

What are the Spatial Linkage Patterns in East Kalimantan Region?

Endah Kurnia Lestari^{1*}, Fivien Muslihatinningsih², Achmad Faridh As Shidqy³

^{1,2,3}Faculty of Economics and Business, University of Jember, Indonesia

E-mail: ¹endahkurnialestari8@gmail.com, ²fivien.feb@unej.ac.id, ³faridhasshidqy@gmail.com

*Corresponding author

JEL Classification:

O1
O18
R11
R12

Received: 27 March 2025

Revised: 12 July 2025

Accepted: 17 July 2025

Available online: October 2025

Published regularly: October 2025

ABSTRACT

Research Originality: This research is original research that examines the spatial linkage between regions in East Kalimantan Province comprehensively

Research Objectives: This study examines economic concentration and inter-regional connectivity and their impact on growth dynamics in East Kalimantan.

Research Methods: This research uses a Spatial Autocorrelation Analysis based on Moran's Index, Herfindahl-Hirschman Index, and Gravity Index. Data was analyzed from 10 regencies/cities in East Kalimantan from 2017 to 2023.

Empirical Results: The study results indicate weak spatial integration among regencies/cities in East Kalimantan. Moran's Index shows low positive spatial autocorrelation, suggesting limited economic spillover from high-GRDP regions. Market structure analysis reveals sectoral dominance, particularly in mining, leading to low diversification and oligopolistic tendencies. Gravity Index findings highlight strong spatial interaction between Kutai Kartanegara and Samarinda, while Mahakam Ulu remains isolated.

Implications: This study shows that spatial linkages between regions in East Kalimantan remain weak, with the dominance of extractive sectors leading to a concentrated market structure and regional disparities. To address this, strategic regional planning is needed through improved connectivity, economic diversification, and the strengthening of non-extractive sectors. An inclusive and integrative policy approach is essential to achieve equitable and sustainable growth across the region.

Keywords:

Spatial Autocorrelation Analysis, Spatial Linkage, Economic Concentration, Spatial Interaction

How to Cite:

Lestari, E. K., Muslihatinningsih, F., & Shidqy, A. F. A (2025). What are the Spatial Linkage Patterns in East Kalimantan Region?. *Signifikan: Jurnal Ilmu Ekonomi*, 14(2), 303-324. <https://doi.org/10.15408/sjie.v14i2.45607>.

INTRODUCTION

The development of a region cannot be separated from its geographical relations and interactions with other regions, considering the specific potential and needs of each area. Spatial interconnectedness (spatial linkage). It is important in regional economic analysis to determine the influence between geographically adjacent regions, both directly and indirectly, namely by identifying economic resources and activities in one region that can support each other to reduce inequality between more developed and less developed regions by optimizing the management of local resources and potentials (Rodriguez-Pose & von Berlepsch, 2023).

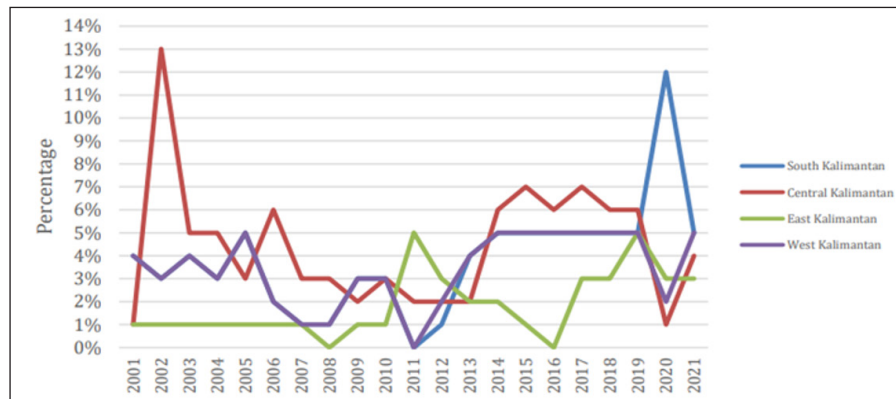
Various studies have examined spatial linkages in Indonesia, such as the analysis of the spatial linkage of economic growth between provinces (Fahmi, 2022), the linkages between metropolitan areas (Wijayanti et al, 2023), and the linkages of transportation infrastructure between regencies/cities (Fadhil et al, 2022). These studies generally use economic spatial model approaches such as the Spatial Autoregressive Model (SAR), the Spatial Durbin Model (SDM), or the Location Quotient (LQ) to statistically analyze the relationship between regions. Moreover, most of the research focuses more on the islands of Java and Sumatra, which historically have a high concentration of development.

Specifically, efforts to align Indonesia's economic growth focus on Kalimantan because, as part of Indonesia, each region's economic growth positively impacts the national economy. This fact is shown in Figure 1, which contributed an average of 9.46% to Indonesia's total GDP. The gross regional product (GRDP) of all provinces in Kalimantan has continued to make a considerable contribution to the national economy over the past ten years. Therefore, Kalimantan is a crucial region for the country's development and must be considered when integrating Indonesia's overall development. However, the difference in GRDP between 2000 and 2021 in each province in Kalimantan shows that there is income inequality on the island. Over the past 20 years, East Kalimantan's average GRDP per capita growth has been 8.48%, which is 1.12 times slower than South Kalimantan's average growth of 9.43%. In contrast, Central Kalimantan's growth rate is 1.15 times faster than South Kalimantan's. For this reason, it is necessary to examine the mechanism behind this economic gap, as shown by the variation in the GRDP per capita growth rate between provinces. (Imaduddin & Kharisma, 2024).

Kalimantan is a part of Indonesia with striking economic development in each region, which has different economic characteristics compared to Java and Sumatra. Kalimantan is a region that is highly dependent on the mining sector and natural resources, especially coal and petroleum. This dependence causes Kalimantan's economic structure to pay less attention to connectivity between regions, making it vulnerable to fluctuations in global commodity prices (Lasaiba, 2023). Although Kalimantan's economy is growing relatively fast (+5.43%), its share of contribution to the national economy remains small because Java and Sumatra still dominate the economic base, so regional growth in Kalimantan tends to be stagnant and uneven, as shown by income inequality between provinces (Imaduddin & Kharisma, 2024). Economic growth in Kalimantan is

closely linked to the influence of road infrastructure and private investment (Hermawan & Yunani, 2025), as well as the quality of human resources, which increases the region's contribution to the national economy (Fitrianiingtyas & Nuryadin, 2025).

Figure 1. Economic Growth in all Provinces in Kalimantan (percent)



Source: Central Statistics Agency, 2001-2021

One of the regions of Kalimantan, especially East Kalimantan, still receives relatively little attention despite having unique spatial characteristics, such as the dominance of the extractive sector, the spread of scattered settlements, and the plan to relocate the National Capital. East Kalimantan Province has a high GRDP, but its economic growth is still relatively low and uneven between regions. The economy still depends on the mining sector, and inequality between regions tends to decrease each year, driven by improvements in coal prices and strategic IKN projects that strengthen regional economic growth. (Permatasari et al, 2024).

In the last decade, geospatial studies in East Kalimantan have developed, mainly focusing on spatial distribution patterns. Moran's I and LISA identify the concentration of economic activity in big cities, showing inequality between regions. The results of the LISA cluster map show one new growth center in East Kalimantan Province, namely East Kutai Regency, which indicates a potential shift in regional economic dynamics (Pratiwi & Kuncoro, 2016). Likewise, research by Wijaya et al. (2020) on the mapping of spatial interactions between regions in East Kalimantan, using the gravity model and Klassen typology, shows a growth pattern centered in economic centers such as Kutai Kartanegara and Samarinda. This condition aligns with Hirschman's (1958) polarization theory and explains how economic growth tends to concentrate at the poles, drawing resources from surrounding regions and leading to widening regional gaps.

Therefore, a growth center-based development strategy requires policies that strengthen connectivity between regions, infrastructure development in buffer zones, and economic incentives for productive sectors outside the main centers (Rodríguez-Pose & Wilkie, 2018). The importance of the close relationship between spatial aspects and economic growth in East Kalimantan is evident, as areas with good transportation access,

such as toll roads and ports, have a higher GRDP than areas with limited infrastructure. Because they have connectivity, investment, and trade between regions, they can reduce regional disparities and encourage inclusive economic growth (Fahmi, 2022). Spatial linkages such as inter-regional connectivity play a role in shaping regional disparities and economic concentrations. To overcome this, efforts are needed to encourage the effect of spread, namely the spread of growth benefits to surrounding areas through strengthening connectivity, equitable distribution of infrastructure, and investment incentives for disadvantaged areas (Krugman, 1991; Combes & Gobillon, 2015; Rahayu & Febriaty, 2024).

However, previous studies are still focused on the interaction patterns or distribution of a single indicator (e.g., hotspots, GRDP, economic mobility), without explicitly examining the traces of multivariate spatial linkage between various economic components, infrastructure, and regional interactions in East Kalimantan. In addition, most previous studies are still based on traditional methods such as single-variable autocorrelation or static gravity models. Different spatial linkage analysis approaches have never been applied holistically in East Kalimantan. Consequently, there is no comprehensive analysis that integrates various variables, such as economic concentration, regional distance, and interaction between regions, to determine how regions in East Kalimantan are interconnected and impact regional economic growth.

Spatial dependence has an impact on economic growth between regions. Therefore, this study aims to reduce disparities by identifying spatial linkage patterns in East Kalimantan. It focuses on the distribution patterns, spatial concentrations, and interactions between regencies/cities regarding the distribution of GRDP, as well as effective economic interactions between developed and developing regions. Thus, this research is expected to expand the analytical discourse from focusing solely on the distribution or interaction of single indicators to a deeper understanding of the structural and functional connections between regions in East Kalimantan within the context of sustainable development.

METHODS

The research covers 10 regencies/cities in the province of East Kalimantan in Indonesia. In this study, a 6-year time series of data from 2017 to 2023 was used. This time frame provides a more comprehensive picture of changes in economic structure and the potential for the emergence of new economic patterns. The data used in this study are secondary, obtained from official publications by Statistics Indonesia (BPS) and other institutions related to the research topic.

The variables observed in this study in each region are economic growth, Gross Regional Domestic Product (GRDP), population (P), and distance between regions (d). The definition of variables is as follows: (1) Economic Growth is a change in economic conditions from time to time in percentage; (2) GRDP is defined as the total gross amount of all sectors in the region, both oil and gas and non-oil and gas, based on fixed prices in a given base year in units of millions of rupiah; (3) Total population (P)

is defined as the total number of persons residing in the area who are aged 15 years and above and are considered to be in the productive age group (on thousand); (4) The distance between regions (d) is defined as the distance from one city to another, i.e. the distance of several city from the city of Samarinda in km.

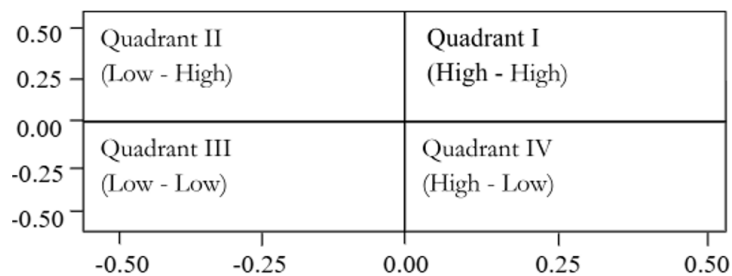
The analysis method in this study uses Spatial linkage, or spatial autocorrelation, which occurs due to inter-regional interactions and similarities in the characteristics of an object in space. Spatial patterns can be clustered, dispersed, or random. Positive spatial autocorrelation indicates that adjacent areas have similar characteristics and tend to form clusters, while negative spatial autocorrelation indicates differences in characteristics between adjacent areas, resulting in scattered patterns.

Moran's I is a method used to identify the characteristics of spatial patterns in three forms, namely clustered, random, and separated. Moran's I is used to see whether there is spatial autocorrelation in a region. Moran's I can be measured by the equation (Moran, 1950):

$$I = \frac{N \sum_i \sum_j w_{ij} (x_i - \bar{x})(x_j - \bar{x})}{S_0 \sum_i (x_i - \bar{x})^2}$$

The Moran Index includes a Moran Scatterplot that displays the spatial influence distribution graph, divided into four quadrants (see Figure 2).

Figure 2. Morans Scaterplot



Source: (Marliani, 2021)

Quadrant I (High-High) reflects the concentration of high-value areas close to each other, while Quadrant II (Low-High) indicates the presence of low-value areas in the middle of high-value neighborhoods. Quadrant III (Low-Low) represents the interconnectedness of low-value areas close to each other, while Quadrant IV (High-Low) depicts high-value areas surrounded by low-value areas.

The Herfindahl Index is used to measure the degree of spatial concentration of a subsector within a region. The index indicates whether a subsector is evenly distributed or concentrated in a few locations. The value of the index ranges from 0 to 1, where a value close to 0 indicates even distribution, while a value close to 1 indicates high concentration in a region (Setiawan et al, 2021). The higher the value of this index, the greater the inequality of subsector distribution, which may indicate economic dominance in a particular region. Conversely, the lower the value of this index, the more evenly

distributed the subsectors are in the region being analyzed. The Herfindahl Index is widely used in regional economic analysis to understand spatial patterns and potential inequality between regions.

$$HHI_i = \sum_{i=1}^J (TK_i)^2$$

Description: *HHI_i* = The level of concentration of Large and Medium Industries for each Regency/City in East Kalimantan and *TK_i* = The total number of Large and Medium Industry workers in each Regency/City in East Kalimantan.

The Gravity Index measures economic linkages between regions based on economic attractiveness, population and distance. A high index value indicates close economic interaction, while a low value signifies a weak relationship. This concept assumes that regions with large GRDP or population tend to have stronger economic linkages. Conversely, the greater the distance between regions, the weaker the economic interaction due to increased transportation costs and geographical barriers. Gravity Index Formula (Sen & Smith, 1995):

$$i = \frac{P_1 \times P_2}{J}$$

The amount of inter-regional interaction (I) is influenced by the population in each region, namely *P₁* for region *i* and *P₂* for region *j* (in thousands). The larger the population, the higher the potential for economic interactions, such as trade and labor mobility. However, this interaction also depends on *J*, the distance between regions (in km). The longer the distance, the greater the barriers to interaction due to transportation costs and accessibility.

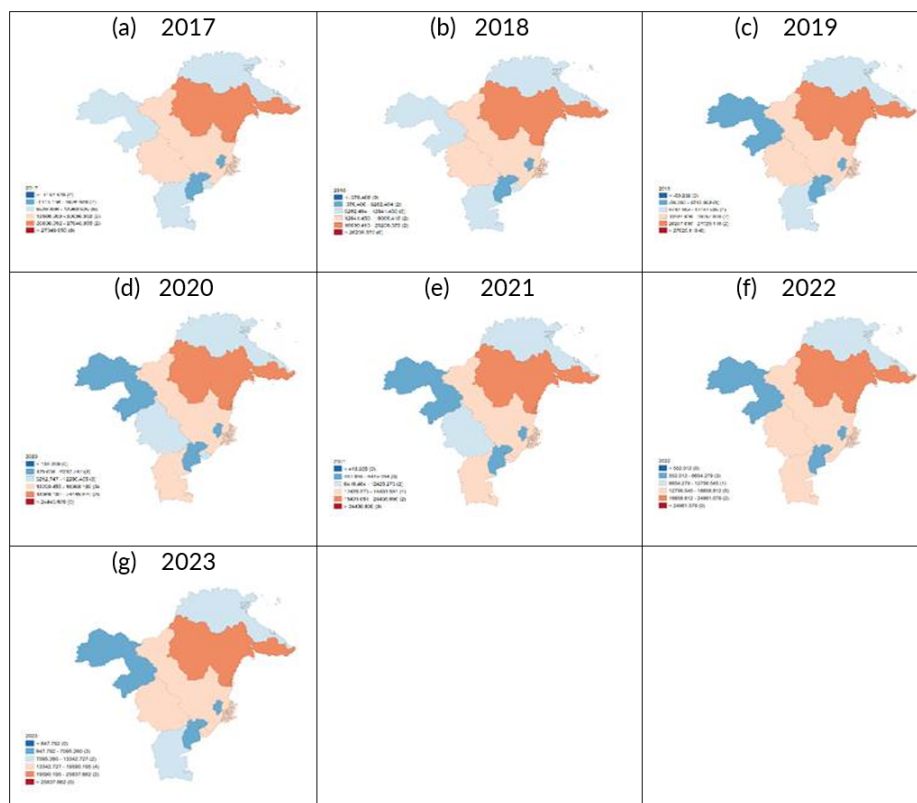
RESULTS AND DISCUSSION

The results of spatial autocorrelation analysis in East Kalimantan, which measures the level of spatial interdependence or inter-regional relationships, occur due to the interaction between regions and the similarity of regional characteristics. Using a spatial analysis approach, it is possible to identify patterns of clustering geographically (spatial clustering) or randomly dispersed. This can be seen from the results of the spatial autocorrelation analysis of each regency/city in East Kalimantan. The GRDP data description results for East Kalimantan from 2017 to 2023, based on 10 regencies/cities, are shown in Figure 3.

The results of the analysis show that East Kutai has the highest average GRDP per capita during the 2017-2023 period due to its large-scale coal mining sector, dominant exports, and relatively small population. Spatially, East Kutai has a stronger economic interaction with the global market (coal and CPO exports) than with the local region. This condition will create a potential regional spatial disparity, even though it is part of a strong economic cluster with regional spatial interactions dominated by the mining sector and its strategic position. East Kutai is in Quadrant I (high growth + high per capita GRDP) and is included in the advanced and fast-growing category, confirming the per capita disparity in East Kalimantan (Wijaya et al, 2020; Nur, 2021; Espinosa et al, 2024).

Furthermore, the groups with the second-highest GRDP per capita order are found in the Kutai Kartanegara, Balikpapan, and Paser areas due to their strategic position in the economic corridor and IKN development. Balikpapan has become a growth center, while Kutai Kartanegara and North Penajam Paser are the second-level growth centers in the IKN corridor based on the centrality index and scalography (Wahyudin, 2022), as well as the existence of spatial linkages dominated by extractive sectors such as mining and oil and gas, and supported by relatively better infrastructure (access to ports) and roles as distribution/logistics centers. This reflects the economic interaction between regions and the pattern of agglomeration in economic activities, namely by utilizing port and transportation infrastructure to create economic clusters. In line with the research of Kinanthi & Indrayati (2023), analyzing the distribution of the oil and gas sector in Kutai Kartanegara and proving the existence of a multiplier effect and clustered distribution that supports the role of this region as an extractive and regional distribution economic center, and with the analysis of Location Quotient and ShiftShare, this result also shows that the base sector in Balikpapan reaches the processing, electricity & gas, trade, transportation & communication that strengthens the strategic position of this city as a logistics center and economic agglomeration so that from the analysis of Klassen Balikpapan as "developing quickly but not advanced" and Kutai Kartanegara as "developed but depressed", reflects the dynamics of the economic agglomeration of extractive clusters in the IKN corridor (Sari et al, 2018; Espinosa et al, 2024).

Figure 3. Thematic Map of GRDP 2017-2023 Regency in East Kalimantan



Source: Geoda Data Processing Results

Meanwhile, the groups with the third-highest average GRDP per capita are West Kutai and Berau because their economic sectors are dominated by mines and plantations with high output, low population, and spatially geographical position as economically independent hinterland areas, which are rich in natural resources, even though they are separate from the growth center. Research by Wijaya et al. (2020) on spatial gravity analysis reveals a one-way relationship pattern from coastal growth (such as Berau) to inland areas, reflecting an economically independent hinterland pattern in resource-rich regions like West Kutai and Berau. This pattern creates a large concentration of economic added value because the impact of economic agglomeration and infrastructure connectivity that is not yet optimal will have the potential to form similar economic clusters in natural resource-based growth, namely from the results of the Location Quotient (LQ) analysis, it was found that the leading sector in West Kutai shows the dominance of the natural resources sector (mining and quarrying) and contributes significantly to GRDP (Karmini et al, 2022).

The regencies/cities with the lowest average GRDP per capita are Samarinda, North Penajam Paser, and Mahakam Ulu. Samarinda, despite being the provincial capital and having strategic geographical access, faces challenges due to its high population. These three regions have limited spatial linkages and function more as centers of government, distribution, or hinterland areas that have not been economically productive. It is shown that the highest inequality value is in Samarinda. However, the provincial capital has a low GRDP per capita due to the lack of integration of productive sectors and the absence of strong economic agglomeration. It shows a significant contribution from differences in regional investment and spending. This indicates that administrative functions are not encouraged by the productivity of the primary economic sector (Handoko, 2020). Spatially, they do not have a strong economic linkage with the surrounding productive areas, so they do not form economic growth clusters that strengthen each other due to weak infrastructure and connectivity, one of which is that the North Penajam Paser area is still a local logistics hub without optimal productive connectivity to the regional/export market so that there are local growth centers but the interaction is relatively limited. Reflects that this area has not been closely integrated with the surrounding productive economy (Harits et al, 2022; Vidriza, 2024).

To determine the presence of spatial autocorrelation between observation locations in a region, the Moran test is required. The value on the Moran index is between $-1 \leq I \leq 1$, where if the value $-1 \leq I < 0$, then it indicates the presence of negative spatial autocorrelation, while the value $0 < I \leq 1$ indicates the presence of positive spatial autocorrelation. In this study, the calculation of the Moran index uses distance weighting with the K-Nearest Neighbor approach. The Moran index value can be seen in Table 1.

Table 1. Moran's Index Value of GRDP 2017-2023

Year	Moran's Index	results
2017	0.211	positive spatial autocorrelation
2018	0.169	positive spatial autocorrelation
2019	0.144	positive spatial autocorrelation
2020	0.110	positive spatial autocorrelation
2021	0.079	positive spatial autocorrelation
2022	0.081	positive spatial autocorrelation
2023	0.093	positive spatial autocorrelation

Source: processed data

Table 1 shows that an analysis of the Moran's Index of Gross Regional Domestic Product (GRDP) per capita in East Kalimantan Province from 2017 to 2023 indicates significant spatial linkages between regions. These findings illustrate changes in economic distribution patterns that reflect non-static spatial relationships between regencies and cities in the region (Table 1). From 2017 to 2020, Moran's I values showed a positive spatial autocorrelation, with values that continued to decline: 0.211 in 2017, 0.169 in 2018, 0.144 in 2019, and 0.110 in 2020. Although Moran's Index tends to be low, its positive direction suggests that regions with high GRDP per capita are generally located near regions with high GRDP, and the same is true for regions with low GRDP. This reflects the existence of weak but still positively significant spatial linkages among regencies/cities in East Kalimantan. This research is in line with research from Jeleskovic & Loeber (2023), which analyzes the spatial dimension of the industrial sector that has an impact on local economic growth due to competition and synergy between regions, as well as spatial grouping to expand the scope of spatial interaction beyond adjacent areas and cover areas with similar characteristics (Fitriani et al, 2024).

From 2021 to 2023, there is a tendency to weaken spatial autocorrelation, although the value of Moran's Index still indicates a positive trend. It was recorded that the index value was 0.079 in 2021, slightly increased to 0.081 in 2022, and reached 0.093 in 2023. Despite the numerical increase, this trend actually reflects a decline in the strength of spatial linkages between regions. This result means that the level of GRDP per capita between regions is no longer geographically concentrated. This fact indicates that regions with high GDP per capita are beginning to coexist with those having lower GDP levels. This phenomenon indicates a weakening of spatial agglomeration and an increase in regional disparities.

Changes in the spatial pattern of GRDP per capita distribution in East Kalimantan during the 2017–2023 period can be attributed to some structural determinants, including high but uneven economic dependence on the mining sector, inequality in access and quality of infrastructure between regions, and the initial impact of the development of the new capital city of Indonesia (IKN) which began to trigger the relocation and

redistribution of economic activities in certain regions. The results of the Moran Scatterplot analysis and distribution map in Figure 4 reveal no dominant spatial cluster. The data distribution across the quadrants reflects the absence of a stable and integrated spatial pattern between regions.

Analysis of the Moran Scatterplot and the map of the distribution of GRDP per capita in East Kalimantan during the period 2017–2023 shows that the distribution of economic activities between regencies/cities is uneven and does not form a stable spatial pattern. The low but still positive value of Moran's Index, close to zero in some years, reflects the weak spatial linkage in the dynamics of regional economic growth. This result shows that the geographical proximity between regions has not been enough to create a significant economic spillover effect. The distribution of areas across the Moran Scatterplot quadrant reflects geographically adjacent areas, highlights similarities in development or economic growth levels, and indicates significant differences in economic dynamics between regions. According to Krugman (1991), in New Economic Geography, spatial concentration can produce increasing returns and encourage uneven regional growth, but they affect each other, and economic growth in a region is not entirely determined by internal factors alone, but also by its proximity to other developing regions.

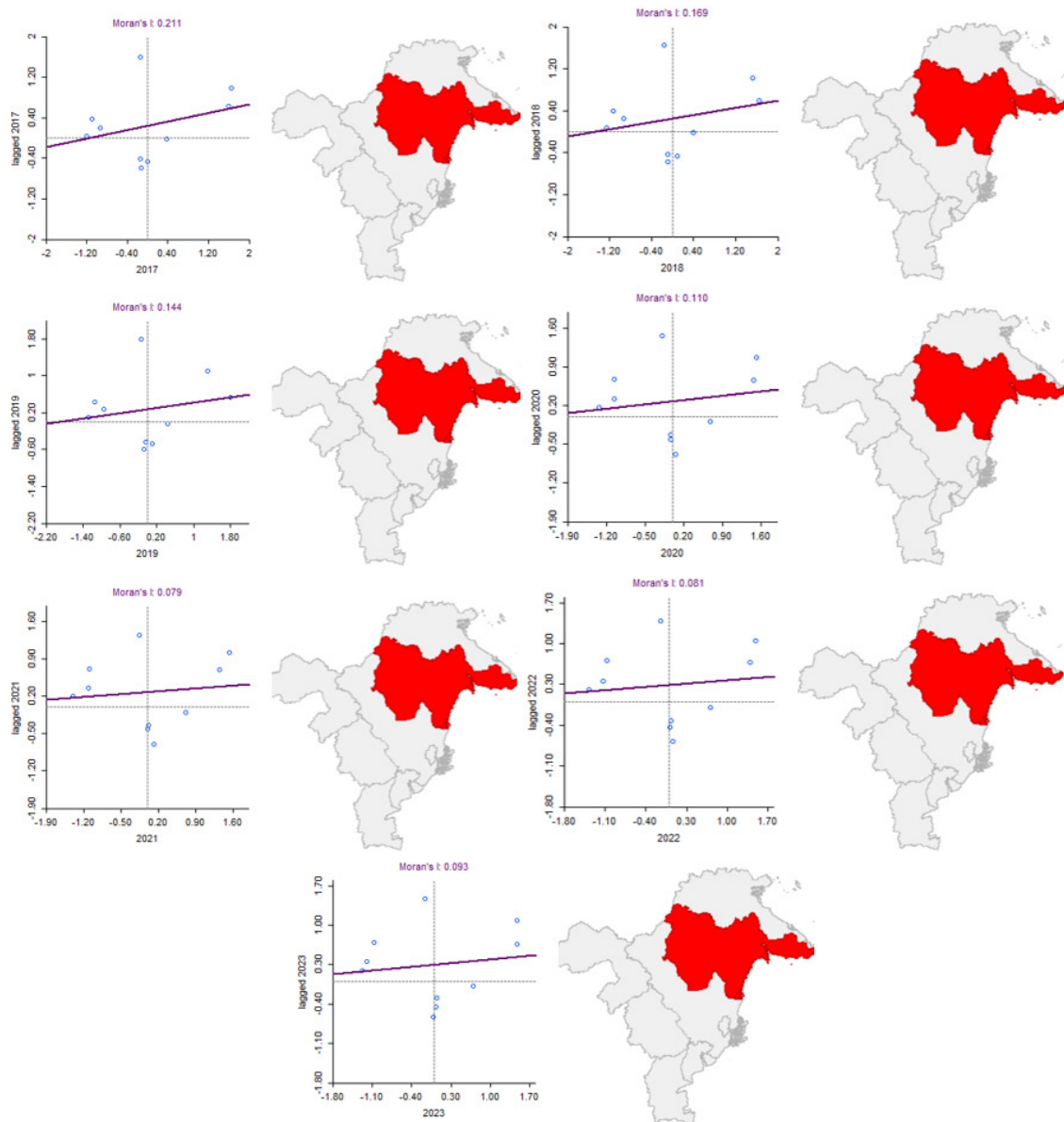
The results of the Moran Scatterplot analysis show that Bontang and East Kutai Regency occupy Quadrant I (High-High), which represents areas with high GRDP per capita levels and are surrounded by areas with similar economic characteristics. This reflects the significant contribution of their leading sectors to the establishment of economic growth centers in East Kalimantan.

Bontang demonstrates high economic performance due to the dominance of the processing industry sector, particularly the petrochemical and Liquefied Natural Gas (LNG) industries, which provide significant added value and attract national and international investment. Meanwhile, East Kutai regency relies on the large-scale coal mining sector and is the main coal production center in Indonesia. These extractive activities not only contribute significantly to local GRDP but also create a multiplier effect on economic activity in the surrounding region.

The geographical position of the two regions near other resource-rich areas will strengthen the spatial linkages in extractive-based economic clusters. This shows that the strength of the main sectors in Bontang and East Kutai is sustainable and highly competitive, enabling them to encourage stable and cohesive regional economic growth. The spatial interaction between these regions reflects the positive interconnectedness that supports the formation of an integrated economic cluster, particularly when natural resources are used as the main engine of economic growth. The same study from Wang et al (2019) shows significant spatial dependency and heterogeneity in economic growth between provinces in China, where the effects of natural resource spillovers tend to impact growth negatively.

The areas classified as Quadrant II (Low-High) in the Moran Scatterplot, namely Berau, Samarinda, Mahakam Ulu, and North Penajam Paser, show interesting spatial

Figure 4. Moran Scatterplot and GRDP distribution map 2017-2023



Source: Geoda Data Processing Results

characteristics. Although these regions have relatively low GRDP per capita rates, they are directly adjacent to regions with high GRDP. The results of this study align with the research of Khotiawan & Sakti (2023) on the existence of a positive spillover effect on per capita income between adjacent regions where the spatial pattern of growth is clustering. This pattern reflects the potential for local spatial inequality, where areas with weak economic performance are located around growth centers, or the occurrence of a backwash effect, as growth centers provide spillover to the surrounding areas. However, these effects are not always even (Richardson, 1978).

The city of Samarinda, as the capital of East Kalimantan province, has a diverse economic structure, covering the trade, service, and transportation sectors. However,

the phenomenon of overurbanization, characterized by a high population that is not balanced by adequate employment, results in the GRDP per capita being lower than in the surrounding areas. Meanwhile, North Penajam Paser, before the influence of the development of the new capital city of Indonesia (IKN), still relied on primary sectors such as agriculture and forestry, which have relatively low economic added value. Mahakam Ulu, as the youngest regency in the province, faces significant development challenges, particularly due to limitations in basic infrastructure and inter-regional accessibility. This condition hinders the optimization of local economic potential. Berau regency, despite having considerable natural resources, especially from the mining and plantation sectors, has not been able to encourage a significant increase in the per capita income of its people.

The inclusion of these four regions in the Low-High category reflects the opportunity for growth diffusion from areas with high GRDP to the surrounding areas. However, it also indicates the need for more targeted development policy interventions to optimally utilize the potential of existing spatial linkages, thereby reducing disparities between regions and designing more efficient strategies (Zhang & Gibson, 2024).

Furthermore, Quadrant III (Low-Low) is Balikpapan and Paser. These regions have low GDP per capita and are surrounded by other regions with similarly low GDP. This spatial pattern shows a low potential for positive linkages in economic growth and indicates a concentration of underdevelopment. This can reinforce development stagnation in the region, meaning that economically weak areas tend to be close together, reinforcing the pattern of spatial underdevelopment (Fitriani et al, 2024). In other words, there is a phenomenon of "spatial inertia" or "spatial poverty trap", which strengthens the poverty trap because the underdeveloped areas tend to form clusters and do not change without large-scale external intervention (Fitz & Gouri, 2021). Balikpapan, which was once one of the centers of the oil and gas industry, is now experiencing a decline in the sector's contribution and has not been entirely able to transform into other economic sectors, thereby hindering its economic growth and oil and gas dominance, creating a less inclusive and sustainable economic structure (Obeng-Odoom, 2024). Paser, although it has the potential of the mining and plantation sectors, faces challenges in maximizing the sector's contribution to sustainable per capita GRDP due to limited supporting infrastructure. This is strengthened by the theory of economic development, which emphasizes the importance of infrastructure in increasing economic growth by utilizing linkages between economic sectors (Hirschman, 1958). Affirmative policy interventions and local capacity building are the drivers of economic structural transformation in these areas with a Low-Low spatial pattern.

The areas of Kutai Kartanegara and West Kutai, identified as being in Quadrant IV (High-Low) in the Moran Scatterplot, exhibited contrasting spatial characteristics: they have a high level of Gross Regional Product per capita. However, they are surrounded by areas with low levels of GRDP per capita. This configuration reflects an isolated economic growth pattern or enclave, where the economic progress of the surrounding region does not mirror the achievements of the enclave itself. This is in

line with the phenomenon of "growth divergence": one region is self-developing, but the adjacent region is not developing or is declining (Evcim et al, 2023; Jayadevan et al, 2025).

Kutai Kartanegara has gained a strategic position in the economic map of East Kalimantan thanks to the dominance of leading sectors such as mining, oil and gas, and the processing industry, which contribute significantly to the creation of regional added value. This research is in line with (Jeleskovic & Loeber, 2023; Imaduddin & Kharisma, 2024) research that the existence of industrial sector clusters has a significant effect on local and national GRDP growth as well as the existence of relatively adequate industrial infrastructure, which has helped strengthen the region's economic position and become a center for knowledge spillovers, with technology, management, and innovation flowing to other sectors to support economic diversification (Khlystova & Kalyuzhnova, 2025). On the other hand, West Kutai, despite being geographically more remote, is still able to maintain a high GRDP per capita through the exploitation of the resources of the mining and forestry sectors. A similar empirical case in Africa that mining areas despite being remote and underpopulated show a surge in the local economy during the mining operation period (Asatryan et al, 2024), while the same empirical case in China shows that remote areas with high mining can maintain high GRDP when supported by green education and innovation, which turns the "resource curse" into sustainable development opportunities and forestry technology innovations can transform the primary sector in remote areas into more value-added, thereby keeping GRDP per capita high through productivity spillover and more advanced industrial structures (Ma & Chen, 2023; Li et al, 2024).

This spatial condition indicates a disconnect between the growth centers and the surrounding regions, reflecting the weak economic linkages between them. According to Krugman (1991), the absence of spatial integration reinforces the polarization between the center and the periphery, which will further widen the regional gap. In other words, only pockets of local growth/growth occur and the spillover effect or economic diffusion to the surrounding area has not occurred optimally (Myrdal, 1957; Hirschman, 1958) This emphasizes the importance of regional development policies that not only focus on increasing the output of the superior regions, but also encourage spatial integration and connectivity between regions with high GRDP and the surrounding regions that are underdeveloped as a strategic step to create more equitable and sustainable growth in East Kalimantan.

The Herfindahl-Hirschman Index (HHI) is a quantitative measure used to assess the level of market concentration and competition structure in an economy. This index is calculated by summing the square of the market share of each economic actor or sector in a region (Pepall et al, 2014). The calculation of the Herfindahl-Hirschman Index in East Kalimantan shows that the market structure in the area has different levels of concentration. This concentration is generally influenced by the dominance of one or two major sectors, especially the mining and processing industries. This phenomenon aligns with the characteristics of East Kalimantan's economy, which is highly dependent on

natural resources, particularly coal, oil, and gas, resulting in an undiversified economic structure. When one sector dominates a region's economy, market conditions become uneven, leading to decreased competition among economic actors and market structures that often result in oligopoly and even monopolies.

Using the top four concentration ratio (CR4) and Herfindahl-Hirschman Index (HHI) approaches, the market structure of East Kalimantan reveals a significant difference in economic competition between the regency and the city. If these two indicators are used together, they will provide a complete picture of the economy's concentration and the dominant direction of a particular sector in the local economy. Most regions, such as Paser, West Kutai, Kutai Kartanegara, East Kutai, Berau, Mahakam Ulu, Balikpapan, and Bontang, showed a CR4 value > 0.70 and an HHI ranged between 0.25 and 1.00. Based on market structure theory (Schmalensee, 1989), CR4 values above 0.60 and HHI above 0.25 indicate a high level of concentration, which can lead to oligopoly or monopoly structures. In East Kalimantan, the dominance of the mining and quarrying industry, along with the agricultural or processing industries in some other regions, leads to limited market access for other companies, decreases competition, and increases economic dependence on global changes. In contrast to these conditions, areas such as North Penajam Paser have a CR4 value of ≈ 0.17 and an HHI $\approx$ of 0.18, indicating a moderate oligopoly structure with the dominance of several sectors but greater opportunities for competition. With a CR4 ≈ 0.46 and an HHI ≈ 0.11 , the provincial capital of Samarinda shows competitive market conditions. This value shows that the market is very open and that no single sector really dominates the economy. This is in accordance with the fact that Samarinda has many service, trade, and government sectors scattered throughout the city, which results in a more balanced economic structure and more advanced infrastructure, showing a more competitive and sustainable market structure in East Kalimantan.

According to structure behavior performance theory, non-competitive market forces are more likely to form if the market is more concentrated (Bain, 1951). When economic sectors are not diversified, there is an inequality of opportunity. As a result, the market becomes less able to absorb labor and innovate (Pepall & Norman, 2014). As a result, if an economic transformation that results in sector diversification is not carried out, areas with high concentration values, such as Mahakam Ulu or Kutai Kartanegara, have the potential to experience structural vulnerability in the long term because the economic structure that is not inclusive and minimal diversification makes it difficult for regions to transition. After all, the linkages with other sectors are weak and show dominance that limits competition (Irawan et al, 2021; Bruno, 2022; Dira et al, 2023; Banurea & Benardin, 2024). Highly concentrated economic structures in regions tend to increase regional disparities, reduce the efficiency of resource distribution, and decrease the resilience of local economies to external changes. Regencies with high concentrations should be encouraged by sector diversification and pro-competition policies to increase market efficiency (e.g., through small business subsidies, new investor incentives, deregulation). Meanwhile, in regions such as North Penajam Paser and Samarinda, which are more competitive, the focus is

on improving the quality of human resources and infrastructure to support sustainable growth.

Understanding the patterns of spatial interaction between the growth center and the surrounding area is crucial in the study of regional economics and spatial planning, as it helps identify the dynamics of regional interconnectedness in terms of population mobility, flow of goods, and services. The gravitational model, which is based on the analogy of Newton's law of gravity, states that the force of attraction between two objects is directly proportional to the size of their mass and inversely proportional to the square of the distance between them (Isard, 1960; Anderson, 2011).

In this study, a gravity model was used to calculate the strength of spatial interaction between Samarinda City, the regional growth center in East Kalimantan, and nine other regencies or cities that have economic, social, and geographical relationships. In this model, two main variables are used: the number of people aged 15 years and older as indicators of mobility and market potential, and distance between regions as an obstacle to interaction. According to the theory of spatial interaction, which emphasizes the importance of complementarity, transferability, and intervention opportunities in explaining patterns of interlocation relationships, serves as the basis for selecting these variables. Based on the results of the gravity index calculation for the period 2017 to 2023 (Table 3), it is evident that there is a variation in the level of interaction between the city of Samarinda and other regions.

Table 3. Results of the Gravity Index of Samarinda City as the Center of Annual Growth 2017-2023

Regency	Rank	Interaction Value
Kutai Kartanegara	1	2565966683
Balikpapan	2	549117852
East Kutai	3	212095841
Bontang	4	172388343
North Penajam Paser	5	84934862
Paser	6	83977162
West Kutai	7	51607736
Berau	8	48867763
Mahakam Ulu	9	5074764

Source: processed data

Kutai Kartanegara Regency showed the highest interaction value, followed sequentially by Balikpapan City, East Kutai Regency, Bontang City, North Penajam Paser Regency, Paser Regency, Berau Regency, West Kutai Regency, and Mahakam Ulu Regency. Samarinda and Kutai Kartanegara have a high interaction value because they are geographically close and have a large, productive population. This data indicates the high intensity of labor movements, distribution of goods, and economic activity

across regions. As an industrial city and regional logistics hub, Balikpapan also shows strong interconnectedness. This finding aligns with the growth pole theory by Perroux (1955), who argued that growth centers attract and influence the surrounding region through the spillover effect. However, areas such as Mahakam Ulu and West Kutai have low interaction values. Geographical barriers, limited transportation infrastructure, and a small population cause this condition. This fact suggests that differences in spatial connectivity can influence variations in development between regions (Myrdal, 1957; Hirschman, 1958).

Table 3 presents the analysis of spatial interaction using the gravity model, indicating that Kutai Kartanegara Regency has the highest level of interaction with Samarinda City, which serves as the center of growth in East Kalimantan. Geographical proximity (± 17 km) is the main factor that drives the high mobility of the population, the flow of goods, and services between the two regions. This condition creates a strong economic synergy, where Kutai Kartanegara serves as a production area and supplier of raw materials, while Samarinda acts as a regional distribution and trade center. These findings are in line with the theory of spatial interaction, which states that complementarity, transferability, and intervention opportunities are the main prerequisites for inter-regional interaction. The study by Wijaya et al (2020) reinforces this by showing the highest gravitational interaction value (606.77) between the two regions. In addition, population growth in Kutai Kartanegara contributes to increased labor absorption and shifts in economic structure from primary to secondary sectors. Improved infrastructure connectivity also strengthens regional supply chains and encourages more inclusive economic growth.

On the other hand, Mahakam Ulu Regency is recorded to have the lowest level of spatial interaction with Samarinda, due to its remote location (about 250 km) and lack of basic infrastructure. Geographical conditions dominated by forests and hills, and dependence on river transportation routes, limit the accessibility and mobility of goods and people. As a result, economic development, education, and regional connectivity have become very limited. Higang & Liestiawati (2025) noted that the travel time to Mahakam Ulu can reach 25 hours via the river route. This is reinforced by Purwadi et al (2019), who found that limited infrastructure is the main obstacle in the development of logistics between regions, despite the potential for natural resources. David et al (2024) and Kaiser & Barstow (2022) also emphasized that the lack of physical connectivity has a direct impact on low access to education, health, and economic growth in rural areas. In the education sector, the limitation of qualified teachers and educational facilities is a significant challenge, as revealed by Nurjanana et. al (2025). Therefore, improving functional relations with Samarinda is important in encouraging inclusive growth and Mahakam Ulu's contribution to East Kalimantan's GRDP.

CONCLUSION

This study concludes that the spatial linkage pattern between regencies/cities in East Kalimantan Province still shows a weak level of integration. Measurements using Moran's Index indicate a positive but weak spatial autocorrelation, suggesting that regions with high GRDP per capita rates have not yet fully formed strong growth clusters around them. This reflects the absence of a significant economic spillover effect between regions. Analysis of market structure shows that most of the region is dominated by one or two major sectors, particularly the mining and processing industries. This dominance tends to create an oligopolistic market structure, which can even lead to monopolies. This high dependence on the extractive sector has implications for weak economic diversification and risks widening the gap between regions.

Furthermore, the results of the Gravity Index analysis reveal an uneven pattern of spatial interaction. Kutai Kartanegara and Samarinda are the growth centers with the highest level of interaction, whereas Mahakam Ulu exhibits the lowest interaction due to geographical and infrastructure barriers. This underscores the importance of policy interventions to strengthen regional connectivity, encourage basic infrastructure investment, and facilitate integration between economic sectors to reduce spatial fragmentation. Conceptually, the findings of this study align with the theory of New Economic Geography and the Polarization Hypothesis, which state that without proper intervention policies, economic growth tends to concentrate in the core region, thereby widening the gap with the periphery. This condition is clearly reflected in East Kalimantan; a spatially integrative policy approach is needed, which is not only oriented towards strengthening growth centers but also creating functional connectivity and equitable distribution of investment between regions to form an inclusive and sustainable regional economic system.

REFERENCES

- Anderson, J. E. (2011). The Gravity Model. *Annual Review of Economics*, 3, 133–160. <https://doi.org/10.1146/annurev-economics-111809-125114>.
- Asatryan, Z., Baskaran, T., Birkholz, C., & Hufschmidt, P. (2024). The Regional Economics of Mineral Resource Wealth in Africa. *Economica*, 91(364), 1424–1453. <https://doi.org/10.1111/ecca.12540>.
- Bain, J. S. (1951). Relation of Profit Rate to Industry Concentration. *The Quarterly Journal of Economics*, 65(3), 293–324. <https://doi.org/10.2307/1882217>.
- Banurea, D., & Benardin, E. (2024). Analysis of Development Inequality and Leading Sectors in East Kalimantan. *Formosa Journal of Multidisciplinary Research*, 3(7), 2603–2618. <https://doi.org/10.55927/fjmr.v3i7.10143>.
- Bruno, R. L. (2022). Market Concentration and Productivity in Resource-Based Economies: Evidence from Norway's Oil And Gas Sector. *Scottish Journal of Political Economy*, 69(3), 342–362. <https://doi.org/10.1111/sjpe.12304>.

- Combes, P.-P., & Gobillon, L. (2015). The Empirics of Agglomeration Economies. *Handbook of Regional and Urban Economics* 2, 5, 247–348. <https://doi.org/10.1016/B978-0-444-59517-1.00005-2>.
- David, T., Ito, H. D., Noor, M., & Effendi, S. N. (2024). Strategi Peningkatan Ekonomi Masyarakat berbasis Sumber Daya Alam dan Kearifan Lokal di Kabupaten Mahakam Ulu. *International Journal of Demos*, 6(3), 502. <https://doi.org/10.37950/ijd.v6i3.502>.
- Dira, A., Utomo, K., Bangun, M., Pramularso, E., & Syarief, F. (2023). Pengaruh Investasi dan IPM terhadap Pertumbuhan Ekonomi Hijau di Provinsi Kalimantan Timur. *EKOMBIS REVIEW: Jurnal Ilmiah Ekonomi dan Bisnis*, 11(2), 1437–1446. <https://doi.org/10.37676/ekombis.v11i2.4181>.
- Espinosa, Y. G., Suparta, I. W., & Moniyana, R. (2024). *International Journal of Economics, Management and Accounting (IJEMA)*, 2(1), 43–54. <https://doi.org/10.47353/ijema.v2i1.144>.
- Evcim, N., Yesilyurt, M. E. (2023). Spatial Interaction and Economic Growth: a Case of OECD Countries. *Future Business Journal*, 9, 102. <https://doi.org/10.1186/s43093-023-00270-9>.
- Fadhil, M. A., Haris, A., & Muhimmah, B. R. (2022). Kaji Dampak Pembangunan Infrastruktur Transportasi Terhadap Pertumbuhan Inklusif Ekonomi Regional. *JMES: Jurnal Magister Ekonomi Syariah*, 1(2), 87–96. <https://doi.org/10.14421/jmes.2022.012-07>.
- Fahmi, A. (2022). Efek Spasial Infrastruktur Terhadap Pertumbuhan Ekonomi. *Jurnal Ekonomi dan Keuangan*, 19(2), 468–474. <https://doi.org/10.30872/jakt.v19i2>.
- Fitriani, R., Wardhani, N. W. S., & Abdila, N. S. (2024). Spatial Autocorrelation of East Java's Economic Growth Using Cluster-Based Weights. *Economics Development Analysis Journal*, 13(4), 491–503. <https://doi.org/10.15294/edaj.v13i4.19161>.
- Fitrianingtyas, W., & Nuryadin, M. R. (2025). Kualitas Sumber Daya Manusia dan Pertumbuhan Ekonomi Kalimantan. *Jurnal Ilmu Ekonomi dan Pembangunan*, 6(2), 1119–1130.
- Fitz, D., & Gouri Suresh, S. (2021). Poverty Traps Across Levels of Aggregation. *Journal of Economic Interaction and Coordination*, 16, 909–953. <https://doi.org/10.1007/s11403-021-00333-6>.
- Handoko, M. S. H., Riyanto, W. H., & Syaifullah, Y. (2020). Determinan Ketimpangan Pembangunan Ekonomi di Kabupaten dan Kota Provinsi Kalimantan Timur. *Jurnal Ilmu Ekonomi (JIE)*, 4(4), 637–649. <https://doi.org/10.22219/jie.v4i4.13951>.
- Harits, D., Surahman, S., Mardhanie, A. B., Hutaaruk, T. R., Salmani, M., & Faisal, M. (2022). Kajian Kawasan Pergudangan di Kabupaten Penajam Paser Utara. *Abdimas Universal*, 4(1), 72–78. <https://doi.org/10.36277/abdimasuniversal.v4i1.166>.
- Hermawan, A., & Yunani, A. (2025). Pengaruh Investasi Swasta, Infrastruktur Jalan, dan Belanja Modal Pemerintah terhadap Pertumbuhan Ekonomi di Provinsi Kalimantan

- Selatan Tahun 2006-2021. *JIEP: Jurnal Ilmu Ekonomi Dan Pembangunan*, 6(2), 631–641.
- Higang, G., L., & Liestiawati, F., I., D. (2025). Evaluation of Budget Expenditure (Mandatory) of the Education Sector in Mahakam Ulu Regency. *Dinasti International Journal of Education Management and Social Science*, 6(3), 2170–2179. <https://doi.org/10.38035/dijemss.v6i3.3930>.
- Hirschman, A. O. (1958). *The Strategy of Economic Development*. New Haven: Yale University Press.
- Imaduddin, F. L., & Kharisma, B. (2024). Convergence of Regional Income Among Provinces in Kalimantan. *Ekonomi dan Bisnis*, 11(1), 78–94. <https://doi.org/10.35590/jeb.v11i1.7697>.
- Irawan, B., Akbar, P., Purnomo, E.P., & Nurmandi, A. (2021). Development Planning to Accelerate Sustainable Development Goals (SDGs) in the Mahakam Ulu District as a New Autonomous Region. *Masyarakat, Kebudayaan dan Politik*, 34, 184–195. <https://doi.org/10.20473/MKP.V34I22021.184-195>.
- Isard, W. (1960). *Methods of Regional Analysis: An Introduction to Regional Science*. Cambridge: MIT Press.
- Jayadevan, C., Hoang, N., & Yarram, S. (2025). Spillover Effects of Globalization Using Alternative Spatial Approaches. *Applied Economics*, 57(34), 5128–5147. <https://doi.org/10.1080/00036846.2024.2364118>.
- Jeleskovic, V., & Loeber, S. (2023). How Industrial Clusters Influence the Growth of the Regional GDP: A Spatial Approach. *Papers*, 2401.10261, *arXiv.org*.
- Kaiser, N., & Barstow, C. K. (2022). Rural Transportation Infrastructure in Low- and Middle-Income Countries: A Review of Impacts, Implications, and Interventions. *Sustainability*, 14(4), 2149. <https://doi.org/10.3390/su14042149>.
- Karmini, Saroyo, Karyati, Widiati, K.Y, Widuri, N, Sulichantini, E. D. (2022). Sektor Unggulan di Kabupaten Kutai Barat dan Kontribusinya dalam Penyerapan Tenaga Kerja di Provinsi Kalimantan Timur. *Jurnal Riset Pembangunan*, 5(1), 22–32. <https://doi.org/10.36087/jrp.v5i1>.
- Khlystova, O., Kalyuzhnova, Y. (2025). Exploring Knowledge Spillovers: Innovation Strategies in Resource-Rich Countries. *The Journal of Technology Transfer*, In-press. <https://doi.org/10.1007/s10961-025-10221-x>.
- Khotiawan M., Sakti R. K., W. S. T. (2023). An Analysis of the Effects of Spatial Dependence on Economic Growth Among Regency and City in Java. *Jurnal Ekonomi Pembangunan*, 24(1), 202–220. <https://doi.org/10.23917/jep.v24i2.22109>.
- Kinanthi Y, & Indrayati, A. (2023). Distribution of Migas and Multiplier Effect for Local Revenue Income in Kutai Kartanegara Regency. *Geo-Image: Spatial-Ecological-Regional*, 12(1), 78–88. <https://doi.org/10.15294/geoimage.v12i1.64700>.
- Krugman, P. (1991). Increasing Returns and Economic Geography. *Journal of Political Economy*, 99(3), 483–499.

- Lasaiba, M. A. (2023). Pengembangan Wilayah Tertinggal di Indonesia: Optimalisasi Sumber Daya Alam dan Teknologi untuk Kemajuan yang Berkelanjutan. *Jendela Pengetahuan*, 16(1), 13–23. <https://doi.org/10.30598/jp16iss1pp13-23>.
- Li, X., Ma, L., Ruman, A.M., Iqbal, N., & Strielkowski, W. (2024). Impact of Natural Resource Mining on Sustainable Economic Development: The Role of Education and Green Innovation in China. *Geoscience Frontiers*, 15(3), 101703. <https://doi.org/10.1016/j.gsf.2023.101703>.
- Ma, Z., Liu, T., Li, J., Liu, Z., & Chen, W. (2023). Spatial Effect Analysis of Forestry Technology Innovation on Forestry Industry Economic Growth. *Forests*, 14(3), 557. <https://doi.org/10.3390/f14030557>
- Marliani, R. (2021). Identifikasi Autokorelasi Spasial Tingkat Pengangguran Terbuka. *Buletin Statistika dan Aplikasi Terkini*, 1(2), 39–49.
- Moran, P. A. P. (1950). Notes on Continuous Stochastic Phenomena. *Biometrika*, 37(1/2), 17–23. <https://doi.org/10.2307/2332142>.
- Myrdal, G. (1957). *Economic Theory and Under-Developed Regions*. Richmond: Duckworth.
- Nur, F. (2021). Analisis Perencanaan Pembangunan Ekonomi Kabupaten Kutai Kartanegara. *Fair Value: Jurnal Ilmiah Akuntansi dan Keuangan*, 4(2), 873–894. <https://doi.org/10.32670/fairvalue.v4i2Special Issue 2.756>.
- Nurjanana, N., Darma, D. C., Suparjo, S., Kustiawan, A., & Wasono, W. (2025). Two-Way Causality Between Economic Growth and Environmental Quality: Scale in the New Capital of Indonesia. *Sustainability*, 17(4), 1656. <https://doi.org/10.3390/su17041656>.
- Obeng-Odoom, F. (2024). Balikpapan as a Developmental Environmentalist City: A Stratification Economics Approach. *The Journal of Environment & Development*, 34(2), 492–519. <https://doi.org/10.1177/10704965241300206>.
- Pepall, L., Richards, D. J., & Norman, G. (2014). *Industrial Organization: Contemporary Theory and Empirical Applications*. New Jersey: John Wiley & Sons.
- Permatasari, K. A., Pambudi, A., Puspitawati, E., & Kautsar, A. (2024). Analisis Sektor Unggulan dan Ketimpangan Antar Wilayah: Studi Kasus Provinsi Kalimantan Timur. *Jurnal Ekonomi, Lingkungan, Energi, dan Bisnis (ELEGIS)*, 2(1), 1–26.
- Perroux, F. (1955). Note Sur La Notion de 'Pôle de Croissance'. *Economie Appliquee*, 8, 307–320.
- Pratiwi, M. C. Y., & Kuncoro, M. (2016). Analisis Pusat Pertumbuhan dan Autokorelasi Spasial di Kalimantan: Studi Empiris di 55 Kabupaten/Kota, 2000–2012. *Jurnal Ekonomi dan Pembangunan Indonesia*, 16(1), 51–60.
- Purwadi., Darma, D. C., Aprianti, D. I., & Hakim, Y. P. (2019). Investment Development Strategy Management in Mahakam Ulu Regency, Indonesia. *Journal of Poverty, Investment and Development*, 51, 66–75. <https://doi.org/10.7176/JPID/51-07>.

- Rahayu, S. E., & Febriaty, H. (2024). Analisis Faktor-Faktor yang Mempengaruhi Ketimpangan Distribusi Pendapatan di Propinsi Sumatera Utara. *Jurnal Ekonomi dan Studi Pembangunan*, 24(2), 286-300.
- Richardson, H. W. (1978). *Urbanization, Regional Development and Peripheral Regions*. Massachusetts: Methuen.
- Rodriguez-Pose, A., & von Berlepsch, V. (2023). Spatial Development and the Role of Regional Interactions in Reducing Inequalities. *Journal of Regional Science*, 63(1), 74–90. <https://doi.org/10.1111/jors.12538>.
- Rodríguez-Pose, A., & Wilkie, C. (2018). Innovating in Less Developed Regions: What Drives Patenting in the Lagging Regions of Europe and North America. *Growth and Change*, 50(1), 4–37. <https://doi.org/10.1111/grow.12280>.
- Sari, R. D., Warsilan., & Roy, J. (2018). Analisis Penggerak Ekonomi Kota Balikpapan. *Jurnal Ilmu Ekonomi Mulawarman (JIEM)*, 3(4), 1-9. <https://doi.org/10.29264/jiem.v3i4.4049>.
- Schmalensee, R. (1989). Inter-Industry Studies of Structure and Performance. In. Schmalensee, R., & Willig, R. D. (Eds.). *Handbook of Industrial Organization*. Netherland: Elsevier.
- Sen, A., & Smith, T. E. (1995). *Gravity Models of Spatial Interaction Behavior*. Berlin: Springer.
- Setiawan, M., Indiasuti, R., Hidayat, A. K., & Rostiana, E. (2021). R & D and Industrial Concentration in the Indonesian Manufacturing Industry. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(2), 112. <https://doi.org/10.3390/joitmc7020112>.
- Vidriza, U. (2024). Interaksi dan Keterkaitan Spasial Wilayah di Kabupaten Penajam Paser Utara. *Jurnal Kajian Ekonomi dan Pembangunan (JKEP)*, 6(1), 68–78. <http://doi.org/10.24036/jkep.v6i1.15841>.
- Wahyudin, Y. (2022). Analisis Desa/Kelurahan Pusat Pertumbuhan Wilayah Sekitar Calon Ibukota Negara Indonesia. *Forum Ekonomi*, 24(1), 195–203. <https://doi.org/10.30872/jfor.v24i1.10448>.
- Wang, R., Zameer, H., Feng, Y., Jiao, Z., Xu, L. & G. A. (2019). Revisiting Chinese Resource Curse Hypothesis Based on Spatial Spillover Effect: A Fresh Evidence. *Resources Policy*, 64, 101521. <https://doi.org/10.1016/j.resourpol.2019.101521>.
- Wijaya, A., Darma, S., Darma, D. C. (2020). Spatial Interaction between Regions: Study of the East Kalimantan Province, Indonesia. *International Journal of Sustainable Development and Planning*, 15(6), 937–950. <https://doi.org/10.18280/ijstdp.150618>.
- Wijayanti, W. P., Machmud, S. K., & Subagiyo, A. (2023). Linkage among Two Satellite City: What Makes People Move? (Case Study: Bogor Regency and Depok City). *Regional and Rural Studies*, 1(1), 1–5. <https://doi.org/10.21776/rrs.v1i1.2>.

Zhang, X., Li, C. & Gibson, J. (2024). The Role of Spillovers When Evaluating Regional Development Interventions: evidence from administrative upgrading in China. *Letters in Spatial and Resource Sciences*, 17, 9. <https://doi.org/10.1007/s12076-024-00371-1>.