

The Effect of General Allocation Fund and Government Capital Expenditure on Regional Gross Domestic Product in the Toba Caldera Geopark Area (A Panel Data Study of Seven Regencies in the Toba Caldera Geopark Area, 2010–2024)

Vincentius M. Lumbantoruan

Universitas HKBP Nommensen, Medan

vincentius.lumbantoruan@student.uhn.ac.id

Nancy Nopeline

Universitas HKBP Nommensen, Medan

Elvis F Purba

Universitas HKBP Nommensen, Medan

Abstract

This study examines the effect of the General Allocation Fund (DAU) and government capital expenditure on Regional Gross Domestic Product (PDRB) in seven regencies surrounding the Toba Caldera Geopark area — Simalungun, Toba, Samosir, Karo, Humbang Hasundutan, Dairi, and Tapanuli Utara — over the period 2010–2024. Using annual secondary data from the Central Bureau of Statistics (BPS) and the Directorate General of Fiscal Balance, the study applies panel data regression on a log-log model. Model selection through the Chow and Hausman tests indicates that the Fixed Effect Model (FEM) is the most appropriate specification. Because the classical assumption tests detected heteroscedasticity, the final estimation was corrected using White cross-section robust standard errors. The results show that DAU has a positive and statistically significant effect on PDRB ($\beta = 1.1366$; $t = 3.0853$; $p = 0.0081$), while government capital expenditure has a positive but not statistically significant effect on PDRB ($\beta = 0.1889$; $t = 1.1618$; $p = 0.2647$). Jointly, the two variables explain 91.12% of the variation in PDRB ($R^2 = 0.9112$; $F = 123.0775$; $p = 0.000$). These findings indicate that fiscal transfers from the central government play a stronger role than local capital spending in driving regional economic performance in this geopark area, and that regional government investment has not yet translated into a statistically measurable effect on output during the period studied.

Keywords: General Allocation Fund, Government Capital Expenditure, Regional Gross Domestic Product, Panel Data Regression, Toba Caldera Geopark

1. Introduction

The Toba Caldera Geopark is one of Indonesia's strategic areas, recognized globally for its geological, ecological, and cultural value, and was officially designated a UNESCO Global Geopark on 7 July 2020. This designation gives Indonesia both an opportunity and a responsibility to promote economic development and sustainable growth in the surrounding area, guided by the three pillars of sustainable development: economic growth, environmental preservation, and social justice. Regional

economic growth is commonly measured through the growth of Regional Gross Domestic Product (PDRB).

The Toba Caldera Geopark area covers parts of seven regencies bordering Lake Toba within the caldera rim: Simalungun, Toba, Samosir, Karo, Humbang Hasundutan, Dairi, and Tapanuli Utara. PDRB data for 2010–2024 show a generally rising long-term trend across all seven regencies, although several experienced a temporary decline early in the period. Simalungun recorded the largest PDRB growth, rising from IDR 14,882.41 billion in 2010 (after a dip to IDR 11,627.58 billion in 2011) to IDR 58,906.11 billion in 2024, making it the region's leading economic contributor. The other six regencies — Toba, Samosir, Karo, Humbang Hasundutan, Dairi, and Tapanuli Utara — also show consistent long-term growth, though at comparatively smaller magnitudes.

PDRB is influenced by regional fiscal policy, particularly capital expenditure and intergovernmental transfers such as the General Allocation Fund (DAU). DAU is an unconditional transfer intended to close the fiscal gap and support equitable public service delivery across regions, including strategic tourism areas. DAU in the seven regencies generally trended upward over 2010–2024, with notable fluctuations during the 2020–2022 pandemic period before recovering. Government capital expenditure — spending on infrastructure, buildings, equipment, and other fixed assets that support public services — showed a more volatile pattern across the same period, with a sharp contraction in most regencies in 2020 followed by renewed growth from 2021 onward, consistent with a post-pandemic acceleration of infrastructure development.

Although prior studies have examined the effects of DAU and capital expenditure on PDRB in various regions, research focusing specifically on the seven regencies surrounding the Toba Caldera Geopark — using data updated through 2024 — remains limited. This gap motivates the present study, which aims to: (1) examine the effect of DAU on PDRB, and (2) examine the effect of government capital expenditure on PDRB, in the seven regencies of the Toba Caldera Geopark area.

2. Literature Review

Regional Gross Domestic Product (PDRB)

PDRB is defined as the total gross value added produced by all economic sectors in a region over a given period (Tarigan, 2014), reflecting regional production capacity and economic performance (Sjafrizal, 2014). It can be calculated through three approaches — production, income, and expenditure — and is commonly expressed through the expenditure identity $PDRB = C + I + G + X - M$, where consumption, investment, government spending, and exports relate positively to PDRB while imports relate negatively to it (Purba, 2021). PDRB growth is driven by capital accumulation, labor, technology, human capital quality, infrastructure, and fiscal policy instruments such as capital expenditure and central transfers (Adisasmita, 2013; Ridwan & Saprudin, 2024). In this study, PDRB is the dependent variable representing regional economic performance, which DAU and government capital expenditure are hypothesized to influence through financing of infrastructure, public services, and productive activity.

General Allocation Fund (DAU)

DAU is an unconditional fiscal transfer from the central government to regional governments, intended to equalize regional fiscal capacity and close the fiscal gap between fiscal needs and fiscal capacity (Mardiasmo, 2018). It represents the largest component of Indonesia's fiscal balancing funds and is intended to support regional autonomy objectives, particularly improving public services such as health and education (Christia & Ispriyarso, 2019).

Government Capital Expenditure

Capital expenditure is government spending directed at acquiring fixed assets — infrastructure, buildings, equipment, and networks — with a useful life beyond one year, supporting public service delivery (Mardiasmo, 2018). Under regional autonomy, capital expenditure is an important instrument for expanding regional production capacity through infrastructure development (Badrudin, 2017); a larger share of capital expenditure in the regional budget is generally interpreted as an indicator of more productive fiscal management, since capital assets are typically used for public services that benefit the wider community.

Relationships Between Variables and Hypothesis Development

A larger DAU expands a regional government's capacity for spending, which stimulates the production of goods and services, accelerates local economic turnover, and is theorized to raise PDRB (Wulantari et al., 2017). Likewise, capital expenditure is theorized to raise PDRB by expanding infrastructure and public service networks, improving regional economic efficiency, encouraging capital accumulation, and generating multiplier effects through higher aggregate demand and long-term production capacity (Sjafrizal, 2014; Ridwan & Saprudin, 2024). Regional autonomy gives local governments flexibility to align capital spending with local needs, further reinforcing PDRB growth through the development of regional economic potential (Badrudin, 2017).

Several prior studies support these relationships: DAU has been found to have a positive and significant effect on PDRB in Nusa Tenggara Barat (Mafahir & Soelistiyo, 2017) and in North Sumatra (Gulo, 2022), while capital expenditure has been found to have a positive and significant effect on regional economic growth in the Lake Toba area (Damanik & Panjaitan, 2024), in Sumba (Ama & Renggo, 2022), and in West Sumatra (Iqbal, 2025). Based on this theoretical and empirical foundation, the following hypotheses are proposed:

H1: The General Allocation Fund (DAU) has a positive and significant effect on PDRB in the seven regencies of the Toba Caldera Geopark area.

H2: Government capital expenditure has a positive and significant effect on PDRB in the seven regencies of the Toba Caldera Geopark area.

3. Research Methods

Research Design

This study uses a quantitative approach based on panel data regression to examine the effect of DAU and government capital expenditure on PDRB in the seven regencies of the Toba Caldera Geopark area.

Population and Data

The study covers all seven regencies within the Toba Caldera Geopark area — Simalungun, Toba, Samosir, Karo, Humbang Hasundutan, Dairi, and Tapanuli Utara — over the period 2010–2024, forming a balanced panel of 105 cross-section–year observations. Secondary data on realized DAU, realized government capital expenditure, and PDRB at current prices were obtained from the Central Bureau of Statistics (BPS) and the Directorate General of Fiscal Balance.

Data Analysis Technique

All variables were transformed into natural logarithms (a log-log/double-log specification), which simplifies the interpretation of regression coefficients as elasticities and helps reduce heteroscedasticity, normalize the data distribution, and limit the influence of outliers (Basuki & Prawoto, 2016). The estimated model is:

$$\ln(PDRB)_{it} = \beta_0 + \beta_1 \ln(DAU)_{it} + \beta_2 \ln(BM)_{it} + \varepsilon_{it}$$

where i denotes the seven regencies (cross-section) and t denotes the year (2010–2024). Three panel estimation approaches were compared — the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM) — with the Chow test used to choose between CEM and FEM, and the Hausman test used to choose between FEM and REM. Classical assumption tests (normality, multicollinearity, and heteroscedasticity) were then applied to the selected model. Where heteroscedasticity was detected, White cross-section robust standard errors were used to correct the estimation. Hypotheses were tested via the individual t -test, the coefficient of determination (R^2), and the F -test, with a path considered significant when $p < 0.05$.

4. Result and Discussion

Descriptive Statistics

Table 1 summarizes the descriptive statistics of the (logged) study variables across the 105 panel observations.

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
DAU	9.02826	8.92053	10.98370	7.51502	0.78190
Government Capital Expenditure	20.15287	20.11866	20.93809	18.96039	0.36288
PDRB	18.96184	19.00986	20.07019	17.64676	0.40719

Table 1. Descriptive Statistics (natural-log values)

Panel Data Model Estimation

The three panel estimation approaches produced the following results, summarized in Table 2.

Variable	Model	Prob.	R-squared	F-statistic
DAU / Capital Expenditure	CEM	0.0000 / 0.5469	0.77593	176.60670
DAU / Capital Expenditure	FEM	0.0000 / 0.0165	0.91116	123.07750
DAU / Capital Expenditure	REM	0.0000 / 0.0236	0.61870	82.75274

Table 2. Summary of the Three Panel Regression Models

The Chow test comparing CEM and FEM produced a Cross-section F statistic of 24.3559 and a Cross-section Chi-square of 97.1406, both with $p = 0.0000$ (< 0.05), rejecting the Common Effect Model in favor of the Fixed Effect Model. The subsequent Hausman test comparing FEM and REM produced a Chi-square statistic of 10.998865 ($p = 0.0041 < 0.05$), confirming the Fixed Effect Model as the most appropriate specification for this panel.

Classical Assumption Tests

The Jarque–Bera normality test produced a statistic of 17.15719 ($p = 0.000188 < 0.05$), indicating that the residuals are not normally distributed; however, normality is not a requirement for the Best Linear Unbiased Estimator (BLUE) property and was therefore not treated as a binding constraint. The multicollinearity test showed a correlation coefficient of 0.6395 between DAU and capital expenditure, well below the 0.80 threshold, indicating no multicollinearity problem. The heteroscedasticity test, however, showed significant coefficients for both DAU ($p = 0.0007$) and capital expenditure ($p = 0.0000$), indicating that heteroscedasticity was present. The model was therefore re-estimated using White cross-section robust standard errors, after which both variables' heteroscedasticity-test coefficients were no longer significant (DAU $p = 0.2835$; capital expenditure $p = 0.1025$), confirming that the correction was effective.

Final Model and Hypothesis Testing

Table 3 presents the Fixed Effect Model estimation after correction with White cross-section robust standard errors, which forms the basis for hypothesis testing.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-17.4595	5.7248	-3.0498	0.0087
DAU	1.1366	0.3684	3.0853	0.0081
Government Capital Expenditure	0.1889	0.1626	1.1618	0.2647

Table 3. Fixed Effect Model with White Cross-Section Robust Standard Errors ($R^2 = 0.9112$; F -statistic = 123.0775; $Prob(F\text{-statistic}) = 0.0000$)

The estimated regression equation is:

$$\ln(PDRB)_{it} = -17.4595 + 1.1366 \ln(DAU)_{it} + 0.1889 \ln(BM)_{it}$$

The DAU coefficient of 1.1366 is positive and significant ($p = 0.0081 < 0.05$): a 1% increase in DAU is associated with a 1.1366% increase in PDRB, holding other variables constant. Hypothesis H1 is therefore supported. The capital expenditure coefficient of 0.1889 is positive but not statistically significant ($p = 0.2647 > 0.05$): a 1% increase in capital expenditure is associated with a 0.1889% increase in PDRB in direction, but this relationship cannot be confidently distinguished from zero at conventional significance levels. Hypothesis H2 is therefore not supported. Jointly, DAU and capital expenditure explain 91.12% of the variation in PDRB ($R^2 = 0.9112$), and the F-test confirms that the two variables are jointly significant predictors of PDRB ($F = 123.0775$; $p = 0.000$).

The fixed cross-section effects indicate that Simalungun (+1.270) and Karo (+0.678) have PDRB levels systematically above the panel average, consistent with more effective use of fiscal transfers and capital spending in driving local economic activity, while Samosir (−0.848), Humbang Hasundutan (−0.524), Toba (−0.256), Tapanuli Utara (−0.226), and Dairi (−0.093) show PDRB levels below the panel average, suggesting comparatively limited economic scale or less optimal use of fiscal resources. The fixed period effects show a gradual shift from negative values in 2010–2016 (from −0.593 in 2010 to −0.033 in 2016) to positive and increasing values from 2017 onward, reaching +0.523 in 2024 — indicating that time-specific conditions, including the post-pandemic recovery, increasingly reinforced PDRB growth toward the end of the study period, independent of DAU and capital expenditure.

Discussion

The finding that DAU has a positive and significant effect on PDRB (H1) is consistent with Mafahir & Soelistiyo (2017), Gulo (2022), and Syahrani et al. (2025), and indicates that fiscal transfers from the central government meaningfully contribute to rising economic activity in the seven regencies of the Toba Caldera Geopark area.

The finding that government capital expenditure has a positive but not statistically significant effect on PDRB (H2) diverges from the theoretical expectation of a significant relationship, but is consistent with Rahmawati & Jumaedi (2026), Zahra et al. (2025), and Primasari et al. (2024), who likewise found capital expenditure to be positively but not significantly associated with PDRB. This suggests that regional government investment in fixed assets points in the right direction for regional economic growth, but its impact has not yet reached statistical significance during the 2010–2024 period — possibly reflecting lags between infrastructure investment and measurable output effects, or variation in the productivity of capital spending across regencies.

5. Conclusion

Based on the Fixed Effect Model results, this study concludes that the General Allocation Fund (DAU) has a positive and significant effect on PDRB in the seven regencies of the Toba Caldera Geopark area over 2010–2024, while government capital expenditure has a positive but not statistically significant effect over the same period. Descriptively, Simalungun regency recorded the highest PDRB throughout the study period, reaching IDR 58,906.11 billion in 2024, and stands out as the leading economic contributor within the geopark area; the remaining six regencies show a relatively stable upward PDRB trend but remain below Simalungun in absolute terms.

These findings suggest that regional governments in the Toba Caldera Geopark area should maintain balanced infrastructure development and inter-regional connectivity so that economic growth is not concentrated in a single regency, strengthen investment attractiveness and tourism-sector development as a strategic growth driver, and improve the productivity of capital spending so that its effect on PDRB becomes more clearly measurable. This study is limited to two fiscal variables and seven regencies over a fifteen-year period; future research is encouraged to incorporate additional variables — such as private investment, education levels, labor force size, and tourism-sector development — and to extend the observation period for a more comprehensive picture of regional economic dynamics in the Toba Caldera Geopark area.

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