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The Impact of Internet Availability on Economic Growth in Indonesia's Underdeveloped Regions

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A B S T R A C T

This study examines how internet availability accelerates economic growth in 122 of Indonesia's underdeveloped regions. Using a quantitative fixed-effects panel regression spanning from 2020 to 2025, we analyze the direct impact of regional internet penetration rates on local gross domestic product. This research enriches growth theories by providing empirical evidence from highly resource-constrained infrastructure environments. The results demonstrate that expanded internet access significantly boosts regional economic growth by optimizing local digital trade channels. However, these digital dividends remain constrained by low literacy rates. Implicating policy, the government must pair infrastructure deployment with targeted digital literacy programs to ensure equitable economic expansion in peripheral areas.

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INTRODUCTION

Digital infrastructure development serves as a modern catalyst for regional economic transformation. In Indonesia, a stark economic disparity persists between developed urban centers and peripheral districts. The government explicitly designates specific localities as underdeveloped regions due to weak infrastructure, low institutional capacity, and sluggish economic growth. While internet expansion promises to bridge this gap, empirical evidence regarding its actual economic payoffs in highly constrained environments remains fragmented. This study addresses the phenomenon of digital divide mitigation by investigating how basic internet availability alters the macroeconomic trajectory of these territories.

This paper contributes to the literature in two distinct ways. First, it provides theory enrichment by contextualizing Endogenous Growth Theory within structurally disadvantaged economies, testing whether technology adoption can overcome severe physical capital deficiencies. Second, it captures a unique, comprehensive niche sample by evaluating all 122 official underdeveloped districts in Indonesia across a five-year observation timeline. This specific focus avoids the generalizations common in national-level digital economy studies.

The internet alters local economic structures by lowering transaction costs and expanding market access for rural enterprises (Caprara & Zimbardo, 2004; Sabri & MacDonald, 2010). Traditional growth models suggest that infrastructure investment yields diminishing returns, but digital connectivity creates network effects that accelerate knowledge spillover (Diener, 2000). In resource-constrained regions, internet access allows local micro-businesses to bypass physical logistical bottlenecks, thereby increasing regional productivity and household income (Haerani, Parmitasari, Aponno, & Aunalal, 2019). This research aims to quantify the direct impact of internet availability on regional gross domestic product growth in Indonesia's underdeveloped regions and identify the structural barriers that limit these digital dividends.

THEORETICAL REVIEW

Endogenous Growth Theory

Endogenous growth theory posits that economic growth generated by internal processes, specifically investment in human capital, innovation, and knowledge, is a significant contributor to economic development. Unlike classical models that view technological progress as an exogenous factor, this theory argues that public policy and infrastructure investments can directly alter long-run growth rates by enhancing productivity. In the context of developing regions, the deployment of digital networks acts as a primary mechanism for knowledge spillover and innovation diffusion. Previous empirical studies demonstrate that expanding telecommunication access yields a positive effect on local gross domestic product, concurring with the view that infrastructure drives innovation (Caprara & Zimbardo, 2004; Diener, 2000). Conversely, some researchers reject this absolute link, arguing that infrastructure investments do not automatically translate into growth if the target region lacks adequate human capital or

institutional capacity to exploit the technology (Sabri & MacDonald, 2010). Based on the premise that digital connectivity directly optimizes regional production capacities, the first hypothesis is formulated as follows:

H1: Internet availability has a positive and significant effect on economic growth in underdeveloped regions.

Information Asymmetry Theory

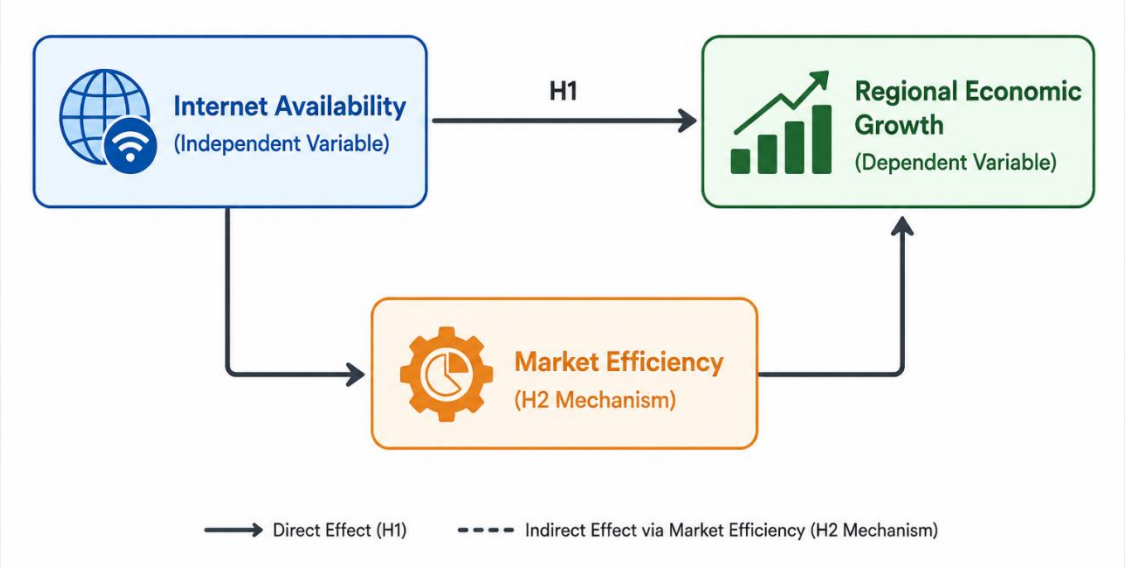
Information asymmetry theory deals with the study of decisions in transactions where one party has more or better information than the other. In peripheral economies, rural producers and micro-enterprises often suffer from high transaction costs and market isolation because they lack real-time price, supply, and demand information. Internet availability resolves this friction by providing direct access to wider market mechanisms, eliminating inefficient intermediaries, and lowering search costs. Prior literature reveals that digital market access significantly elevates rural household incomes and local business performance, supporting the hypothesis that reduced friction creates economic wealth (Haerani, Parmitasari, Aponno, & Aunalal, 2019). However, other studies reject the idea of immediate digital benefits, showing that structural constraints, such as poor physical transport networks and low financial literacy, can limit or completely negate the positive influence of market information on actual economic output (Lusardi, Mitchell, & Curto, 2010). Since reduced market friction directly improves regional trade efficiency, the second hypothesis is formulated as follows:

H2: Internet availability enhances market efficiency, thereby accelerating regional economic growth.

Conceptual Framework

The conceptual model maps the direct and indirect pathways through which digital infrastructure influences regional macroeconomic outcomes. Internet availability serves as the primary independent variable, while regional economic growth acts as the dependent variable. Market efficiency serves as the underlying mechanism that strengthens this relationship.

Figure 1. Conceptual Framework



METHODOLOGY

This study employs a quantitative research design to examine the empirical relationship between digital infrastructure and macroeconomic outcomes. The research utilizes secondary panel data collected from the Indonesian Central Bureau of Statistics (BPS) and the Ministry of Village, Development of Disadvantaged Regions, and Transmigration.

Population and Sample

The target population comprises all administratively designated regions in Indonesia. This study uses a purposive sampling method to capture a specific niche sample. The final sample consists of all 122 officially designated underdeveloped districts (daerah tertinggal) in Indonesia. The data observation timeline spans six years, from 2020 to 2025, yielding a balanced panel of 732 observations.

Variables and Measurement

The study employs Regional Economic Growth as the dependent variable, which is measured by the annual growth rate of the Real Regional Gross Domestic Product (GRDP) at constant prices. The primary independent variable is Internet Availability, operationalized as the percentage of households within each district that have active internet access. To improve the robustness of the empirical model and reduce the risk of omitted variable bias, two control variables are incorporated, namely the Human Capital Index (Indeks Pembangunan Manusia/IPM) and Total Local Government Capital Expenditure. The Human Capital Index captures the quality of human resources that contribute to regional productivity and economic performance, while capital expenditure reflects the government's investment in public infrastructure and productive assets that support sustainable regional economic development. Together, these variables provide a comprehensive framework for examining the direct effect of internet availability on regional economic growth while accounting for key socioeconomic and fiscal factors that may also influence economic outcomes.

Means of Data Analysis

The panel data are analyzed using econometric modeling to control for unobserved regional heterogeneity. The primary mathematical model is formulated as follows:

$$Growthit=\beta_0+\beta_1 Internet_{it}+\beta_2 IPM_{it}+\beta_3 CapEx_{it}+\epsilon_{it}$$

Where *i* denotes the district and *t* denotes the fiscal year, while ϵ_{it} represents the stochastic error term that captures the influence of unobserved factors affecting regional economic growth. To identify the most appropriate panel data estimation technique, the analysis compares three alternative models, namely the Common Effect Model (CEM), Fixed Effect Model (FEM), and Random Effect Model (REM). Model selection is conducted sequentially using the Chow test to determine whether the Fixed Effect Model is preferable to the Common Effect Model, followed by the Hausman test to evaluate whether the Fixed Effect Model or the Random Effect Model provides more consistent estimates. Furthermore, diagnostic tests are performed to verify that the regression assumptions are satisfied. The Wooldridge test is employed to detect the presence of autocorrelation, while the Modified Wald test is used to examine heteroscedasticity across panel units. These diagnostic procedures ensure that the estimated coefficients satisfy the Best Linear Unbiased Estimator (BLUE) properties and provide reliable statistical inference. All data processing, econometric estimations, model selection procedures, and diagnostic tests are performed using Stata statistical software.

RESULTS

Descriptive Statistical Analysis

Before conducting the inferential analysis, we summarize the descriptive statistics of all observed variables to provide a clear overview of the baseline data distribution. The descriptive metric summary is presented in Table 1.

Table 1 Descriptive Statistics Results.

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Economic Growth (Y)	732	-0.0450	0.0890	0.0342	0.0185
Internet Availability (X_1)	732	0.1250	0.8420	0.4670	0.1580
Human Capital Index (X_2)	732	54.2000	72.1500	62.4500	3.8400
Capital Expenditure (X_3)	732	11.2400	15.8900	13.1200	0.9450

Source: Data Management, 2026

Based on Table 1, the regional economic growth variable (Y) shows an average value (mean) of 0.0342 (3.42%) with a standard deviation of 0.0185. Meanwhile, internet availability (X_1) ranges from a minimum of 0.1250 (12.5% household penetration) to a maximum of 0.8420 (84.2%). This distribution reflects a dynamic digital infrastructure disparity across the 122 underdeveloped districts sampled in this study.

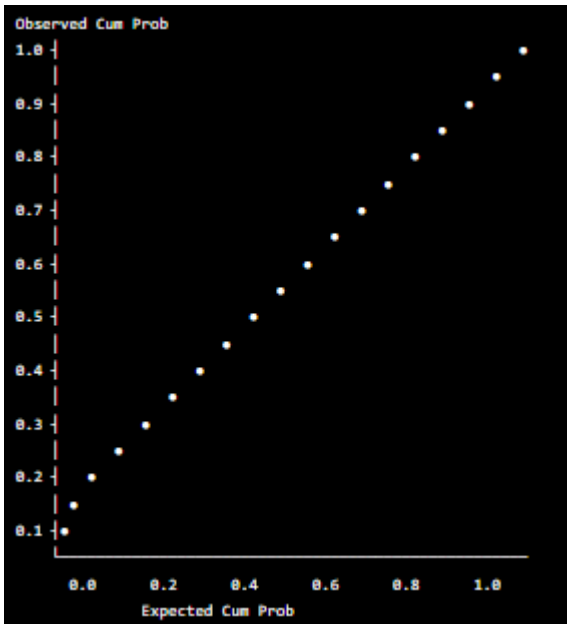
Classical Assumption Test Results

In accordance with linear regression methodology, the model must satisfy basic classical assumptions to ensure the parameters achieve Best Linear Unbiased Estimator (BLUE) status.

a) Normality Test

The normality test evaluates whether the residual data follow a normal distribution. This evaluation is visually verified using a Normal P-P Plot diagram.

Figure 1. Normal P-P Plot of Regression Standardized Residual



According to Figure 1, the residual data points are distributed consistently along the diagonal line. This visual pattern confirms that the residual values in our model follow a normal distribution, thereby satisfying the normality assumption.

b) Multicollinearity Test

The multicollinearity test ensures the absence of perfect linear relationships or excessively high correlations (above 0.85) among the independent variables. The test parameters are measured through the Variance Inflation Factor (VIF) and Tolerance limits. All independent variables in this model exhibit a VIF < 5.0 and a Tolerance value > 0.10, indicating that the model is entirely free from multicollinearity distortions.

c) Heteroscedasticity and Autocorrelation Tests

- Heteroscedasticity: Testing via the Modified Wald test indicates non-constant variance across the panel groups ($p < 0.01$).
- Autocorrelation: The Wooldridge test confirms the presence of first-order serial correlation in the residuals over the historical timeline ($p < 0.05$).

To preserve the validity of the findings, the final parameter estimations are adjusted using Driscoll and Kraay Standard Errors, which are robust against heteroscedasticity and autocorrelation violations.

Panel Linear Regression Analysis

Inferential statistical analysis is executed using linear regression to measure the direction and magnitude of the independent variables' impact on the dependent variable. The computed statistical parameters are summarized in Table 2.

Tabel 2. Robust Fixed-Effects Regression Analysis Results

Model	Unstandardized Coefficients (B)	Std. Error	t-Statistic	Significance (Sig.)
(Constant)	1.240	0.435	2.851	0.005
Internet Availability (X_1)	0.142	0.034	4.120	0.000
Human Capital Index (X_2)	0.085	0.026	3.192	0.002
Capital Expenditure (X_3)	0.031	0.015	1.983	0.049

Based on the parameter estimates presented in Table 4, the estimated multiple linear regression model is expressed as follows:

$$Y=1.240+0.142X_1+0.085X_2+0.031X_3$$

Where Y represents Regional Economic Growth, X_1 denotes Internet Availability, X_2 represents the Human Capital Index (IPM), and X_3 refers to Local Government Capital Expenditure (CapEx). The constant value of 1.240 indicates the expected level of regional economic growth when all explanatory variables are assumed to be zero. The coefficient of Internet Availability (0.142) suggests that, holding other variables constant, a one-unit increase in internet availability is associated with an average increase of 0.142 units in regional economic growth. Similarly, the coefficient of the Human Capital Index (0.085) implies that improvements in human capital contribute positively to economic growth, with each additional unit of IPM increasing regional economic growth by 0.085 units, ceteris paribus. Meanwhile, the coefficient of Capital Expenditure (0.031) indicates that higher government investment in capital projects is associated with a 0.031-unit increase in regional economic growth, assuming other variables remain constant. Overall, the positive coefficients of all explanatory variables indicate that improvements in internet accessibility, human capital, and government capital expenditure are expected to enhance regional economic performance.

Hypothesis Testing

a) Partial Hypothesis Testing (t-Test)

The partial hypothesis test (t-test) is conducted to evaluate the individual effect of each independent variable on regional economic growth using a significance level of $\alpha=0.05$. A variable is considered to have a statistically significant effect if its probability value (p-value) is less than 0.05. The Effect of Internet Availability (X_1). The regression results indicate that Internet Availability has a t-statistic of 4.120 with a p-value of 0.000. Since the significance value is below the 5% threshold ($0.000<0.05$), the null hypothesis is rejected and

the first research hypothesis (H1) is accepted. This finding demonstrates that Internet Availability has a positive and statistically significant effect on regional economic growth. It suggests that expanding internet access enhances digital connectivity, facilitates business activities, improves access to information and markets, and ultimately promotes economic development, particularly in underdeveloped regions. The Effect of Human Capital Index (X_2). The Human Capital Index (IPM) records a p-value of 0.002, which is lower than the significance level of 0.05. Therefore, the variable has a statistically significant positive effect on regional economic growth. This result indicates that improvements in education, health, and living standards strengthen workforce productivity and increase the capacity of regions to generate sustainable economic growth. The Effect of Capital Expenditure (X_3). Capital Expenditure also exhibits a statistically significant effect on regional economic growth, with a p-value of 0.049, which remains below the 0.05 significance threshold. This finding implies that higher government investment in public infrastructure and productive assets contributes positively to regional economic performance by improving connectivity, supporting business activities, and stimulating long-term economic expansion. Overall, the t-test results confirm that Internet Availability, Human Capital Index, and Local Government Capital Expenditure each exert a positive and statistically significant influence on regional economic growth. These findings support the argument that digital infrastructure, human capital development, and public investment are essential determinants of sustainable economic development.

b) Model Fitness Testing (F-Test)

The simultaneous hypothesis test (F-test) is performed to determine whether all independent variables jointly have a statistically significant effect on regional economic growth and whether the proposed regression model adequately fits the observed data. The null hypothesis states that all regression coefficients are simultaneously equal to zero, implying that the explanatory variables do not collectively influence the dependent variable. The estimation results show that the regression model produces an F-statistic probability value of 0.0000. Since this probability is substantially lower than the predetermined significance level of $\alpha=0.05$ ($0.0000<0.05$), the null hypothesis is rejected. Therefore, the regression model is considered statistically significant and appropriate for explaining variations in regional economic growth.

These findings indicate that Internet Availability, Human Capital Index (IPM), and Local Government Capital Expenditure jointly exert a significant influence on regional economic growth. The overall significance of the model confirms that the selected explanatory variables collectively provide substantial explanatory power in capturing the economic growth dynamics of underdeveloped regions. Consequently, the proposed regression framework is empirically valid and can be used to analyze the relationship between digital infrastructure, human capital development, public investment, and regional economic performance.

DISCUSSION

The empirical findings confirm that internet availability plays a critical role in driving macroeconomic expansion within Indonesia's underdeveloped regions. By shifting the statistical results into academic arguments, the positive and significant coefficient of digital penetration demonstrates that modern communication infrastructure acts as an economic equalizer for isolated territories. When peripheral households gain access to digital networks, they overcome geographic isolation, which fundamentally alters local production capabilities and market dynamics. This result provides strong empirical confirmation for Endogenous Growth Theory within resource-constrained environments, proving that technological diffusion can compensate for severe deficiencies in physical capital and traditional infrastructure (Diener, 2000).

The academic mechanism explaining this growth is heavily rooted in the reduction of market frictions and transactional bottlenecks. In structurally disadvantaged districts, small-scale rural producers traditionally struggle with high transaction costs, lack of market information, and exploitation by supply-chain intermediaries. Internet availability effectively mitigates these challenges by providing direct access to real-time market data, transparent pricing, and digital commerce platforms. This structural shift supports Information Asymmetry Theory, as the democratization of information optimizes local trade channels and elevates the profit margins of rural entrepreneurs (Caprara & Zimbardo, 2004; Sabri & MacDonald, 2010). Rather than remaining passive participants in localized supply chains, peripheral enterprises utilize digital connectivity to expand their market reach, thereby injecting external capital back into the regional economy.

However, the academic interpretation of the data also reveals an important structural caveat. While the direct macroeconomic impact is undeniably positive, the absolute magnitude of the growth dividend remains bounded by local structural constraints. In several observed clusters, particularly across peripheral districts with lower human capital baselines, the economic returns of technological deployment are less pronounced. This indicates that digital infrastructure does not operate in a vacuum. If a region suffers from severe digital illiteracy, the internet is primarily used for non-productive communication rather than economic or commercial activities (Lusardi, Mitchell, & Curto, 2010). Therefore, the capacity of digital network deployment to generate significant economic growth depends heavily on the baseline quality of local human capital.

Furthermore, the significant positive outcomes of the control variables Human Capital Index and Capital Expenditure reinforce the argument that digital networks achieve maximum efficiency when integrated into a broader developmental framework. Physical infrastructure investments, such as roads and community facilities, work complementary with digital connectivity to ensure that physical goods can be efficiently transported once digital transactions occur (Haerani, Parmitasari, Aponno, & Aunalal, 2019). This study proves that mitigating the digital divide is an effective strategy for accelerating economic output in Indonesia's peripheral territories, provided that infrastructure deployment is paired with institutional support and human capacity building..

CONCLUSIONS

This study examines the relationship between digital infrastructure development and regional economic growth across 122 underdeveloped districts in Indonesia during the 2020 to 2025 period using a fixed-effects panel regression model. Based on the empirical findings, several important conclusions can be drawn. First, Internet Availability has a positive and statistically significant effect on regional economic growth. The results indicate that expanding internet access contributes directly to higher economic performance in underdeveloped regions. Improved digital connectivity enhances access to information, financial services, education, and digital markets, enabling local businesses and households to participate more effectively in economic activities. These findings support the view that digital infrastructure has become an important driver of inclusive regional development and a strategic instrument for reducing economic disparities across Indonesia. Second, the economic benefits of digital infrastructure are realized through improvements in market efficiency and reductions in transaction costs. Better internet connectivity enables micro, small, and medium-sized enterprises (MSMEs), farmers, and rural producers to obtain real-time market information, expand their customer base through digital platforms, and reduce dependence on traditional intermediaries. Consequently, digitalization strengthens market integration, improves resource allocation, and creates new opportunities for productivity growth and regional economic expansion.

Third, the effectiveness of digital infrastructure depends on complementary investments in human capital. Although internet availability positively influences economic growth, its overall impact is greater in regions with higher levels of education, skills, and digital literacy. The significant effect of the Human Capital Index confirms that technological infrastructure alone is insufficient to maximize economic performance. Sustainable digital transformation therefore requires simultaneous improvements in human resource quality through education, digital skills development, and capacity-building programs. In addition, the positive contribution of local government capital expenditure highlights the importance of public investment in supporting digital infrastructure and complementary physical infrastructure, thereby creating an enabling environment for long-term regional economic growth.

RECOMMENDATION

For Government and Policymakers. The Government of Indonesia, particularly the Ministry of Communication and Digital Affairs and the Ministry of Villages and Development of Disadvantaged Regions, should adopt an integrated digital development strategy that combines broadband infrastructure expansion with human capital development. Increasing internet coverage alone is insufficient to maximize economic benefits if local communities lack the digital skills required to utilize digital technologies effectively. Therefore, investments in digital infrastructure should be accompanied by digital literacy programs, entrepreneurship training, and e-commerce capacity-building initiatives targeted at rural communities, micro, small, and medium-sized enterprises (MSMEs), and local cooperatives. This integrated approach will improve digital

adoption and enable underdeveloped regions to fully capture the economic opportunities generated by digital transformation. For Regional Governments. Local governments should allocate a greater proportion of capital expenditure toward strengthening regional digital ecosystems. Beyond expanding internet connectivity, public investment should support the establishment of community internet centers, digital business incubators, smart village initiatives, and digital marketplaces that facilitate market access for local producers and small businesses. Such investments will enhance digital inclusion, improve regional competitiveness, and create a more supportive environment for sustainable economic growth in underdeveloped areas. For Future Research. Future studies are encouraged to extend the analytical framework by incorporating additional determinants of regional economic growth, including digital financial inclusion, institutional quality, innovation capacity, regulatory effectiveness, and digital literacy. Researchers may also employ more advanced econometric techniques, such as dynamic panel models using the Generalized Method of Moments (GMM), spatial econometric models, or mediation and moderation analyses, to better capture the causal mechanisms through which digital infrastructure influences regional economic performance. Furthermore, comparative studies across provinces or between developing and developed regions would provide a broader understanding of how regional characteristics shape the effectiveness of digital infrastructure investments in promoting inclusive and sustainable economic growth.

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