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Spatial Analysis of Population Migration and Investment on Unemployment in Indonesia

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Abstract

Unemployment is a structural problem that remains a challenge for the Indonesian economy. Unemployment rates across regions are interconnected due to geographic proximity, population mobility, and economic flows. This study aims to analyze the spillover effects of population migration, foreign direct investment (FDI), and domestic investment (DI) on interprovincial unemployment rates in Indonesia, taking into account spatial interdependence. The study uses panel data from 34 provinces over the 2019–2024 period. The Spatial Durbin Model is employed to capture interregional interactions. The estimation results show that in-migration and domestic investment significantly influence local unemployment. Significant spillover effects are observed for in-migration. Meanwhile, FDI does not show a significant effect either directly or indirectly. Population migration flows from other provinces are found to create externalities that trigger an increase in unemployment in the destination province due to high competitive pressure in the local labor market. Furthermore, spillover effects can significantly amplify or reduce the total impact on regional unemployment, depending on the direction of interprovincial investment flows. Thus, a province's unemployment rate is highly vulnerable to the dynamics of population and capital mobility occurring in neighboring regions, necessitating integrated and collaborative interregional labor market policies to address this issue.

Keywords: Unemployment, Migration, Foreign Direct Investment, Domestic Investment, Spatial Econometrics

JEL Classification: J64, J61, F21, R11, and C23

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Introduction

Unemployment is a structural problem that continues to pose a challenge for the Indonesian economy. This situation not only reflects an imbalance in the labor market but also indicates inefficiencies in resource allocation. As the country with the fourth-largest population in the world, Indonesia is supported by an abundance of labor. However, the abundance of labor supply, which is not matched by the availability of jobs, has triggered a surge in unemployment. According to data from the Central Statistics Agency (BPS), Indonesia's unemployment rate has actually shown a downward trend, falling from 5.23% in 2019 to 4.91% in 2024. However, this decline masks underlying disparities, as the unemployment figures reveal significant geographical variations across provinces. The highest unemployment rates in 2024 were recorded in West Java Province at 6.75% and Banten Province at 6.68%, while the lowest rate was in Bali Province at 1.79%.

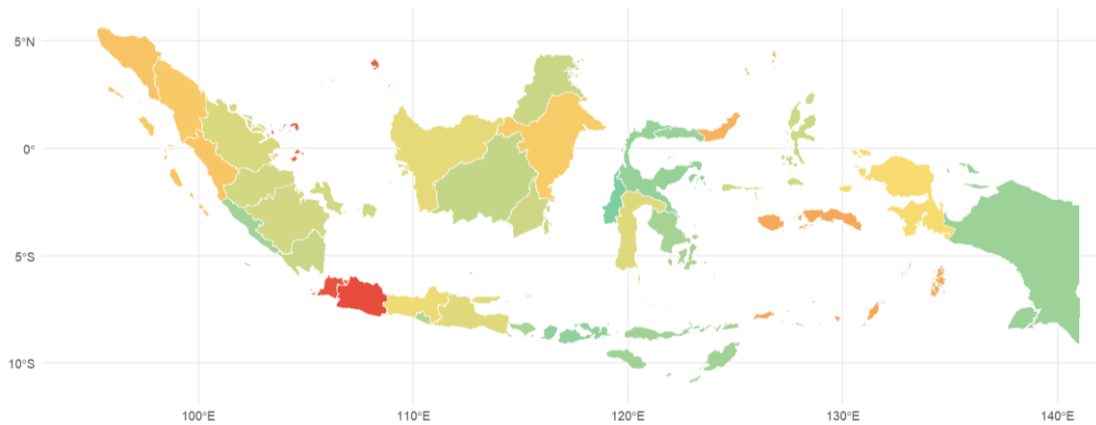


Figure 1. Average Open Unemployment Rate in Indonesia, 2019–2024

Source: Processed data (2025)

Based on the visualization results, the average TPT across Indonesia is not randomly distributed but rather forms a clustering pattern. Provinces and regions that serve as centers of investment accumulation actually form spatial clusters with relatively high open unemployment rates (Fauzi et al., 2023; Usali et al., 2021). High concentrations of unemployment in economic growth centers are driven by the spatial spillover effects of migration (Huynh & Vo, 2023). Regions with large investments act as growth magnets, attracting in-migration from surrounding rural areas (Guo & Qiao, 2020). The high volume of low-skilled migrants arriving with expectations of high wages exceeds the absorption capacity of available job openings, leaving them trapped in open unemployment in their destination regions. Consequently, interregional economic disparities are widening because economic growth is enjoyed only by a handful of sectors, while the social burden of unemployment accumulates in these urban/industrial centers. Interprovincial population migration and the distribution of investment create economic interdependence that generates spillover effects across regional administrative boundaries. This raises questions about the extent to which variations in the economic conditions of provinces and other factors are related to unemployment rates across various provinces in Indonesia. This study aims to assess the spatial spillover effects of population migration and investment on unemployment rates in various provinces in Indonesia.

In Lewis's theory, the province of origin acts as a traditional (subsistence) sector experiencing a labor surplus, while the destination province acts as a modern sector that continues to grow due to investment inflows. The inflow of investment into the destination province will open up new job opportunities and create an attraction in the form of higher wages (Rong et al., 2020). This stimulates spatial labor migration from the origin province to the destination province. For the origin province, this migration has a positive impact as a safety valve that draws the unemployed out of the region, thereby reducing pressure on the local labor market in the origin province. However, the greatest challenge in the Indonesian context is that the majority of the migrating workforce consists of low-skilled workers (Handayani, 2015). When this wave of low-skilled migrants floods growth centers beyond the absorption capacity of existing capital-intensive investments, they cannot be absorbed by the modern sector. As a result, rather than achieving prosperity, this migration flow actually shifts the social burden in the form of a buildup of new open unemployment to the regions, which ultimately widens the gap in economic disparities between regions destination

The dynamics of this inter-regional transfer of labor burdens theoretically underscore the existence of strong geographical linkages, so this phenomenon must be analyzed using a spatial analysis approach. Through a spatial approach, inter-regional interactions can be mapped using a spatial weighting matrix to capture how investment and migration in one region trigger spillover effects on unemployment rates in neighboring regions. It is precisely these dimensions of spatial dependence and the "neighborhood effect" that are key to accurately unraveling the roots of structural inter-regional inequalities a crucial reality of economic geography that, unfortunately, will always remain uncaptured if this research relies solely on conventional, non-spatial analytical approaches.

In line with this, several previous studies have shown that economic factors are closely linked to unemployment rates. A study by Mustafa (2025) conducted in East Nusa Tenggara indicates that migration flows contribute to a decline in unemployment. Meanwhile, empirical evidence regarding the

impact of investment on unemployment yields mixed and sometimes contradictory results. National studies indicate that FDI has a significant negative relationship with provincial unemployment rates in Indonesia, implying that foreign investment contributes to labor absorption (Elia et al., 2023; Hawariyuni & Andrasari, 2022); however, the impact on unemployment shows inconsistent results across regions. A study in East Kalimantan covering the period 2018–2024 found no significant relationship between domestic investment and unemployment, whereas in Mataram City during the period 2008–2022, investment actually showed a positive and significant association with open unemployment (Shofyuddin & Primandhana, 2025; Saputra et al., 2024). These inconsistent findings indicate that the impact of investment requires further analysis, including consideration of spatial effects across regions. Additionally, when assessing the impact of investment, variables such as the minimum wage, foreign workers, and per capita GRDP should also be taken into account (Gunawan & Nuzula, 2020; Elia et al., 2023).

Various studies have analyzed the determinants of unemployment in Indonesia using non-spatial approaches such as OLS, FEM, and GMM. Unfortunately, these methods assume that regions are not interconnected. Interprovincial population migration flows and the distribution of investment create economic interdependencies that generate spillover effects across regional administrative boundaries. This phenomenon raises questions about the extent to which variations in the economic conditions of other provinces are related to unemployment rates in various provinces across Indonesia. This study aims to assess the spatial spillover effects of population migration and investment on unemployment rates in various provinces in Indonesia.

Literature Review

Economic growth does not spread evenly but is concentrated in specific regions at varying speeds and intensities (Edwards, 2017). Growth poles exhibit higher job growth compared to surrounding regions. Lewis's dual sector theory explains that growth poles act as modern sectors supported by accumulated investment, while surrounding regions act as traditional sectors (Todaro & Smith, 2015). Investment inflows into growth poles create a surge in new jobs, triggering massive population migration from traditional sectors in response to expectations of higher wages. Harris–Todaro explain that migration decisions are based on income expectations, not on actual income earned; thus, individuals continue to migrate despite the risk of unemployment. If the heavy flow of migrants from surrounding areas is dominated by a less-skilled labor force that exceeds the absorption capacity of modern capitalism, these growth poles will actually experience a buildup of open unemployment across regional boundaries.

Meanwhile, for the regions being left behind, this outflow of residents has a dual and contradictory impact. On the one hand, migration acts as a short-term safety valve capable of absorbing excess labor and reducing hidden unemployment in traditional sectors. This reduction in population burden could, in theory, increase the marginal productivity of the workers remaining in their regions of origin. However, if this mobility occurs on a massive scale and continuously drains the productive-age group—who possess higher work motivation—the regions left behind risk facing the “backwash effect.” As a result, the regions of origin will experience economic stagnation and a shortage of potential human resources, which will ultimately widen the gap in economic disparities between regions in Indonesia.

A study by Huynh & Vo (2023) examined the relationship between migration and unemployment in countries Asian, including Indonesia. The authors concluded that increased migration raises unemployment in low-income and lower-middle-income countries such as India, Indonesia, the Philippines, and Vietnam. This occurs due to migrants' lack of skills relative to the demands of employers in urban areas. The failure of labor market competition in cities exacerbates unemployment in those areas (Fajri et al., 2023). In a study by Mustafa (2025) aimed at examining the impact of out-migration in NTT, the results showed a significant negative effect on unemployment. Out-migration reduces disparities in the regions left behind, but in-migration actually worsens the situation (Fajri et al., 2023). Migration to urban areas creates significant environmental disparities, such as the emergence of settlements along riverbanks.

Firms seeking to maximize profits will adjust their use of production inputs in response to increased investment. Firms will reallocate input factors to an optimal level, where the ratio of input prices equals the marginal product ratio. When capital increases due to investment, the price of capital relative to labor decreases. The substitution effect encourages firms to replace labor with capital at the same output level. Additionally, increased investment drives firms to expand their operations by

increasing production output. Business expansion requires more labor and boosts labor demand. The scale effect indicates that as firms increase production output, the demand for all inputs rises (Borjas, 2008). Research on the impact of investment on unemployment has yielded mixed results. Based on the above discussion, the effect of increased investment on labor absorption depends on the magnitude of the substitution effect and the scale effect. FDI has a negative relationship with the unemployment rate (Alalawneh & Nessa, 2020; Elia et al., 2023; Hawariyuni & Andrasari, 2022; Nguyen et al., 2024), is not significant (Tegep et al., 2019). Domestic investment has a positive relationship with unemployment (Shofyuddin & Primandhana, 2025; Saputra et al., 2024), a negative relationship (Simamora, 2025), and no significant relationship.

Research Method

This study uses provincial-level data from Indonesia for the years 2019–2024, compiled by relevant agencies. As a secondary data study, this research utilizes annual quantitative panel data from various regions. The cross-sectional data covers all 34 provinces in Indonesia, while the time series spans from 2019 to 2024. A total of 204 observations were used. The dependent variable in this study is the open unemployment rate (TPT). The independent variables are migration, FDI, and domestic investment (PMDN). Additionally, the control variables used include the minimum wage (UMP), GRDP per capita, and foreign workers (TKA).

Table 1. Classification and Data Sources

Variable	Data	Unit	Source	Agency
Unemployment	TPT	Percent (%)	bps.go.id	BPS
Migration	Inward Migration	Percent (%)	bps.go.id	BPS
Minimum Wage	UMP	Rp	bps.go.id	BPS
FDI	FDI Realization	Million USD	satudata	BKPM
Domestic Investment	Realized Domestic Investment	Billion rupiah	satudata	BKPM
GRDP	GRDP per capita	Million USD	bps.go.id	BPS
TKA	RPTKA	People	satudata	BKPM

Source: Processed data (2025)

To capture spatial effects, this study requires a spatial weighting matrix W (Yasin et al., 2020). These weights indicate the interdependence between one region and another. To determine the weight values of a region's matrix, the distances between the centroids of provincial polygons on the map (Husada & Yuhan, 2022) were used. The matrix used is of order $n \times n$, where n in this study represents the 34 provinces in Indonesia.

$$w_{ij} = \begin{cases} \frac{1}{d_{ij}} & (i \neq j) \\ 0 & (i = j) \end{cases} \quad (1)$$

with

$$d_{ij} = \sqrt{(u_i - u_j)^2 + (v_i - v_j)^2} \quad (2)$$

The weight matrix w_{ij} has a value of 0 on the diagonal ($i = j$), while the other elements $i \neq j$ represent the weight of the interaction between regions i and j (Anselin & Bera, 1998). The weights in matrix W fall within the range (0,1) after row standardization (Golgher & Voss, 2016). A weight of 0 is assigned if a region is not adjacent to another region. The closer the distance between regions, the larger the assigned weight (Agustina et al., 2022). The values d_{ij} are determined based on u = long and v = lat.

In this study, spatial autocorrelation testing is necessary to determine the presence of associations between one region and another. Autocorrelation analysis was conducted globally using Moran's I and locally using LISA (Local Indicators of Spatial Association). The Moran's I index indicates the presence of spatial dependence, characterized by clustering patterns. The results of the Moran's I autocorrelation test fall within the range of -1 to +1 (Husada & Yuhan, 2022). The closer the Moran's I value is to 1, the stronger the spatial pattern. To identify the specific locations of areas that are associated with other areas, the autocorrelation analysis can be supplemented with LISA (Local Indicators of Spatial Association).

This study uses the Spatial Durbin Model and impact analysis. The SDM is an extension of the SAR model, which captures only spatial lags in the dependent variable. The SDM was selected for this study

without conducting an LM test because the aim was to examine both global and local indirect effects. Global indirect effects emerge when the inverse matrix contains ρ , and local effects emerge when the matrix contains θ (Golgher & Voss, 2016). The SDM approach in this study utilizes three spatial weighting methods adapted to the conditions of the Indonesian archipelago, including the KNN, IDW, and Queen's Contiguity methods. These models were compared based on AIC and BIC values (Burnham & Anderson, 2004). Models with lower AIC and BIC values are considered more optimal than others (Primayesa et al., 2023).

The human resource estimate can be expressed in the following formula:

$$\begin{aligned} \text{Unemployment} = & a_i + \rho \sum_{j=1}^{34} w_{ij} \text{Unemployment}_{jt} + \beta_1 \text{MIGRASI}_{jt} + \beta_2 \text{Log UMP}_{jt} + \\ & \beta_3 \text{Log FDI}_{jt} + \beta_4 \text{Log DI}_{jt} + \beta_5 \text{Log GRDP}_{jt} + \beta_6 \text{TKA}_{jt} + \theta_1 \sum_{j=1}^{34} w_{ij} \text{MIGRASI}_{jt} + \\ & \theta_2 \sum_{j=1}^{34} w_{ij} \text{Log UMP}_{jt} + \theta_3 \sum_{j=1}^{34} w_{ij} \text{Log FDI}_{jt} + \theta_4 \sum_{j=1}^{34} w_{ij} \text{Log DI}_{jt} + \\ & \theta_5 \sum_{j=1}^{34} w_{ij} \text{Log GRDP}_{jt} + \theta_6 \sum_{j=1}^{34} w_{ij} \text{TKA}_{jt} \end{aligned} \quad (3)$$

Where ρ = spatial lag coefficient of the dependent variable, a = constant term, β = direct effect coefficient, θ = indirect effect coefficient, W = weight matrix of order $n \times n$, ε = error vector of order $n \times 1$.

To examine the overall impact of inter-regional dependencies, an impact analysis is required. The coefficients in the SDM model only indicate the partial effects of each variable. Spatial analysis requires consideration of multiplier effects because a change in one variable will trigger a chain reaction that affects the entire spatial system (Oktafianto et al., 2019). Direct effects are the average of the independent variables' influence on the dependent variable within the same region, including feedback effects from spatial dependence (diagonal areas of the matrix). Indirect effects are the average influence of independent variables in neighboring regions on the dependent variable in the local region (non-diagonal areas of the matrix) (Golgher & Voss, 2016).

Results and Discussion

Autocorrelation Test

Table 2. Moran's I Index

Year	Moran's I Index				
	Moran's I	Expected I	Z-Score	p-value	Notes
2019	0.168	-0.030	2.164	0.015	autocorrelation
2020	0.185	-0.030	2.398	0.008	autocorrelation
2021	0.139	-0.030	1.87	0.031	autocorrelation
2022	0.200	-0.030	2.507	0.006	autocorrelation
2023	0.221	-0.030	2.724	0.003	autocorrelation
2024	0.227	-0.030	2.783	0.003	autocorrelation
2019–2024	0.258	-0.005	5.747	0.000	autocorrelation

Moran's I index for 34 provinces in Indonesia for the 2019–2024 period shows significant results, as indicated by p-values below the 0.05 significance level. The increase in Moran's I from 0.168 in 2019 to 0.227 in 2024 indicates a strengthening of spatial clustering patterns. Provinces with high unemployment are increasingly clustered near other regions with high unemployment. Similarly, areas with low unemployment tend to be adjacent to other areas with low unemployment. This is due to the flow of economic activity between neighboring regions (Akai et al., 2007). This condition is also supported by inter-regional population migration, which increases with greater geographical proximity. Thus, it can be concluded that there is strong autocorrelation in unemployment across Indonesia as a whole. This finding identifies a spatial pattern in unemployment and a tendency for it to cluster in neighboring regions.

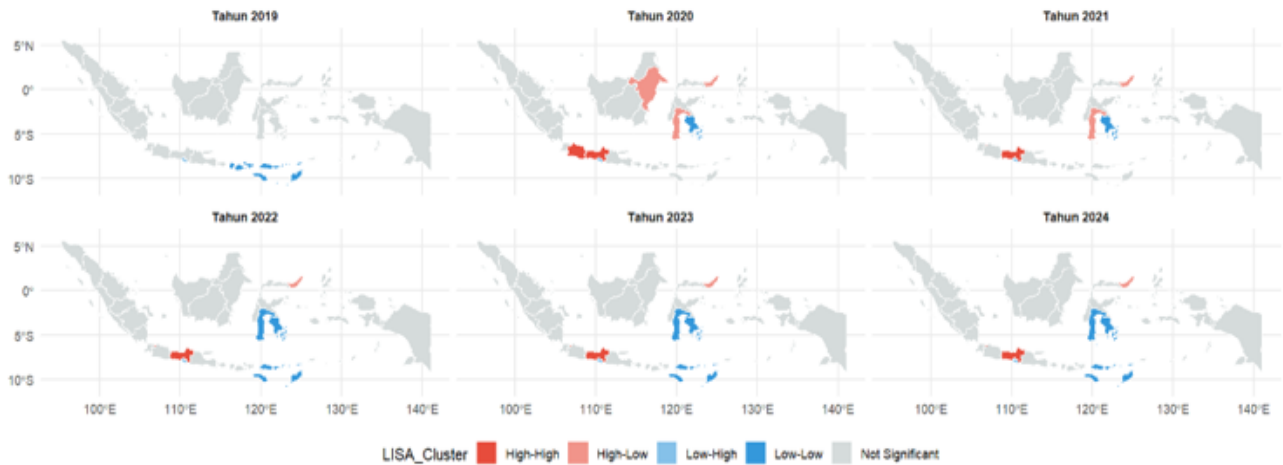


Figure 2. LISA Map
Source: Processed data (2025)

Based on the LISA analysis for the years 2019– 2024, the Indonesian provinces showing significant spatial correlation patterns ($p\text{-value} < 0.05$) are DKI Jakarta, West Java, Central Java, South Sulawesi, North Sulawesi, East Kalimantan, Yogyakarta Special Region, Southeast Sulawesi, and East Nusa Tenggara.

Partial Analysis

Table 3. Human Resources Model

Variables	SDM_KNN	SDM_IDW	HR_Queen
	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
Intercept	-36.756*** (13.09)	-36.856 *** (12.62)	-2.069 (7.86)
Migration	0.078*** (0.02)	0.0763*** (0.02)	0.074*** (0.02)
Log UMP	0.367 (0.68)	0.203 (0.68)	0.521 (0.59)
Log FDI	-0.011 (0.11)	-0.029 (0.11)	0.060 (0.12)
Log DI	0.381*** (0.13)	0.397 *** (0.13)	0.367*** (0.12)
Log GRDP	-0.939** (0.38)	-0.916** (0.39)	-0.761* (0.39)
Log TKA	0.140 (0.09)	0.147* (0.09)	0.098 (0.09)
W× Migration	-0.105*** (0.03)	-0.096*** (0.03)	-0.053** (0.026)
W× Log UMP	2.040* (1.05)	2.181** (1.00)	-0.371 (0.23)
W× Log FDI	-0.230 (0.18)	-0.269 (0.18)	-0.378** (0.15)
W× Log DI	-0.018 (0.18)	0.008 (0.18)	-0.102 (0.16)
W× Log GRDP	1.025 (0.64)	1.060* (0.62)	0.784 (0.52)
W× Log TKA	0.304** (0.137)	0.318 ** (0.13)	0.382*** (0.12)
$\rho(rho)$	0.263***	0.20716	
AIC		732.14732.94	743.86
BIC		781.91782.71	793.63
n		204	

Note: significance levels 0.10, 0.05**, 0.01***

The estimation results show that the KNN HR model has the lowest AIC and BIC values compared

to the other models. Therefore, in the interpretation, this study uses the KNN HR model as the selected model.

Table 4. Direct and Indirect Effect

	Direct	Indirect	Total
MIGRATION	0.072*** (0.017)	-0.110*** (0.04)	-0.038 (0.04)
logUMP	0.492 (0.65)	2,774** (1.30)	3,266** (1.31)
logFDI	-0.025 (0.11)	-0.302 (0.23)	-0.327 (0.24)
logDI	0.386*** (0.13)	0.106 (0.22)	0.492** (0.20)
logGRDP	-0.893** (0.39)	1.010 (0.82)	0.117 (0.89)
logTKA	0.160 (0.09)	0.442*** (0.16)	0.602*** (0.16)

Note: significance levels 0.10, 0.05**, 0.01***

The Effect of Migration on Unemployment

Based on the results of the OLS estimation of the migration variable on unemployment, there is a significant effect on both the direct and indirect effects. The direct effect shows that a 10 percentage-point increase in the rate of inbound migration in a local region will result in a 0.72 percentage-point increase in unemployment in the same region, holding other variables constant (*ceteris paribus*). This finding is consistent with research conducted by [Huynh and Vo \(2023\)](#), which shows an increase in unemployment due to the effects of migration in middle- and low-income Asian countries.

These findings indicate that the Lewis dual-sector model holds, explaining migration flows from regions of origin which act traditional sectors toward growth poles which act as modern sectors driven by the availability of jobs and higher wages. Harris–Todaro explain that migration decisions are based on income expectations, not on actual income earned; thus, individuals continue to migrate despite the risk of unemployment. If the heavy flow of migrants from surrounding areas is dominated by a less-skilled labor force that exceeds the absorption capacity of modern capitalism, these growth poles will actually experience an accumulation of open unemployment across regional boundaries. This phenomenon aligns with conditions in Indonesia, particularly on the island of Java, which is the top destination for inter-island migration, especially from West Java Province and the Special Capital Region of Jakarta (DKI Jakarta). ([Central Statistics Agency, 2025](#)). Java's role as the center of national economic activity, coupled with its attractive infrastructure and comprehensive facilities compared to other regions, makes it a key consideration for migrants choosing to come to the island. The impact can be observed through a LISA analysis, which reveals a pattern of relatively high unemployment concentrated in the Java region.

Furthermore, indirect effects also show significant results: a 10-percentage-point increase in the inflow migration rate in surrounding areas will result in a spillover effect of 1.10 percentage points in the reduction of unemployment in the local area, *ceteris paribus*. This finding aligns with a spatial study on unemployment rates conducted by [Mustafa \(2025\)](#), which was carried out in the East Nusa Tenggara region. Although no significant effect was found, the East Nusa Tenggara region indicates a decline in unemployment in the origin area due to out-migration flows in surrounding areas. The results of this study expand the urban–rural migration model: if surrounding areas possess factors that attract inflow migration to their regions, residents in the local area will choose to migrate to those surrounding areas rather than remain in their current location. This creates a redistribution of the labor force, which reduces labor supply pressure in a given region, as migrants choose to pursue new opportunities elsewhere. The reduction in labor supply pressure leads to a more even distribution of the labor force across regions. Consequently, the local region shows a significant reduction in the unemployment rate.

The Effect of Investment on Unemployment

Based on the estimation results, these investment measured using the variables, FDI and DI show mixed results. FDI indicates no significant effect on the direct, indirect, or total effects. These non-significant findings are consistent with research conducted by [Tegep et al. \(2019\)](#) across 26 provinces in Indonesia. Meanwhile, DI shows a significant effect on the effect direct. The direct effect indicates that a 10 percent increase in a local region will result in a 0.039 percentage point increase in unemployment in the same region, *ceteris paribus*.

Investment realization in Indonesia remains uneven and tends to be concentrated in certain regions or sectors, particularly in provinces on the island of Java. According to the UNDP (2025), 64% of Indonesia's national income is supported by the formal sector, while the remaining 36% comes from the informal sector. Informal employment accounts for 59% of national income. In other words, there is a disparity between formal and informal employment in Indonesia. While investment plays a role in creating formal jobs, the reduction in unemployment resulting from investment represents only a small portion of total employment.

The inflow of FDI that employs a workforce similar to that of domestic investment intensifies competition in the skilled labor market. The migration of skilled workers to companies with a technological edge forces domestic investment to reduce its hiring of unskilled workers in order to remain sustainable (Matsuura & Saito, 2023). New domestic investment in other regions will trigger the migration of skilled workers from the local area. The decline in the employment of less-skilled workers increases unemployment, not to mention that the local area will lose its top human resources. As a result, unemployment in the local area rises. The alignment between these direct and spillover effects amplifies the increase in unemployment, resulting in a significant total effect of 0.492.

The Effects of the UMP, PMDN, and TKA on Unemployment

Based on the estimation results, other variables showing a significant influence on unemployment include the direct effect of and the indirect effects of the regional minimum wage (UMP) and foreign workers (TKA). An increase in GRDP per capita has been shown to reduce regional unemployment. Conversely, an overall increase in foreign workers leads to a rise in the unemployment burden due to labor market competition. The issue is that an increase in the regional minimum wage (UMP) in other regions has a positive correlation with rising unemployment in the local region. According to theory, when other regions have a higher UMP, unemployment in the region of origin should decrease due to migration. However, empirical data actually show the opposite trend. This empirical contradiction can be explained through several interregional labor market mechanisms. First, an increase in the UMP in other regions triggers policies aimed at improving production cost efficiency and industrial automation in the destination region. This creates strict entry barriers for less-skilled migrants from the local region, preventing the theoretical potential for labor absorption from materializing. Second, these spatial wage differentials trigger business relocations from high-wage regions to local regions with more competitive wages. Relocating factories often bring their own skilled workforce with them, while the arrival of these new industries disrupts the local labor market, sparks intense competition, and actually increases the open unemployment rate due to the local labor market's inability to absorb the influx of workers. Third, according to the Model Lewis, high regional minimum wages trigger speculative migration. When these migrants fail to find jobs outside their home regions due to intense competition, they return to their home regions (return migration) and cumulatively increase the open unemployment rate in their local areas.

Conclusion

This study successfully demonstrated the existence of significant spatial dependence and spillover effects between regional economic conditions and interprovincial unemployment rates in Indonesia. Population migration from other provinces was found to create externalities that trigger an increase in unemployment in the destination province due to intense competitive pressure in the local labor market. Conversely, the distribution of investment in neighboring provinces significantly does show a spatial impact not significant on the local region. Nevertheless, spillover effects can either amplify or reduce the total impact on regional unemployment, depending on whether the direction of the contribution from interprovincial investment aligns with or opposes its direct impact. Thus, the

unemployment rate in a province is clearly vulnerable to the dynamics of population and capital mobility occurring in neighboring regions, so addressing this issue requires integrated and collaborative inter-regional labor market policies.

This analysis has limitations: the research model uses a Durbin spatial model (MLE) with pooled data, which ignores the panel data structure that includes both time-series and cross-sectional dimensions. The choice of this model is based on the limitations of RStudio for analyzing the Durbin spatial model on panel data. This study also has limitations because it only uses static panel data analysis, whereas several previous studies have used dynamic panel models with the GMM approach. Therefore, it is recommended that future analyses use models that account for panel data structure, such as SDM with fixed effects and random effects. Additionally, analyses that account for temporal dynamics can be conducted using SDM through a dynamic GMM approach.

CRedit Author Statement

Tri Rohmy Wainrni Purwanti: Conceptualization, Methodology, Formal analysis, Resources, Data curation, Writing – original draft, Writing – review and editing, Visualization. **Maal Naylah:** Conceptualization, Methodology, Validation, Supervision, Funding acquisition.

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Generative AI Disclosure

During the preparation of this manuscript, the authors used SciSpace, Gemini, and ChatGPT to improve grammatical quality, refine sentence structures, and edit the draft. Following the use of these services, the authors thoroughly reviewed and edited the generated content. For data processing in RStudio, DeepSeek was utilized to assist with the coding process and error checking. DeepL was also employed for English translation. The authors have independently verified all results and assume full responsibility for the final outcome of this research.

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