model demonstrates a strong overall fit, with GE being the only variable that has a statistically significant individual impact on the dependent variable. The non-significance of PD and GFCI suggests that these variables may need to be reconsidered or replaced in future model refinement. Table 3 shows the appropriate model between the pooled OLS and FEM, and the redundant fixed effect test is used.

The results of the Redundant Fixed Effects Tests provide important evidence regarding the suitability of employing a Fixed Effects Model (FEM) in panel data regression analysis. Two statistical tests were conducted: the cross-sectional F-test and the cross-sectional Chi-square test, both designed to assess whether individual-specific (cross-sectional) effects are present and significant in the model.

The cross-section F-test produced an F-statistic of 21.603 with degrees of freedom (23, 139) and a corresponding p-value of 0.000. This test evaluates the null hypothesis that all cross-sectional effects are redundant, implying that there

are no significant differences in intercepts across individual units (such as regions, firms, or countries). The highly significant p-value leads to rejection of the null hypothesis, suggesting that individual-specific effects are indeed present and should be accounted for.

Similarly, the cross-sectional chi-square test yielded a statistic of 252.411 with 23 degrees of freedom and a p-value of 0.000. This test, based on the likelihood ratio principle, also evaluates the null hypothesis of no cross-sectional effect. The result again provides strong evidence against the null hypothesis, confirming that the fixed effects are not redundant.

Table 3. Redundant Fixed Effects Test.

Redundant Fixed Effects Tests			
Effects Test	Statistic	d.f.	Prob.
Cross-section F	21.603	(23,139)	0.000
Cross-section Chi-square	252.411	23	0.000

In summary, the results of both tests strongly support the adoption of a Fixed Effects Model. The presence of significant cross-sectional effects implies that a pooled OLS approach, which assumes homogeneity across entities, is inappropriate. Therefore, accounting for individual-specific heterogeneity through fixed effects is necessary to obtain consistent and unbiased parameter estimates in this panel data analysis.

3.3. Random Effects Model

The regression output provides an analysis of the relationship between the dependent variable and the three explanatory variables: PD, EG, and GFCI. The estimated regression equation is expressed as:

$$Y = -0.537 + 0.919PD - 0.054EG - 0.000GFCI$$

Table 4 shows that the intercept (C) is -0.537, but not statistically significant (p-value = 0.724), indicating that the model does not provide sufficient evidence to suggest that the expected value of the dependent variable differs from zero when all explanatory variables are zero.

Among the independent variables, PD was statistically significant at the 1% level (p = 0.000) with a positive coefficient of 0.919. This implies that holding the other variables constant, a one-unit increase in PD is associated with an increase of approximately 0.919 units in the dependent variable. The significance of PD indicates that it is a strong predictor in the model.

The variable EG also exhibits statistical significance at the 5% level (p-value = 0.038), with a coefficient of -0.054. This

suggests that an increase in EG is associated with a small but statistically significant decrease in the dependent variable, assuming that the other variables are held constant.

On the other hand, the GFCI variable has a coefficient very close to zero and is not statistically significant (p -value = 0.700), indicating that there is no meaningful linear relationship between GFCI and the dependent variable in this model specification. In terms of model fit, the R-squared value was 0.088, meaning that only 8.8% of the variation in the dependent variable was explained by the model. This has relatively low explanatory power, suggesting that the model may omit other important variables or that the dependent variable is influenced by factors not captured in the model. The adjusted R-squared value is 0.071, which is slightly lower because of the adjustment for the number of predictors, and confirms the limited explanatory capability of the model.

Despite the low R-squared value, the model is statistically significant as a whole, as indicated by the F-statistic of 5.253 and associated p -value of 0.001. This means that the independent variables taken together significantly explain some of the variation in the dependent variable, even though individual explanatory power remains limited.

Table 4. Random Effects Test.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.537	1.523	-0.352	0.724
PD	0.919	0.265	3.467	0.000***
EG	-0.054	0.026	-2.090	0.038**
GFCI	-0.000	0.000	-0.384	0.700
R-squared		0.088		
Adjusted R-squared		0.071		
F-statistic		5.253		
Prob (F-Statistic)		0.001		

In summary, the model identifies PD and GE as significant determinants of the dependent variable, with PD having a positive and EG having a negative impact. However, the low R-squared values suggest that the model's overall ability to explain variations in the dependent variable is weak. Future research should consider incorporating additional or alternative variables to improve the explanatory power of the model.

Table 5 shows the appropriate model between FEM and REM, and the Hausman test was used. The Correlated Random Effects Hausman test is a diagnostic tool used to determine the most appropriate panel data estimation technique: the Fixed Effects Model (FEM) or Random Effects Model (REM). The test evaluates whether unique errors (random effects) are correlated with the explanatory variables in the model.

The chi-square statistic was 12.278, with three degrees of freedom, and the associated p -value was 0.0065. The null hypothesis of the Hausman test states that the preferred model is the Random Effects Model, meaning that there is no correlation between individual effects and explanatory variables. Conversely, the alternative hypothesis favors the fixed-effects model, implying that such a correlation exists. Given a p -value of 0.0065, which is statistically significant at the 1% level, we rejected the null hypothesis. This indicates that random effects are not uncorrelated with the explanatory variables, violating one of the key assumptions of REM.

The results of the Hausman test suggest that the fixed-effects model is more appropriate for the data than the random-effects model. This decision is grounded in the evidence of a correlation between unobserved individual-specific effects and explanatory variables, which would bias the estimates in a random-effects framework. Therefore, for this panel dataset, a fixed-effects approach should be employed to ensure consistent and reliable parameter estimations.

Table 5. Correlated Random Effects – Hausman Test.

Correlated Random Effects – Hausman Test			
Test cross-section random effects			
Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f	Prob.
Cross-section random	12.278	3	0.0065

4. Discussion

Regression analysis examining the determinants of unemployment in South Sulawesi reveals varying degrees of influence from the explanatory variables, namely population density, economic growth, and gross fixed capital investment (GFCI). Each variable exhibits a negative relationship with the unemployment rate, although the levels of statistical significance differ.

First, population density has a negative but statistically insignificant effect on unemployment in South Sulawesi. This result suggests that although areas with higher population density might be associated with lower unemployment rates, the relationship is not strong enough to be deemed statistically meaningful. The insignificance of this effect may reflect the complexity of labor market dynamics in densely populated areas, where potential labor market advantages (such as greater access to jobs and services) may be offset by challenges such as increased competition for employment, underemployment, or informal sector dominance. Consequently, the role of population density as a determinant of unemployment appears limited in this context.

Economic growth is also linked to lower unemployment

rates. This follows classical economic theory, which states that when the economy grows, more jobs are created and unemployment decreases. In South Sulawesi, better economic performance leads to more jobs and helps to reduce unemployment. This shows the need for ongoing economic growth to address unemployment in the region. According to the latest data from BPS South Sulawesi (2024), South Sulawesi's labor market has some key features and challenges. As of February 2024, the Labor Force Participation Rate (LFPR) was 68.52%, a slight increase from the previous year. The unemployment rate was 4.18%, which is lower than the national average; however, there is still a need for more jobs, especially in cities. Most people work in agriculture, forestry, and fisheries, which employ approximately 35% of their workforce, followed by trade and manufacturing. However, the shift to more productive industries has been slow. Many people work in informal jobs, with over 60% of such roles, especially in rural areas and traditional industries, which affects job quality and income stability. There were also gender differences, with more men than women working. Youth unemployment, especially for those aged 15–24 years, is high, indicating a gap between education and job market needs. Although education levels have improved, many workers only have a junior high school education or less, limiting their access to formal and skilled jobs. In summary, South Sulawesi's labor market faces challenges such as informal work and under-employment, but there are opportunities for improvement through vocational training, industrial growth, and better matching of education with job market needs.

Lastly, GFCI also exerts a negative effect on unemployment, but the effect is statistically insignificant. While the negative coefficient suggests that higher levels of investment in physical capital (such as infrastructure, machinery, and equipment) may lead to reductions in unemployment, the lack of statistical significance implies that such investments do not have a consistent or robust impact on employment outcomes in South Sulawesi during the study period. This may be due to the nature of investments being capital-intensive rather than labor-intensive or a time lag in the translation of investment into tangible employment benefits.

In summary, the findings indicate that, among the variables considered, only economic growth has a significant and reliable impact on reducing unemployment in South Sulawesi. While population density and GFCI showed negative relationships with unemployment, their effects were not statistically significant, suggesting the need for more targeted and sector-specific policies to enhance their employment-generating potential.

Between 2017 and 2023, the overall economic landscape of South Sulawesi revealed a nuanced relationship between unemployment and economic growth at the regency/city level. A general decline in unemployment rates is observable across most regions, which, at first glance, signals improvement in labor market conditions. For instance, several areas experi-

enced notable reductions in unemployment by 2023 compared to their 2017 levels, suggesting either improved job creation, increased participation in informal employment, or shifts in labor force engagement. This declining trend in unemployment may be attributed to both regional economic policies and the national recovery programs implemented in response to the COVID-19 crisis.

However, this positive employment development is not consistently mirrored by the corresponding gains in economic growth. In contrast, many districts exhibited a downward trend in their economic growth rates over the same period. Prior to 2020, the growth rates in numerous regions were relatively robust, often exceeding 6% to 8%; however, these figures fell sharply during and after the pandemic, with some regencies experiencing growth below 4% by 2023. This stagnation or deceleration in growth implies that the local economies have not fully recovered to their pre-pandemic trajectories. The divergence between falling unemployment and weakening economic performance raises critical questions about the quality and sustainability of employment gains.

Several possible explanations for this have been proposed. First, employment growth may have been concentrated in low-productivity or informal sectors, which tend to absorb labor but do not significantly contribute to the GDP. Second, many regions might have relied on labor-intensive but low-output activities as a stop-gap during economic downturns. Third, fixed capital formation, as reflected in the relatively stable trends in GFCI, has not shown sufficient dynamism to suggest strong investment-led recovery, further limiting the capacity for high-growth and high-quality employment generation.

Therefore, while the reduction in unemployment is a positive indicator, it should not overshadow the underlying structural issues revealed by the stagnating growth rates. A comprehensive strategy that integrates labor market improvements with efforts to stimulate productive investment and diversify regional economic bases is essential. Policies should also consider the enhancement of human capital, infrastructure development, and innovation to ensure that future economic expansion translates to meaningful and sustainable employment across all regencies in South Sulawesi.

5. Conclusion

This study found that unemployment in South Sulawesi is a multifaceted issue shaped by a complex interplay of economic, demographic, and investment-related factors. While economic growth emerges as a statistically significant factor in reducing unemployment, gross fixed capital investment and population density do not demonstrate consistent impacts, reflecting limitations in capital allocation effectiveness and urban labor market dynamics. The dominance of a young labor force, coupled with a skill mismatch, indicates a pressing need to align educational and vocational training pro-

grams with labor market demands.

The empirical evidence supports the adoption of a fixed-effects model, affirming the regional heterogeneity in labor market responses. Moreover, cultural and geographic disparities, particularly between urban and rural areas, exacerbate labor market segmentation and hinder inclusive employment growth. Therefore, policy interventions must go beyond generic growth stimulations. They should include

- 1) strategic investment in labor-intensive sectors;
- 2) support for micro, small, and medium enterprises (MSMEs);
- 3) digital literacy and entrepreneurship promotion; and
- 4) equitable education reform.

A coordinated and adaptive policy framework is essential for the long-term sustainable reduction of unemployment across all regions of South Sulawesi.

Abbreviations

GFCI	Gross Fixed Capital Investment
GDP	Gross Domestic Product
VAR	Vector Autoregressive
FDI	Foreign Direct Investment
OLS	Ordinary Least Square
FE	Fixed Effects
RE	Random Effects
BPS	Central Bureau Of Statistics
VIF	Variance Inflation Factor
EG	Economic Growth
PD	Population Density
LFPR	Labor Force Participation Rate
MSME	Micro, Small, and Medium Enterprises

Author Contributions

Adya Syukri: Conceptualization, Project administration, Resources, Visualization, Writing – original draft

Sri Mustafa: Data curation, Methodology, Software, Validation

Dyan Suryadi: Formal Analysis, Investigation, Supervision, Writing – review & editing

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Data Availability Statement

The data that support the findings of this study can be found at: <https://www.bps.go.id/id>

Conflicts of Interest

This work is no conflicts of interest.

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Biography



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Research Field

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Sri Mustafa: Economic growth, poverty reduction, Islamic finance, labor absorption, and regional development.

Dyan Suryadi: Management, organizational behaviour, human resources, managerial, resources in economic.