

The Effects of Regional Own-Source Revenue and General Allocation Fund on Economic Growth: Evidence from Spatial Panel Regression in North Kalimantan Province, Indonesia

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ABSTRACT

Purpose: This study examines variations in Regional Own-Source Revenue (PAD), the General Allocation Fund (DAU), and economic growth across North Kalimantan's five local governments during 2014–2023.

Research Method: The study uses an observational panel-data design based on 50 local-government-year observations obtained from Statistics Indonesia and the Directorate General of Fiscal Balance. Descriptive analysis and the Pesaran cross-sectional dependence test were applied. Spatial panel estimation was excluded because the five-unit cross-sectional dimension was insufficient for stable spatial parameters and the original weights matrix could not be reproduced.

Results and Discussion: Economic growth and fiscal capacity varied substantially across jurisdictions and years. The Pesaran CD statistic was 9.215 ($p < 0.001$), indicating general residual dependence, but not geographically structured spatial dependence. Accordingly, no reliable spatial or causal conclusion regarding PAD and DAU was retained.

Implications: Fiscal policy should consider regional heterogeneity, revenue composition, transfer dependence, and common economic shocks. Broader samples and explicit endogeneity strategies are required for confirmatory analysis.

Originality: The study provides context-specific fiscal evidence from Indonesia's newest border province while clarifying the distinction between cross-sectional and spatial dependence.

Keywords: regional economic growth; regional own-source revenue; general allocation fund; fiscal capacity.

1. Introduction

Economic growth remains one of the most important indicators for assessing regional development because it reflects the capacity of an economy to increase production, create employment opportunities, improve household income, and enhance social welfare. In Indonesia, regional economic development has undergone substantial transformation since the implementation of fiscal decentralization through regional autonomy. The decentralization framework delegates broader fiscal authority to local governments, enabling them to determine development priorities according to local economic characteristics and public needs. However, the delegation of fiscal authority does not necessarily produce uniform development outcomes because local governments differ in fiscal capacity,



institutional quality, economic structure, infrastructure, and administrative capability. Accordingly, understanding the relationship between regional fiscal resources and economic growth remains an important empirical issue in evaluating Indonesia's decentralization framework.

Fiscal decentralization is theoretically expected to improve allocative efficiency because local governments possess better information regarding regional preferences than the central government. According to Fiscal Federalism Theory, decentralizing fiscal authority can facilitate more efficient public-resource allocation and improve the responsiveness of public-service provision (Oates, 1972). Nevertheless, the realization of these benefits depends not only on the amount of fiscal resources transferred to local governments but also on institutional quality, expenditure efficiency, governance capacity, and intergovernmental coordination (Shah, 2006). Therefore, Fiscal Federalism Theory provides a conceptual basis for expecting an association between regional fiscal capacity and economic performance. However, it does not imply that additional local revenue or transfers automatically generate higher economic growth.

In Indonesia, the implementation of fiscal decentralization is primarily reflected through two major fiscal instruments: Regional Own-Source Revenue (Pendapatan Asli Daerah/PAD) and intergovernmental fiscal transfers, particularly the General Allocation Fund (Dana Alokasi Umum/DAU). PAD represents fiscal resources generated internally by local governments through local taxes, service charges, profits from regionally owned enterprises, and other legitimate local revenues. Higher PAD may provide local governments with greater flexibility to finance public services and regional development priorities. Conversely, DAU functions as an equalization transfer intended to reduce horizontal fiscal disparities and support minimum public-service provision across regions. The relationships between these fiscal instruments and economic growth may nevertheless vary according to expenditure composition, regional economic structure, fiscal-management quality, and the extent to which fiscal resources are directed toward productive activities.

Despite more than two decades of fiscal decentralization, considerable disparities in regional economic performance remain evident across Indonesian regions. Border provinces, newly established administrative regions, and geographically isolated areas continue to face structural constraints related to limited infrastructure, unequal investment distribution, relatively weak fiscal capacity, and restricted accessibility. These conditions indicate that regional economic growth cannot be understood solely from the amount of PAD and DAU. Investment, employment, human capital, infrastructure, sectoral composition, natural-resource dependence, institutional conditions, national policies, commodity-price fluctuations, and major common shocks such as the COVID-19 pandemic may also shape regional economic performance. Consequently, an empirical model containing only PAD and DAU must be interpreted as a parsimonious fiscal specification rather than a complete causal explanation of economic growth.

North Kalimantan Province provides a relevant setting for examining this issue. Established as Indonesia's newest province, North Kalimantan comprises four regencies—Bulungan, Malinau, Nunukan, and Tana Tidung—and one municipality, Tarakan. These five local governments exhibit differences in economic structure, fiscal capacity, infrastructure availability, and accessibility. Tarakan functions as an important commercial and service center, whereas the four regencies display varying degrees of dependence on natural resources, intergovernmental transfers, and geographically dispersed economic activities. The province also shares an international border with Malaysia, creating potential economic connections through cross-border trade, labor mobility, logistics, and investment. These characteristics provide a substantive reason to investigate whether economic outcomes across the five

local governments are geographically related. However, geographical proximity alone does not establish spatial dependence; the existence and form of such dependence must be evaluated using a clearly defined spatial weights matrix and appropriate spatial diagnostic tests.

Spatial interaction has long been recognized in regional economics. Tobler's First Law of Geography states that "everything is related to everything else, but near things are more related than distant things" (Tobler, 1970). Building upon this concept, spatial econometric theory explains that neighboring regions may exhibit related economic outcomes because they can share transportation networks, labor markets, production systems, investment flows, institutional environments, and public infrastructure (Anselin, 1988; Elhorst, 2014; LeSage, 2009). When the geographical pattern specified by a spatial weights matrix is supported empirically, ignoring that structure may result in inefficient estimates or an incorrectly specified error process. Nevertheless, general cross-sectional dependence is not equivalent to geographical spatial dependence. For example, national fiscal policy, province-wide programs, commodity-price movements, or the COVID-19 pandemic may produce correlated outcomes among local governments without following the neighborhood structure represented by the spatial weights matrix.

Recent Indonesian studies report mixed evidence concerning the relationship between regional fiscal variables and economic growth. Nany *et al.*, (2022) found that PAD did not have a statistically significant relationship with economic growth in the context they examined, whereas Prasetyo *et al.*, (2022) reported a significant positive relationship. More recent evidence remains similarly inconclusive. Tuwaidan *et al.*, (2024) identified a significant positive relationship between PAD and economic growth in North Sulawesi, while Megawati *et al.*, (2024) reported a negative relationship in their empirical setting. Using data from 34 Indonesian provinces for 2014–2023, Maulana *et al.*, (2025) found a positive and significant relationship. Collectively, these findings suggest that the association between PAD and regional economic performance may differ across periods, geographical settings, economic structures, and model specifications.

Evidence concerning DAU is also not uniform. Nany *et al.*, (2022) reported evidence supporting the role of DAU in economic growth, whereas Hutasuht *et al.*, (2025) found a positive but statistically insignificant relationship in Sumatra. Sinta *et al.*, (2024) likewise reported an insignificant relationship in North Sumatra, while Maulana *et al.*, (2025) identified a positive and significant relationship at the national provincial level. These differences indicate that DAU should not be assumed to have a uniform association with economic growth across Indonesian regions. Its relationship with regional economic performance may depend on fiscal dependence, expenditure allocation, institutional capacity, and local economic conditions. However, these mechanisms must be tested directly before they can be presented as empirical explanations.

Evidence specific to North Kalimantan remains limited. Kusumaningrum & Sugiyanto (2021), using North Kalimantan data for 2013–2019, found that economic growth was positively related to capital-expenditure allocation. However, their study did not directly examine the relationships of PAD and DAU with economic growth within an explicitly defined geographical dependence structure. The available studies therefore provide useful evidence concerning regional fiscal relationships but do not establish whether economic outcomes among North Kalimantan's five local governments correspond to a reproducible neighborhood structure. Furthermore, differences in findings across Indonesian regions show that conclusions obtained from other provinces cannot automatically be generalized to North Kalimantan.

Three research gaps emerge from this literature. First, previous findings concerning PAD, DAU, and regional economic growth are inconsistent, indicating an unresolved empirical gap. Second, evidence from North Kalimantan is limited, particularly regarding the simultaneous relationships of PAD and DAU with economic growth across its five local governments. Third, the possible geographical pattern of interregional dependence has received limited attention in this provincial context. However, the spatial dimension must be distinguished from general cross-sectional dependence. A Pesaran CD test can identify residual correlation across local governments, but it cannot demonstrate that this correlation follows the geographical structure encoded in a spatial weights matrix. Evidence of geographical dependence consequently requires a transparent matrix construction procedure, a reproducible neighborhood structure, and spatial diagnostic statistics linked directly to that matrix.

The small cross-sectional dimension of North Kalimantan creates an additional methodological limitation. Because the province contains only five local governments, the data provide limited spatial variation and may produce unstable spatial parameters, low statistical power, and sensitivity to the selected weights matrix. Accordingly, the spatial analysis in this study is positioned as exploratory and context-specific. It is not intended to provide broad causal inference or to establish that a spatial panel estimator is universally superior to a conventional panel model. Instead, the analysis evaluates whether the observed geographical structure contains sufficient evidence to justify a spatial specification, while the estimated relationships are interpreted cautiously as conditional associations.

Based on these gaps, this study addresses the following questions: (1) Are economic-growth observations across North Kalimantan's five local governments characterized by general cross-sectional dependence? (2) Does any detected dependence correspond to the geographical structure specified in a transparent and reproducible spatial weights matrix? Moreover, (3) What are the conditional relationships of PAD and DAU with regional economic growth after accounting for observed panel characteristics and, where empirically supported, the specified spatial error structure? Accordingly, this study aims to examine the relationships of PAD and DAU with economic growth in North Kalimantan, distinguish general cross-sectional dependence from geographically structured spatial dependence, and compare conventional and spatial panel specifications using explicitly reported diagnostic criteria.

The contribution of this study is deliberately contextual rather than universal. Empirically, it provides evidence concerning fiscal variables and economic growth in Indonesia's newest border province. Methodologically, it demonstrates the importance of separating general residual dependence from dependence associated with a specified geographical matrix. The study also evaluates the sensitivity of the results to the limited number of local governments and the selected spatial specification. Its originality lies in combining a fiscal analysis of PAD and DAU with an explicitly documented and cautiously interpreted spatial assessment for North Kalimantan. Given the observational design and small cross-sectional dimension, the study does not claim causal effects or unrestricted generalizability.

The remainder of this paper is organized as follows. Section 2 provides a literature review and hypothesis development. Section 3 presents the research method and design. Section 4 provides the results and discussion. Section 5 presents Concluding Remarks and Recommendations.

2. Literature Review and Hypothesis Development

2.1 Regional Economic Growth

Regional economic growth refers to the sustained increase in the production capacity of a particular region over a given period, generally reflected in the growth of real Gross Regional Domestic Product (GRDP). This concept captures changes in the value of goods and services produced within a regional economy after controlling for price changes. Economic growth is important because it indicates a region's ability to expand employment, generate income, strengthen its productive base, and improve public welfare. However, regional growth is multidimensional and cannot be explained solely by capital accumulation. It is also shaped by investment, labor-force participation, productivity, industrial structure, technological capability, institutional quality, and fiscal capacity. In the Indonesian context, regional growth is commonly assessed using real GRDP, while its variation may be associated with investment, labor participation, and the fiscal capacity of local governments (Lee *et al.*, 2023). Geographical conditions may also influence growth by determining accessibility, transportation costs, resource distribution, and the location of economic activities (Albalade *et al.*, 2022).

Regional economic growth generally differs across territories because regions possess unequal productive resources, infrastructure, human capital, innovation capacity, and economic specialization. Regions with stronger industrial foundations and more complex technological knowledge tend to have greater opportunities to transform their productive structures and develop new sources of growth (Zhang *et al.*, 2024). Employment structure and labor productivity are also important because differences in workers' and economic sectors' capacity to produce added value can generate persistent disparities in regional income and development (Carullo *et al.*, 2025). Nevertheless, differences in regional growth may change over time through a convergence process in which lower-income regions grow faster than more developed regions. Investment and improved spatial connectivity may support such convergence, although the process is not uniform across regions (Chen *et al.*, 2023). Consequently, regional economic performance should be interpreted as the outcome of interacting economic, structural, geographical, and institutional conditions rather than a single fiscal or production factor.

Regional growth also contains a spatial dimension because individual regions do not operate as isolated economic units. Economic activities may cross administrative boundaries through trade, transportation networks, labor mobility, investment flows, knowledge diffusion, and shared infrastructure. Accordingly, growth in one region may be statistically related to conditions in other regions. Cartone *et al.*, (2022) demonstrate that the analysis of regional disparities is sensitive to spatial dependence and the proximity structure used to represent interregional relationships. Evcim & Yesilyurt (2023) similarly show that spatial interaction can be relevant when explaining differences in economic growth, particularly where innovation and economic activities generate cross-regional connections. However, Piribauer *et al.*, (2023) emphasize that regional economic relationships are not necessarily determined by physical distance alone because trade linkages and broader economic networks may create alternative forms of connectivity. Therefore, examining regional economic growth requires explicit attention to the geographical and economic structure connecting regions. At the same time, any spatial relationship must be verified empirically using a transparent and theoretically justified spatial weights matrix.

2.2 Regional Own-Source Revenue (Pendapatan Asli Daerah/PAD)



Regional Own-Source Revenue (Pendapatan Asli Daerah/PAD) refers to revenue generated and administered by local governments from economic activities and resources within their jurisdictions. Under Indonesia's fiscal decentralization framework, PAD consists of local taxes, local service charges, returns from separated regional assets, and other legitimate locally generated revenues. PAD represents an important dimension of local fiscal capacity because it provides local governments with greater discretion in financing public services and development priorities. A higher PAD ratio may indicate greater fiscal independence and lower dependence on central-government transfers. Nevertheless, the quality of PAD cannot be assessed solely from its nominal value. Evaluation should also consider revenue realization, contribution to total regional income, growth, elasticity, and collection efficiency. Jonni Parulian *et al.*, (2024) demonstrate that contribution, elasticity, and local-tax performance provide complementary information for assessing PAD management. Similarly, Yakub *et al.*, (2022) emphasize that the contribution of taxes and service charges depends on the effectiveness and efficiency of their collection.

The capacity to generate PAD differs substantially among regions because local governments possess unequal economic bases, populations, business activities, public assets, and administrative capabilities. Population size may expand the potential tax and service-charge base, while vehicle ownership, employment conditions, and other socioeconomic characteristics can influence locally generated revenue (Rahman & Restiatun, 2023). However, expanding PAD should not merely involve increasing the fiscal burden on residents and businesses. Local governments must improve taxpayer databases, administrative systems, digital payment services, regulatory certainty, and the management of regionally owned assets. Moreover, the individual components of PAD should not be treated as homogeneous because each has a different economic base and collection mechanism. Sinaga *et al.*, (2024) show that local taxes, service charges, returns from separated regional assets, and other legitimate revenues may have different relationships with regional economic growth. Pradana & Putri (2025) similarly demonstrate that the components of PAD do not uniformly correspond to regional growth, indicating the importance of evaluating both revenue composition and aggregate PAD.

Conceptually, PAD can support regional economic activity by increasing the fiscal space available for infrastructure, public services, and productive expenditure. Puspitasari *et al.*, (2023) indicate that the relationship between regional revenue and GRDP may operate through capital expenditure, suggesting that revenue does not automatically translate into economic expansion. Empirical findings concerning PAD and economic growth also vary across regional contexts. Rahmawati & Yuliana (2022) report a positive relationship in Pamekasan, while Marbun (2023) identifies PAD as a relevant element in the relationship between economic growth and poverty in Ngawi. These findings should nevertheless be interpreted cautiously because observational evidence does not by itself establish causality. The association between PAD and economic growth may be influenced by expenditure quality, institutional capacity, economic structure, and reverse causality, as stronger regional economies may also generate broader tax bases and higher PAD. Therefore, PAD is best understood as an indicator of locally generated fiscal capacity whose relationship with growth depends on how revenue is collected, structured, and allocated.

2.3 General Allocation Fund (Dana Alokasi Umum/DAU)



The General Allocation Fund (Dana Alokasi Umum/DAU) is an intergovernmental transfer allocated through Indonesia's State Budget to reduce disparities in fiscal capacity among local governments and support regional needs in implementing decentralization. Unlike transfers earmarked for specific programs, DAU generally provides local governments with discretion to allocate funds according to regional expenditure priorities, subject to prevailing fiscal regulations. Its allocation is principally associated with the difference between regional fiscal needs and fiscal capacity, together with other components prescribed in the national transfer system. Therefore, regions with limited own-source revenue or relatively large expenditure needs may depend more heavily on DAU to finance governmental administration and minimum public-service provision. Ridho & Wijayanti (2022) show that DAU is relevant to the distributional role of intergovernmental transfers because it is associated with regional income inequality. Nevertheless, the effectiveness of DAU should not be evaluated solely from the amount transferred, as differences in fiscal needs, institutional capacity, expenditure structure, and budget management can influence its utilization.

DAU remains an important component of regional financing, particularly for local governments with limited fiscal independence. Safitri & Widarjono (2023) demonstrate that the efficiency of DAU management varies among regencies and municipalities in Kalimantan, indicating that similar transfer arrangements do not necessarily generate uniform fiscal outcomes. DAU can expand regional expenditure capacity, including the financing available for infrastructure and public assets. Maula *et al.*, (2023) report a positive association between DAU and capital expenditure among local governments in West Java. Comparable evidence is provided by Rowena & Hanifa (2024) for Indonesian provinces and by Safriyeni & Hidayat (2024) for West Sumatra. These findings suggest that DAU may support development financing. However, they do not establish that every increase in DAU is automatically allocated to productive investment because the transfer may also finance personnel expenditure, routine administration, and other public-service responsibilities.

The relationship between DAU and regional economic growth is therefore conditional rather than automatic. Conceptually, DAU may be associated with economic performance when it enables local governments to improve infrastructure, maintain essential services, and reduce fiscal disparities that constrain productive activity. Dewi & Huda (2023) identify an empirical relationship between fiscal transfers, including DAU, and economic growth in Pamekasan. Andhini *et al.*, (2023) likewise show that DAU is associated with local-government financial performance, although financial performance is not equivalent to economic growth. Consequently, DAU may contribute to regional development through expenditure channels, but these mechanisms must be examined directly rather than inferred from the DAU coefficient alone. Its association with growth may also be influenced by expenditure quality, transfer dependence, institutional conditions, omitted economic variables, and reverse causality. Accordingly, DAU should be understood as a fiscal-equalization instrument whose developmental relevance depends on how effectively and productively local governments manage the transferred resources.

3. Research Method



3.1 Research Design

This study employed a quantitative observational panel-data design to examine the conditional associations of Regional Own-Source Revenue (Pendapatan Asli Daerah/PAD) and the General Allocation Fund (Dana Alokasi Umum/DAU) with regional economic growth in North Kalimantan Province. The term “observational” is used because the fiscal variables were not experimentally assigned. At the same time, “association” is preferred to causal terminology because economic growth may simultaneously influence the fiscal capacity of local governments. Accordingly, the design does not claim that changes in PAD or DAU independently cause changes in regional economic growth.

The analysis used a parsimonious two-way fixed-effects panel specification rather than a spatial panel estimator. This revision was necessary because North Kalimantan contains only five local governments, providing insufficient cross-sectional variation for reliable estimation of spatial autoregressive parameters. With such a small spatial dimension, spatial fixed-effects estimates would be highly sensitive to the selected weights matrix. They could exhibit unstable parameters, low statistical power, and unreliable asymptotic inference. The spatial autoregressive model, spatial error model, spatial coefficients panel λ , and AIC-based spatial-model selection were therefore excluded from the revised analysis.

District or municipal fixed effects were used to control for time-invariant characteristics that differ across local governments, including geographical location, administrative status, persistent accessibility constraints, and relatively stable natural-resource endowments. Year fixed effects were included to absorb common shocks affecting all five local governments in a particular year, including national fiscal policies, province-wide programs, commodity-price movements, inflationary shocks, and the COVID-19 pandemic. This specification reduces, but does not eliminate, omitted-variable bias. The resulting coefficients are therefore interpreted as within-region conditional associations rather than causal effects.

3.2 Study Population, Observations, and Data Collection

The study was conducted in North Kalimantan Province, Indonesia. It covered the complete population of local governments in the province: Bulungan Regency, Malinau Regency, Nunukan Regency, Tana Tidung Regency, and Tarakan City. Because all five local governments were included, the study used a census of jurisdictions rather than probability sampling. The unit of analysis was the local-government-year. Annual data covering 2014–2023 produced a balanced panel of 50 local-government-year observations before lagging the fiscal variables. The period was selected because 2014 was the first complete fiscal year following the establishment of North Kalimantan as a province, while 2023 was the latest year for which the fiscal and regional economic series used in the study were consistently available. The period also includes the pre-pandemic years, the economic disruption of 2020–2021, and the subsequent recovery. These common temporal shocks were controlled through year fixed effects rather than interpreted as geographical dependence.

Secondary data were collected from official publications issued by Statistics Indonesia (Badan Pusat Statistik/BPS) and the Directorate General of Fiscal Balance (Direktorat Jenderal Perimbangan Keuangan/DJPK), Ministry of Finance of the Republic of Indonesia. Annual constant-price GRDP, current-price GRDP, the GRDP implicit price index, and mid-year population were obtained from the BPS publications for each regency and municipality. Realized PAD and DAU were obtained from the DJPK

Regional Budget Realization database. Budget targets were not used because the study examined fiscal resources actually received during each fiscal year.

Data collection followed three stages. First, the fiscal and macroeconomic series were downloaded for each local government and year. Second, regional names, years, monetary units, and price bases were standardized before the datasets were merged using the local-government code and fiscal year. Third, the merged panel was checked against the original BPS and DJPK tables to identify duplicated records, inconsistent units, missing values, and transcription errors. Monetary observations were recorded in rupiah, and no missing values were replaced through interpolation. No winsorization or discretionary deletion of observations was applied. Fiscal variables were lagged by one year in the regression model. Consequently, economic growth for 2015–2023 was associated with PAD and DAU observed in 2014–2022, resulting in 45 regression observations. The lag structure establishes temporal ordering and reduces contemporaneous simultaneity, although it does not fully resolve endogeneity or reverse causality.

3.3 Variables and Measurement

The dependent variable was regional economic growth, measured using the annual percentage change in Gross Regional Domestic Product at constant 2010 prices. Constant-price GRDP was used to ensure that changes in the dependent variable represented changes in real regional production rather than changes in the general price level. Economic growth was calculated as the percentage change between real GRDP in year t and real GRDP in year $t-1$. PAD and DAU were employed as the principal fiscal variables. PAD represents revenue generated within a local government's jurisdiction through local taxes, local service charges, returns from separated regional assets, and other legitimate own-source revenues. DAU represents a general intergovernmental transfer intended to reduce differences in fiscal capacity and support decentralized governmental functions. Both variables were measured using realized annual receipts rather than budgeted amounts.

Table 1. Variables and Measurement

Variable	Code	Operational measurement	Unit and transformation	Data source
Regional economic growth	GROWTH	$[(GRDP_{it}^{2010}/GRDP_{i,t-1}^{2010}) - 1] \times 100$	Percentage points; GRDP at constant 2010 prices	BPS regency/municipality GRDP publications
Regional Own-Source Revenue	LRPAD	Realized PAD divided by the local GRDP implicit price index, multiplied by 100, and divided by mid-year population	Constant 2010 rupiah per capita; natural logarithm; one-year lag	DJPK and BPS
General Allocation Fund	LRDAU	Realized DAU divided by the local GRDP implicit price index, multiplied by 100, and divided by mid-year population	Constant 2010 rupiah per capita; natural logarithm; one-year lag	DJPK and BPS
Local-government effects	α_i	Indicator for each regency or municipality	Time-invariant fixed effects	Constructed by the authors
Year effects	γ_t	Indicator for each observation year	Common annual fixed effects	Constructed by the authors

Note: BPS = Statistics Indonesia; DJPK = Directorate General of Fiscal Balance; GRDP = Gross Regional Domestic Product; PAD = Regional Own-Source Revenue; DAU = General Allocation Fund. LRPAD and LRDAU refer respectively to the natural logarithms of one-year-lagged real PAD per capita and real DAU per capita.

Nominal PAD and DAU were converted into constant 2010 rupiah using the local GRDP implicit price index published by BPS. The real fiscal values were subsequently divided by the mid-year population of the corresponding local government to obtain real PAD per capita and real DAU per capita. The per-capita transformation reduces scale differences arising from the substantial variation in population among Bulungan, Malinau, Nunukan, Tana Tidung, and Tarakan. Real PAD per capita and real DAU per capita were transformed using the natural logarithm. Because the dependent variable is expressed as a percentage growth rate while the fiscal variables are in logarithmic form, the resulting specification is a semi-log model. Therefore, a 1% increase in a fiscal variable is associated with a change of $\beta/100$ percentage points in regional economic growth, holding the fixed effects constant. The coefficients must not be interpreted as elasticities or as percentage changes in economic growth.

3.4 Data Analysis

The analysis began with descriptive statistics covering the mean, standard deviation, minimum, median, and maximum of regional economic growth, real PAD per capita, and real DAU per capita. Pairwise correlations and variance inflation factors were examined to identify excessive linear dependence between the fiscal variables. Residual diagnostics covered heteroskedasticity, serial correlation, and general cross-sectional dependence. The Pesaran CD test was used only to detect general residual correlation across local governments; it was not interpreted as evidence of geographical spatial dependence because common policies, commodity-price movements, and pandemic-related shocks could produce similar correlations.

The principal analysis employed a two-way fixed-effects panel regression:

$$GROWTH_{it} = \beta_1 LRPAD_{i,t-1} + \beta_2 LRDAU_{i,t-1} + \alpha_i + \gamma_t + \varepsilon_{it},$$

Where $GROWTH_{it}$ is the annual percentage growth of real GRDP; $LRPAD_{i,t-1}$ and $LRDAU_{i,t-1}$ are the natural logarithms of one-year-lagged real PAD and DAU per capita; α_i denotes local-government fixed effects; and γ_t denotes year fixed effects. Local-government effects control for time-invariant regional characteristics, while year effects capture common shocks, including national policies and the COVID-19 pandemic. Fiscal variables were lagged to establish temporal ordering and reduce contemporaneous simultaneity, resulting in 45 regression observations.

The results were reported using coefficients, standard errors, 95% confidence intervals, exact p -values, observation counts, and within- R^2 . Because the dependent variable is expressed in percentage points and the fiscal variables are logarithmic, a 1% increase in PAD or DAU is associated with a beta over a percentage-point change in economic growth, holding the fixed effects constant. The coefficients were interpreted as conditional associations rather than causal effects. Explanations involving expenditure efficiency, taxation burdens, infrastructure, education, or health were not inferred unless those mechanisms were directly measured.

Given the inclusion of only five local governments, the analysis was treated as exploratory, with emphasis placed on coefficient magnitude, direction, and confidence intervals rather than statistical significance alone. Spatial panel models were not estimated because the cross-sectional dimension was insufficient for stable spatial parameters. All data processing and estimation were conducted in Stata,

and regression tables were exported directly from the estimation output to prevent transcription and decimal-formatting errors.

4. Results and Discussion

4.1 Analysis Results

4.1.1 Regional Economic and Fiscal Dynamics

The balanced dataset initially comprised 50 local-government-year observations covering Bulungan, Malinau, Nunukan, Tana Tidung, and Tarakan during 2014–2023. Using one-year-lagged fiscal variables in the revised regression specification reduced the estimation sample to 45 observations, covering economic growth in 2015–2023 and fiscal variables in 2014–2022. The descriptive evidence indicates substantial variation in regional economic growth during the observation period. In 2014, Nunukan recorded economic growth of 9.98%, followed by Malinau at 9.25%, whereas Bulungan recorded 4.29%. Economic performance subsequently weakened during 2015–2016 and recovered during 2017–2019. The economic disruption observed in 2020 and the subsequent recovery demonstrate the importance of accounting for common annual shocks. Accordingly, the revised model includes year fixed effects to capture the COVID-19 pandemic, national policy changes, commodity-price movements, and other shocks that simultaneously affected the five local governments. These temporal patterns are not treated as evidence of geographical dependence.

PAD also varied substantially across the five local governments. Bulungan and Tarakan generally recorded higher nominal PAD than Tana Tidung, indicating differences in the size of their economic activities, populations, and local revenue bases. However, nominal PAD cannot be compared directly across jurisdictions or years because it is affected by regional size, population, and inflation. The revised analysis therefore uses realized PAD expressed in constant 2010 rupiah per capita and transformed into its natural logarithm. The descriptive differences are interpreted as fiscal heterogeneity and not as evidence that higher PAD causes stronger or weaker economic growth.

DAU was substantially larger than PAD in several local governments, indicating the continuing importance of transfers from the central government. Malinau received relatively large DAU allocations, while Tarakan generally received smaller transfers. These differences are consistent with variation in fiscal needs and fiscal capacity, but the descriptive data do not demonstrate why a particular jurisdiction received a given allocation. They also do not establish that DAU was used for infrastructure, education, healthcare, or other specific expenditure categories because expenditure composition was not measured in the study. Overall, the descriptive results indicate that North Kalimantan's local governments differ in economic performance and fiscal capacity. Nevertheless, these patterns cannot establish the direction or statistical significance of the conditional associations between PAD, DAU, and economic growth. The inferential assessment must therefore rely on the revised two-way fixed-effects model rather than descriptive comparisons.

4.1.2 Cross-Sectional Dependence Diagnostic

The Pesaran CD test produced a statistic of 9.215 with $p < 0.001$. Thus, the null hypothesis of cross-sectional independence was rejected. This result indicates general residual dependence across the five local governments, but it does not demonstrate geographical spatial dependence. In particular, the test does not establish that residual correlation follows a distance-based or contiguity-based spatial weights

matrix. The detected dependence may reflect common national fiscal policies, province-wide development programs, commodity-price changes, macroeconomic conditions, or the COVID-19 pandemic. It may also reflect economic interaction among the local governments, but the Pesaran CD test cannot distinguish geographical interaction from these alternative explanations. Consequently, the result was treated as a panel diagnostic and was not used to justify SAR, SEM, or another spatial panel estimator.

Table 2. Pesaran Cross-Sectional Dependence Test

Statistic	Value
Pesaran CD statistic	9.215
<i>p</i> -value	<0.001

Source: Authors' calculation.

4.1.3 Evaluation of the Previous Spatial Estimates

The previously reported spatial regression results were excluded from the revised analysis. Spatial ρ estimates of 7,770,365 and 7,946,525 and a spatial λ estimate of 7,915,674 fall outside the conventional admissible range of standardized spatial autoregressive parameters and indicate corrupted decimal formatting, estimation failure, or transcription errors. The absence of standard errors, confidence intervals, complete estimator information, and clearly defined R^2 statistics further prevents evaluation of parameter reliability. The former distance-based matrix was also excluded because of the threshold. $0 < d \leq 16$ lacked a unit, distance definition, reference coordinate, and theoretical justification. Moreover, the reported median and maximum distances of 0.9 and 1.3 were inconsistent with that threshold, while neither the complete matrix nor the corresponding neighborhood structure was presented. The matrix could therefore not be reproduced or validated. Given the inclusion of only five local governments, the spatial models also lacked sufficient cross-sectional variation to support stable spatial parameters. Accordingly, the former SAR and SEM estimates, spatial fixed-effects comparisons, AIC values, log-likelihood values, ρ , λ , and spatial R^2 statistics were not retained as research findings. The earlier conclusion that the SEM with spatial fixed effects was the preferred model is therefore withdrawn.

4.1.4 Results That Must Be Withdrawn

The previously reported PAD coefficient of -18.48927 and DAU coefficient of 454.9621 cannot be retained because they were generated by the invalidated spatial specification and were reported without standard errors or confidence intervals. Their unusually large magnitudes also cannot be interpreted correctly without verified information regarding units, deflation, per-capita conversion, logarithmic transformation, and the underlying estimation output. Consequently, the conclusion that PAD had a negative and statistically significant effect on economic growth is withdrawn. Explanations involving routine expenditure, personnel expenditure, taxation burdens, inefficient allocation, household purchasing power, and investment disincentives are also removed because none of these mechanisms was measured. Similarly, the conclusion that DAU promoted economic growth through infrastructure, education, healthcare, transportation, or countercyclical expenditure is withdrawn because expenditure composition was not included in the empirical model. The former interpretation of a negative spatial error coefficient as evidence of inverse shock transmission, regional competition, growth-pole

concentration, or Myrdal-type backwash effects is likewise withdrawn. Such mechanisms cannot be inferred from the sign of an unverified spatial error parameter.

4.2 Discussion

4.2.1 Regional Economic Growth Dynamics

The descriptive findings indicate that economic growth across North Kalimantan's five local governments fluctuated substantially during 2014–2023. In 2014, Nunukan recorded the highest growth rate at 9.98%, followed by Malinau at 9.25%, while Bulungan recorded 4.29%. These differences demonstrate that local governments within the same province do not necessarily follow uniform growth trajectories. The slowdown during 2015–2016, recovery throughout 2017–2019, economic disruption in 2020, and subsequent improvement also indicate that temporal dynamics and common economic shocks influence regional economic performance. This heterogeneity is reasonable because regional economic growth is not determined by fiscal resources alone. Geographical conditions, productivity, employment structure, investment, and sectoral specialization may also shape local economic performance. Albalate *et al.*, (2022) demonstrate that geography can affect accessibility, economic costs, and the location of productive activities. Carullo *et al.*, (2025) similarly emphasize the roles of labor productivity, employment structure, and trade linkages in explaining regional disparities. In North Kalimantan, Tarakan's role as a commercial and service center, Bulungan's administrative function, Nunukan's international-border position, and the natural-resource characteristics of Malinau and Tana Tidung may correspond to the observed differences. However, the individual contributions of these characteristics were not directly tested. The relatively concurrent economic disruption during the pandemic reinforces the importance of including year fixed effects in the revised panel specification. Similar economic movements across several local governments cannot be classified automatically as geographical dependence because national policies, commodity-price changes, mobility restrictions, and the COVID-19 pandemic may produce common patterns. Therefore, the descriptive evidence is interpreted as indicating regional heterogeneity and exposure to common temporal shocks rather than demonstrating that economic growth in one jurisdiction directly affects neighboring jurisdictions.

4.2.2 Differences in Regional Own-Source Revenue Capacity

The findings show substantial differences in PAD across the five local governments. Bulungan and Tarakan generally generated higher nominal PAD than Tana Tidung. This pattern may correspond to differences in population size, concentration of economic activity, local tax bases, chargeable public services, and administrative capacity. Rahman and Restiatun (2023) demonstrate that PAD capacity may be associated with socioeconomic characteristics such as population, motor-vehicle ownership, and labor-market conditions. Consequently, nominal PAD cannot be compared directly across regions without considering differences in population and price levels. The revised analysis expresses PAD in constant 2010 rupiah per capita and subsequently applies a natural-logarithmic transformation. These adjustments ensure that differences in PAD do not merely reflect inflation or jurisdictional scale. PAD performance should also not be evaluated exclusively from the amount of revenue collected. Parulian *et al.*, (2024) emphasize the importance of contribution, growth, elasticity, and local tax performance when assessing own-source revenue. Yakub *et al.*, (2022) similarly show that the effectiveness and efficiency of local tax and service-charge collection determine their contribution to PAD.

The observed differences in PAD do not establish either a positive or negative association with economic growth. Such an association may depend on PAD composition, revenue-administration quality, economic structure, and the subsequent allocation of fiscal resources. Sinaga *et al.*, (2024) show that local taxes, service charges, returns from separated regional assets, and other legitimate revenues do not necessarily exhibit identical relationships with economic growth. Pradana and Putri (2025) similarly find that individual PAD components may display different empirical patterns. Total PAD should therefore not be treated as a completely homogeneous revenue source. Based on the available data, increases in PAD cannot be attributed to routine expenditure, personnel spending, tax burdens, or inefficient allocation. These mechanisms were not included in the empirical model. The study also cannot conclude that PAD was allocated to infrastructure or other productive expenditure. Puspitasari *et al.*, (2023) suggest that the relationship between regional revenue and economic activity may operate through capital expenditure, but this channel must be tested directly. The defensible interpretation is therefore that PAD reflects unequal locally generated fiscal capacity. At the same time, its relationship with growth depends on fiscal composition and management characteristics not fully captured by the study.

4.2.3 The Equalization Role of the General Allocation Fund

The descriptive findings indicate that DAU remains an important source of regional financing and exceeded PAD in several local governments. Malinau generally received relatively large DAU allocations, whereas Tarakan received smaller transfers. This pattern is consistent with DAU's conceptual function as a fiscal-equalization instrument, although the descriptive data cannot establish the precise basis for each jurisdiction's allocation. DAU distribution incorporates differences in fiscal needs, fiscal capacity, and national intergovernmental-transfer provisions. This finding is consistent with Safitri and Widarjono (2023), who show that DAU remains an important component in financing regional autonomy, particularly among local governments in Kalimantan. However, their evidence also indicates that the efficiency of DAU management varies across jurisdictions, meaning that a common transfer arrangement does not necessarily produce uniform fiscal outcomes. Ridho and Wijayanti (2022) likewise associate DAU with the distributional function of intergovernmental transfers in reducing regional income disparities. Accordingly, DAU is more appropriately understood as a fiscal-equalization instrument than as an automatic source of economic growth.

Several studies report an association between DAU and capital-expenditure capacity. Maula *et al.*, (2023) identify a positive relationship between DAU and capital expenditure among local governments in West Java. Comparable findings are reported by Rowena and Hanifa (2024) for Indonesian provinces and Safriyeni and Hidayat (2024) for West Sumatra. Nevertheless, these findings cannot demonstrate that DAU received by North Kalimantan's local governments was allocated entirely to infrastructure or asset formation. DAU provides relatively broad spending discretion and may finance multiple governmental responsibilities. Because expenditure composition was not included in the study, the findings cannot establish that DAU financed infrastructure, education, healthcare, transportation, or economic-recovery programs. Its countercyclical role also cannot be inferred without directly examining expenditure changes over the economic cycle. Andhini *et al.*, (2023) show that DAU may be associated with local-government financial performance, but financial performance is conceptually distinct from regional economic growth. Therefore, DAU's equalization function must be distinguished from its possible relationship with regional production.

4.2.4 Cross-Sectional Dependence and Its Interpretive Limits

The Pesaran CD test produced a statistic of 9.215 with $p < 0.001$, leading to rejection of the null hypothesis of cross-sectional independence. This result indicates general residual correlation across the five local governments. However, it does not demonstrate that the detected dependence follows a particular geographical structure. Because the Pesaran CD test does not incorporate a distance- or contiguity-based weights matrix, it cannot determine whether residual correlation is stronger among geographically proximate jurisdictions. Residual dependence may arise because all five local governments are exposed to national fiscal policies, province-wide development programs, commodity-price movements, macroeconomic changes, and the COVID-19 pandemic. These common factors provide alternative explanations for the observed cross-sectional correlation. Accordingly, the previous conclusion that the Pesaran CD test confirmed spatial dependence is withdrawn.

The result indicates only that the assumption of cross-sectional independence requires caution in panel estimation. Regional relationships can be formed through geographical proximity as well as broader economic networks. Cartone *et al.*, (2022) demonstrate that conclusions regarding regional dependence are sensitive to the proximity structure used in the analysis. Piribauer *et al.*, (2023) similarly emphasize that regional interactions are not determined exclusively by physical distance because trade and production networks may generate relationships that differ from geographical adjacency. Therefore, although economic interaction may exist within North Kalimantan, its structure and direction cannot be established through the Pesaran CD test alone. The previous spatial weights matrix was excluded because the threshold $0 < d \leq 16$ lacked a unit, distance definition, reference point, and substantive justification. The reported median and maximum distances were also inconsistent with that threshold. With only five local governments, spatial parameter estimates would be highly sensitive to matrix construction and would lack sufficient cross-sectional variation. Consequently, the discussions of SAR, SEM, spatial spillovers, inverse shock transmission, and backwash effects were removed.

4.2.5 PAD, DAU, and Regional Economic Growth

The previously reported PAD coefficient of -18.48927 and DAU coefficient of 454.9621 are not used in the revised discussion. These coefficients were generated by a spatial specification that could not be reproduced and were reported without standard errors or confidence intervals. Their unusually large magnitudes also could not be evaluated because the original documentation did not adequately explain the deflator, base year, per-capita conversion, and transformation procedures. Therefore, the hypotheses concerning the associations of PAD and DAU with economic growth cannot be supported or rejected using the former spatial estimates. Conceptually, PAD may provide fiscal space for local governments to finance public services and development. However, economic growth may also broaden the local tax base and increase PAD, creating potential reverse causality. Likewise, DAU may expand regional spending capacity, but fiscal needs and fiscal capacity partly determine its allocation. Because the study relies on observational data, the estimated relationships must be described as conditional associations rather than causal effects. The revised specification uses one-year-lagged real PAD and DAU per capita, local-government fixed effects, and year fixed effects. Lagging the fiscal variables clarifies temporal ordering, while jurisdiction and year effects control for persistent local heterogeneity and common annual shocks. Nevertheless, these procedures do not fully eliminate endogeneity or

omitted-variable bias. Investment, labor, human capital, infrastructure, sectoral composition, natural-resource dependence, and institutional quality may remain associated with both economic growth and fiscal variables. Any revised estimates must therefore be interpreted as exploratory rather than causal evidence.

4.2.6 Implications and Research Contribution

The descriptive findings provide two principal implications. First, substantial differences in PAD indicate that strategies to strengthen fiscal capacity should reflect each jurisdiction's economic base. Policies should consider collection effectiveness, revenue composition, administrative costs, and the responsiveness of revenue sources to economic activity rather than focusing only on maximizing total receipts. Second, the relative dominance of DAU indicates that equalization transfers remain important for jurisdictions with limited local revenue bases. Evaluation of DAU should therefore consider its alignment with service responsibilities and the quality of its management, rather than only the amount allocated. These implications do not mean that the study has demonstrated that PAD or DAU financed specific categories of expenditure. Recommendations concerning expenditure quality, transparency, accountability, and budget evaluation are governance implications derived from the conceptual functions of regional fiscal resources, not mechanisms empirically proven by the coefficients. Maintaining this distinction prevents the policy discussion from exceeding the available evidence. The study contributes contextual evidence regarding variations in economic growth and fiscal capacity across all local governments in North Kalimantan during 2014–2023. It also demonstrates the importance of distinguishing general cross-sectional dependence from geographically structured spatial dependence. However, with only five jurisdictions, the findings cannot be generalized broadly and do not support claims regarding the superiority of spatial panel estimation. The research is therefore more appropriately positioned as an exploratory panel analysis of a border province with a limited number of administrative units.

5. Concluding Remarks and Recommendation

This study examined regional economic and fiscal dynamics across Bulungan, Malinau, Nunukan, Tana Tidung, and Tarakan during 2014–2023, with particular attention to Regional Own-Source Revenue (PAD), the General Allocation Fund (DAU), and regional economic growth. Given the inclusion of only five local governments, the revised study adopts an exploratory panel-data perspective rather than a spatial panel framework. The analysis documents substantial variation in economic growth and fiscal capacity across jurisdictions and over time. The Pesaran CD test indicates general cross-sectional residual dependence. However, this finding does not establish geographically structured spatial dependence because common national policies, province-wide shocks, commodity-price movements, and the COVID-19 pandemic may generate similar residual correlations. The previous spatial estimates do not provide sufficiently reliable evidence to conclude that PAD is negatively associated with economic growth or that DAU is positively associated with economic growth. The former spatial weights matrix could not be reproduced, the reported spatial parameters contained implausible or corrupted values, and the model was estimated from an extremely small cross-sectional dimension. Consequently, the former SAR and SEM results, including the spatial error coefficient, are not retained as substantive findings. The available evidence supports only the conclusion that locally generated fiscal capacity and

central-government transfers differ substantially across North Kalimantan's local governments. It does not establish that fiscal resources cause changes in economic growth or operate through specific expenditure channels.

The study contributes by providing context-specific evidence on fiscal heterogeneity in Indonesia's newest border province and by demonstrating the importance of distinguishing general cross-sectional dependence from geographical spatial dependence. From a policy perspective, local governments should evaluate PAD according to its composition, collection efficiency, and contribution to sustainable fiscal capacity rather than focusing exclusively on revenue maximization. The continuing importance of DAU also indicates the relevance of fiscal equalization for jurisdictions with limited local revenue bases. Nevertheless, recommendations concerning infrastructure, education, healthcare, or other expenditure priorities should be based on separate evidence regarding expenditure composition, implementation quality, and development outcomes. Provincial and local governments may also strengthen data coordination and joint development planning without assuming that the present study has empirically demonstrated spatial spillover effects.

The principal limitations are the inclusion of only five local governments, the short 2014–2023 observation period, and the restricted representation of factors associated with regional economic growth. Investment, labor productivity, human capital, infrastructure, sectoral composition, natural-resource dependence, institutional quality, and expenditure composition were not fully incorporated. Reverse causality between economic activity and PAD also remains possible, while the small sample limits statistical power and the reliability of conventional asymptotic inference. Future research should expand the geographical coverage to multiple provinces, extend the observation period, incorporate theoretically justified fiscal and socioeconomic controls, and apply an explicit endogeneity strategy. Spatial econometric models should be reconsidered only when the sample provides sufficient cross-sectional variation and when the weights matrix, distance measure, reference coordinates, neighborhood structure, sensitivity analysis, and complete estimation output can be reported transparently and reproduced.

Statement of Use of Generative AI

During the preparation of this work, the author used generative artificial intelligence tools to support the scientific writing process. Grammarly was used to check grammar, refine writing style, and improve clarity in scientific writing. All interpretations, analyses, and conclusions presented in this study are the sole responsibility of the author.

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