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Government's Role in Enhancing Economic Inclusion Through Digital Infrastructure Equity in Indonesia

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ABSTRACT

Research Originality: This research is original in its examination of the equitable distribution of digital infrastructure in enhancing economic inclusion in Indonesia, employing a fixed effect model and quantile regression approach.

Research Objectives: This study investigates the impact of the equitable distribution of digital infrastructure on enhancing economic inclusion in Indonesia.

Research Methods: This study employs a fixed effect model and quantile regression, analyzing data from 34 provinces between 2019 and 2023. Key variables include internet access, internet speed, the number of Base Transceiver Stations (BTS), and digital literacy.

Empirical Results: The findings reveal that internet access and internet speed have a positive and significant impact on digital financial inclusion, whereas the number of BTS and digital literacy exhibit no significant effect. The impact of digital infrastructure varies across regions, with areas exhibiting lower financial inclusion requiring greater infrastructure optimization compared to those with higher inclusion levels.

Implications: The results imply that digital infrastructure development plays a critical role in promoting equitable financial inclusion. Consequently, policymakers are urged to prioritize and accelerate the expansion of digital infrastructure, particularly in regions lagging behind, to reduce financial exclusion and foster inclusive economic development at the national level.

Keywords:

digital infrastructure; economic inclusion; government; panel data; quantile regression

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INTRODUCTION

The digital economy plays a fundamental role in fostering inclusive economic growth. The integration of digital technologies into economic systems can accelerate growth by improving resource allocation, promoting innovation, and facilitating industrial upgrading (Xiang et al., 2022; Xin et al., 2023). However, the relationship between the digital economy and inclusive growth often follows an inverted U-shape (Xiang et al., 2022). This is particularly evident in developing regions, where digital economic expansion may hinder economic growth due to prevailing digital divides (Zheng & Huang, 2024).

In developing countries, the negative impact of the digital divide on economic growth underscores the importance of the quality and availability of digital infrastructure. Poor infrastructure results in inefficiencies in the digital economy, ultimately impeding digital transformation (Garcia-Escribano et al., 2015). Limited digital access due to inadequate infrastructure exacerbates regional disparities in digitalization (Andres et al., 2014).

The issue of unequal digital infrastructure has become a significant concern for the government, as equitable access is crucial for fostering inclusive growth. The government plays a central role in enhancing economic inclusion by investing in digital infrastructure to minimize the digital divide (Ali & Faroque, 2023). Digital infrastructure should be regarded as a public good, ensuring that all citizens have access to the internet and digital services, which are essential for participating in the digital economy (Dana, 2024; Purandare, 2024). Such infrastructure significantly contributes to high-quality economic development by optimizing the allocation of financial resources and enhancing industrial structures (Liu, 2023).

As a developing and archipelagic country, Indonesia faces considerable challenges in enhancing its digital infrastructure to support inclusive growth. Most digital transformation efforts remain concentrated in Java, while eastern regions experience lower access and infrastructure quality (Jaya et al., 2024). Nevertheless, the Indonesian government has made efforts to improve digital access equity through a range of policies.

Several initiatives have been undertaken, such as constructing the "Palapa Ring" to connect internet networks nationwide, developing Base Transceiver Station (BTS) towers in remote areas, and providing internet subsidies to low-income communities. BTS towers significantly enhance mobile signal strength and internet access, particularly in remote regions, thereby improving communication capabilities (Apriliana & Widodo, 2023). Improved connectivity via BTS has the potential to stimulate local economic development by facilitating e-commerce and access to information, both of which are critical for small businesses (Ayédoun & Ayédoun, 2020).

In addition, the government has sought to improve the digital literacy among Indonesian citizens through the National Digital Literacy Movement (Gerakan Nasional Literasi Digital, GNLD). This initiative not only seeks to provide access to digital technology but also helps the population use it effectively. Enhancing digital skills enables individuals to engage in entrepreneurial activities, generate employment, and reduce regional disparities (Xie & Chen, 2024). Hence, digital literacy plays a vital role in promoting inclusive

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growth by expanding access to opportunities, fostering entrepreneurship, and bridging social inequalities.

Given these developments, it is essential to examine the effectiveness of government efforts in promoting inclusive growth through equitable digital infrastructure. This study aims not only to analyze the impact of digital infrastructure on inclusive growth but also to explore this relationship in greater depth across various regional quantiles.

METHOD

This study employed panel data comprising 34 provinces in Indonesia over the period 2019–2023. The sample selection excluded any administrative changes resulting from the enactment of Law No. 14 concerning the Establishment of South Papua Province, ensuring consistency in provincial boundaries during the observation period. The independent variables used in this study included the number of digital infrastructure access points (X1), internet speed (X2), the number of Base Transceiver Stations (BTS) (X3), and digital literacy (X4). The dependent variable was digital financial inclusion (Y). All variables were measured using a ratio scale. The data for this study were obtained from authoritative and official sources, namely the Ministry of Communication and Information Technology (Kemkominfo) of the Republic of Indonesia, Statistics Indonesia (BPS), and Bank Indonesia.

This study adopted a quantitative approach that emphasizes clearly defined and measurable variables, employs standardized instruments, follows a systematic research process, relies on objective data, and utilizes established theoretical frameworks. The research design is causal-associative, aiming to investigate cause-and-effect relationships between multiple variables. The study applied a non-probability sampling technique, specifically purposive sampling, which involves selecting samples based on specific criteria relevant to the research objectives, ensuring that the chosen data fit the study's analytical needs. The model specification employed in this study is as follows:

$$y_{it} = a_0 + \beta_1 x1_{it} + \beta_2 x2_{it} + \beta_3 x3_{it} + \beta_4 x4_{it} + \varepsilon_{it} \quad (1)$$

Equation (1) illustrates that the enhancement of digital financial inclusion (Y) can be influenced by several key factors, namely internet access (X1), internet speed (X2), the number of Base Transceiver Stations—BTS (X3), and digital literacy (X4). This study employed panel data analysis and quantile regression as the primary analytical methods.

The use of panel data aims to examine the role of government in fostering financial inclusion through the expansion of infrastructure access, improvement of internet speed, development of BTS networks, and enhancement of digital literacy. Within panel data analysis, three primary models are commonly utilized: the Common Effect Model (CEM), the Fixed Effect Model (FEM), and the Random Effect Model (REM). The Common Effect Model (CEM) assumes no variations in individual and temporal characteristics (Wang et al., 2022). The transformation of the model into the Common Effect Model (CEM) follows the specification presented in Equation (1). Conversely, the Fixed Effect Model (FEM) accounts for heterogeneity across individuals by incorporating dummy variables for each entity (Wang et al., 2022). The Fixed Effect Model (FEM) is expressed using the Least Squares Dummy Variable (LSDV) approach, as follows:

$$y_{it} = a_0 + \beta_1 x1_{it} + \beta_2 x2_{it} + \beta_3 x3_{it} + \beta_4 x4_{it} + \sum_{i=2}^{N} \delta_i D_i + \varepsilon_{it} \quad (2)$$

equation (2) represents the Least Squares Dummy Variable (LSDV) model, where D_i serves as a dummy variable for each region. This approach enables the model to account for region-specific effects that remain constant over time.

On the other hand, the Random Effect Model (REM) assumes that individual differences are random and uncorrelated with the independent variables (Wang et al., 2022). Unlike the Fixed Effect Model, which introduces dummy variables to control for heterogeneity, the Random Effect Model treats these variations as part of the error term, allowing for more efficient parameter estimation when the assumption of no correlation holds. The specification of the Random Effect Model (REM) is formulated as follows:

$$y_{it} = a_0 + \beta_1 x1_{it} + \beta_2 x2_{it} + \beta_3 x3_{it} + \beta_4 x4_{it} + u_i + \varepsilon_{it} \quad (3)$$

Equation (3) represents the Random Effect Model (REM), where u_i denotes the individual-specific error term, which is assumed to be random and uncorrelated with the independent variables. This model allows for variations across entities while maintaining efficiency in parameter estimation.

This study also employed the quantile regression method to analyze the role of government in improving financial inclusion through internet access, internet speed, the number of Base Transceiver Stations (BTS), and digital literacy across different quantiles. Unlike conventional regression methods, quantile regression offers for a more detailed examination of relationships at various points in the conditional distribution of the dependent variable. Furthermore, quantile regression effectively addresses issues related to classical assumptions, such as heteroscedasticity and non-normal error distributions (Cade et al., 2022; Yu et al., 2021). The quantile regression equation is formulated as follows:

$$Q_{Y_{it}}(\tau) = a_0(\tau) + \beta_1(\tau) x1_{it} + \beta_2(\tau) x2_{it} + \beta_3(\tau) x3_{it} + \beta_4(\tau) x4_{it} + \varepsilon_{it} \quad (4)$$

Equation (4) represents the quantile regression method, where the quantiles (τ) values are set at 0.25, 0.50, and 0.75 to examine the impact across different economic groups: low, middle, and high quantiles.

RESULTS AND DISCUSSION

The panel data analysis indicated that the Fixed Effects Model (FEM) was the most appropriate specification for this study. The Chow test yielded a p-value of 0.0000, which is less than the significance level of α = 0.05, indicating that the FEM provides a better fit compared to the Common Effects Model (CEM). Furthermore, the Hausman test produced a p-value of 0.000, which is also below the 0.05 threshold, suggesting that the FEM is superior to the Random Effects Model (REM). These findings confirm that the Fixed Effects Model effectively captures the unobserved heterogeneity across provinces

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and is therefore the most suitable model for estimating the relationship between digital infrastructure and digital financial inclusion in Indonesia.

Table 1 presents the estimation results of the panel data analysis. The Fixed Effects Model (FEM) was identified as the most appropriate model for estimation. The variable of internet access (X1) had a p-value of 0.62, which is greater than the 0.05 significance level, indicating that it does not have a statistically significant effect on digital financial inclusion. This suggests that ease of internet access does not directly contribute to inclusive growth, possibly because lower- and middle-income populations do not frequently use the internet for economic activities (Sojka & Pietrucha, 2024). Likewise, digital literacy (X4) was found to have an insignificant relationship with inclusive growth, as its p-value of 0.69 exceeds the 0.05 threshold. Although the level of digital literacy in Indonesia has improved, it has not yet translated into widespread adoption or optimal use of digital financial services. This implies that digital literacy alone may not be sufficient to drive inclusive growth without corresponding improvements in digital engagement and economic participation.

Table 1. Estimation Results of Panel Data Analysis

Variable	Common Effects Model (CEM)	Fixed Effect Model (FEM)	Random Effect Model (REM)
Internet Access (X1)	-3,32* [-3,49] (0,00)	0,21 [0,49] (0,62)	-0,57 [-1,39] (0,165)
Internet Speed (X2)	0.00* [3,14] (0,00)	0,00* [5,27] (0,00)	0,00* [5,04] (0,00)
The Number of BTS (X3)	-0,00* [-2,47] (0,01)	-0,01* [-4,06] (0,00)	-0,00* [-2,73] (0,00)
Digital Literacy (X4)	92,1* [5,58] (0,00)	-4,82 [-0,39] (0,69)	16,3 [1,41] (0,16)
Model Selection Test			
	Chow Test	**Hausman Test**	
Prob.	0,00	0,00	

*Significant level 0,005

In contrast, internet speed (X2) demonstrated a positive relationship with inclusive growth. The p-value of 0.00 is below the 0.05 level, indicating statistical significance. The development of high-speed internet has been shown to positively influence financial inclusion, as observed in China, where a higher proportion of internet users is associated with expanded access to financial services (Zhang et al., 2023). Interestingly, the number of Base Transceiver Stations (BTS) (X3) is negatively associated with inclusive growth. This negative effect may stem from regions with low digital penetration, where insufficient digital literacy and limited economic accessibility hinder the effective utilization of BTS infrastructure. As a result, the presence of BTS alone does not necessarily translate into equitable distribution of economic benefits.

To gain a deeper understanding of regional disparities, this study further applied quantile regression analysis. This approach helps examine how digital infrastructure impacts inclusive growth, which varies across different quantiles of regional development, thereby identifying policy gaps in digital infrastructure improvement strategies.

The estimation results from quantile regression in Table 2 explain that Internet Access (X1) had a positive coefficient across all quantiles (τ = 0.25, 0.50, and 0.75). At the 0.25 quantile, the coefficient is 0.01 with a t-statistic of 2.06 and a p-value of 0.04, indicating that internet access has a positive impact on digital financial inclusion in regions with low levels of inclusion. The effect strengthens at higher quantiles, with the coefficient increasing to 0.02 at the 0.75 quantile, a t-statistic of 4.51, and a p-value of 0.00, suggesting a more substantial impact in regions with higher financial inclusion levels.

Table 2. Quantile Regression Estimation Results

Variable	Quantile 1 (ι=0.25)	Quantile 2 (ι=0.5)	Quantile 3 (ι=0.75)
Internet Access (X1)	0.01* [2.06] (0.04)	0.01* [2.68] (0.00)	0.02* [4.51] (0.00)
Internet Speed (X2)	0.06* [9.15] (0.00)	0.67* [9.15] (0.00)	0.69* [4.25] (0.00)
The Number of BTS (X3)	15.36* [5.08] (0.00)	17.41* [5.43] (0.00)	18.49* [2.24] (0.02)
Digital Literacy (X4)	6.76* [2.11] (0.03)	5.43* [2.08] (0.03)	11.33* [2.47] (0.01)
Adj. R-Square	0.34	0.43	0.47
Systemic Quantiles Test	0.708		
Quantile Slope Equality Test	0.01		

*Significant level 0.005

Internet Speed (X2) also exhibited a positive effect across all quantiles, with higher coefficients compared to other variables. At the 0.25 quantile, the coefficient is 0.06, with a t-statistic of 9.15 and a p-value of 0.00, indicating that faster internet speeds significantly boost digital financial inclusion, especially in regions with low inclusion levels. This effect remains consistent across 0.50 and 0.75 quantiles, with coefficients of 0.67 and 0.69, respectively, demonstrating that internet speed is a crucial factor in expanding access to digital financial services across different regions.

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The Number of BTS (X3) also had a positive influence on digital financial inclusion across all quantiles, though with a more moderate increase than internet speed. At the 0.25 quantile, the coefficient is 15.36, with a t-statistic of 5.08 and a p-value of 0.00, highlighting that the BTS infrastructure plays a key role in improving digital connectivity. The impact remains significant at the 0.50 and 0.75 quantiles, with coefficients of 17.41 and 18.49, respectively. However, the t-statistic at the 0.75 quantile is lower (2.24) than at previous quantiles, suggesting that the effect of BTS infrastructure might be more substantial in regions with medium financial inclusion levels compared to highly developed ones.

Digital Literacy (X4) had a positive impact on digital financial inclusion, but its effect is more potent at higher quantiles. At the 0.25 quantile, the coefficient is 6.76, with a t-statistic of 2.11 and a p-value of 0.03, indicating that digital literacy significantly contributes to financial inclusion in regions with low levels of inclusion. However, its impact increases significantly at the 0.75 quantile, where the coefficient rises to 11.33 with a t-statistic of 2.47, suggesting that digital literacy becomes more important in regions with a higher financial inclusion level.

The Adjusted R-Square showed an increase from 0.34 at the 0.25 quantile to 0.43 at the 0.50 quantile and 0.47 at the 0.75 quantile. This indicates that the model provides a more accurate explanation of variations in digital financial inclusion in regions with higher levels of inclusion. This result means that the analyzed factors become increasingly relevant in explaining differences in digital financial inclusion as financial development progresses.

The Systemic Quantiles Test results showed a probability value of 0.708, which is greater than the significance level ($\alpha = 0.05$). This suggests that there are no significant differences in the effects of independent variables on digital financial inclusion across different quantiles. In other words, the impact of the independent variables remains relatively stable across the distribution of financial inclusion, suggesting that policies can be applied universally without significant differentiation between regions with varying levels of financial inclusion. Conversely, the Quantile Slope Equality Test results showed a probability value of 0.01, which is less than the $\alpha = 0.05$. This indicates significant differences in the impact of variables across different quantiles. In other words, the effects of independent variables are not uniform across the distribution of financial inclusion, suggesting that policy approaches should consider regional characteristics based on different levels of financial inclusion.

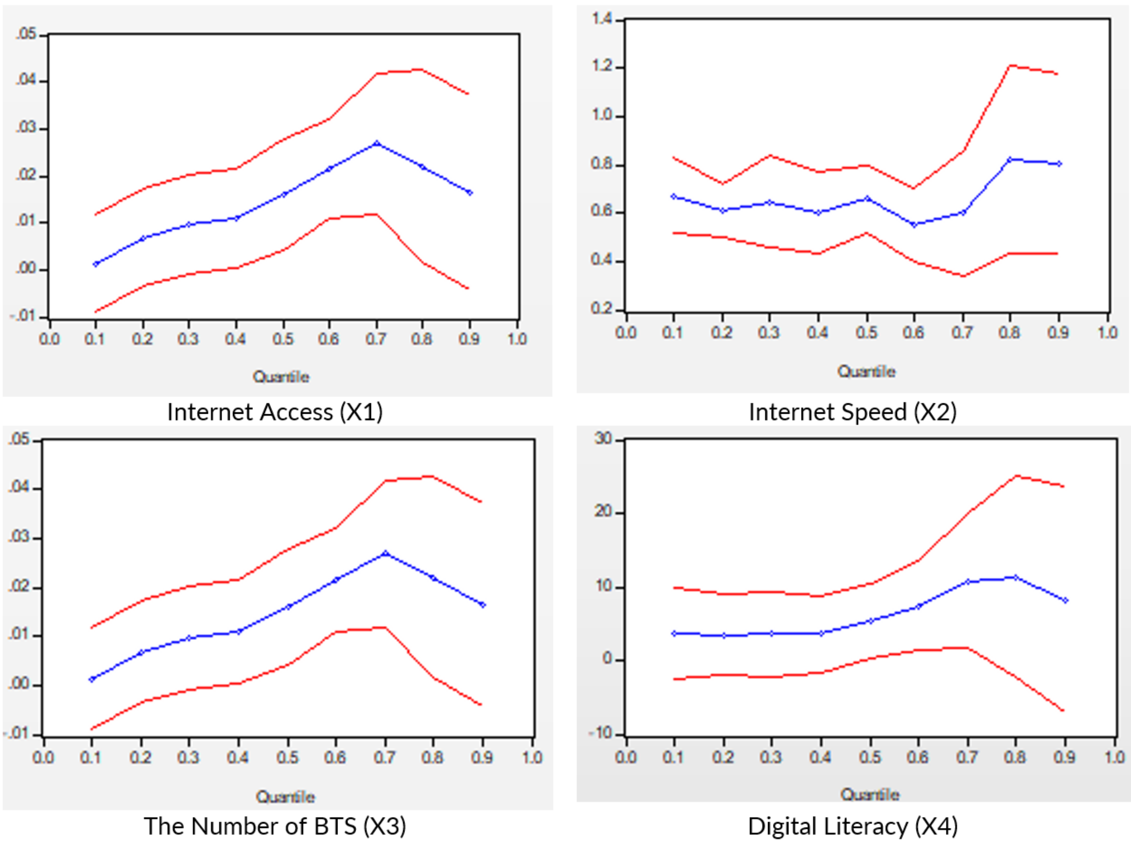
Based on the results of the Systemic Quantiles Test and Quantile Slope Equality Test, it can be concluded that although the model generally follows a consistent pattern, there are differences in the impact of each variable at various levels of financial inclusion. Therefore, while policies can be broadly applied, adjustments should be made to strategies based on the identified differences across various levels of financial inclusion.

Internet Access (X1) had an increasingly positive effect at higher quantiles, indicating that internet access has a greater impact on inclusive growth in regions with higher levels of digital financial inclusion. At lower quantiles, the effect remains relatively small and stable, while at medium to high quantiles, the coefficients increase significantly. The wider confidence intervals at higher quantiles suggest that the effect of internet access is more heterogeneous in areas with greater inclusion. This variation implies that regions with stronger initial digital conditions are better positioned to leverage the benefits of internet access (Li et al., 2025). Thus, the development of internet access appears to be more effective in regions that already possess well-established digital infrastructure.

These findings are in line with Manuel Castells' Network Society theory, which argues that individuals with internet access are easily integrated into social and economic networks. The internet functions as a central channel that connects communities to a variety of services, including digital financial services. Therefore, higher levels of internet access increase the opportunities for individuals to participate in the digital economy and access financial services more efficiently.

This result also supports the findings of Ahmed & Khatoon (2019), who demonstrated that internet connectivity, as proxied by the number of internet users, positively influenced financial inclusion. E-banking services heavily rely on internet availability. With internet access, individuals can easily open bank accounts and conduct financial transactions, facilitating integration into the formal financial system (Ahmed & Khatoon, 2019).

Figure 1. Quantile Process Estimates Results



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Internet Speed (X2) showed a relatively stable pattern across all quantiles, with a slight increase at higher quantiles. This suggests that internet speed significantly influences digital financial inclusion across all levels of inclusion, although the effect is more pronounced in regions with higher levels of inclusion. Faster internet access facilitates engagement with a wide range of financial services, including banking, insurance, and digital payment systems (Bhosale, 2020). The stable coefficient across quantiles indicates that internet speed is a fundamental factor supporting access to digital financial services nationwide. Therefore, efforts to improve internet speed should be equitably distributed to ensure widespread digital financial inclusion.

The consistent effect of internet speed across low, medium, and high inclusion regions highlights its role as a universal enabler of digital finance. While its impact is evident at all levels, it is especially influential in areas with more advanced digital financial ecosystems. Thus, the government must ensure that improvements in internet speed are not solely concentrated in developed regions. Investments in broadband infrastructure, the optimization of 4G networks, the acceleration of 5G deployment, and strategic partnerships with internet service providers are essential to expand coverage and enhance connectivity quality throughout the country.

The number of Base Transceiver Stations (BTS) (X3) exhibited more variation compared to the other variables. From low to medium quantiles, its effect remained relatively stable, but there was a substantial increase at higher quantiles. This suggests that BTS infrastructure development has a more substantial impact in regions with higher levels of financial inclusion, while in areas with lower levels of inclusion, its effect is still limited. The wide confidence interval at the upper quantiles also implies greater uncertainty in the impact of BTS on digital financial inclusion in more developed regions. Therefore, while increasing the number of BTS is important for expanding digital service coverage, strategies must be tailored to the specific needs of each region. BTS infrastructure development significantly influences high-inclusion regions, contributing to economic growth and reducing inequality (Bhukta et al., 2024; Khoirunurrofik, 2023).

Digital Literacy (X4) showed a significant increase in its effect at higher quantiles, indicating that digital literacy plays a more prominent role in regions with higher levels of financial inclusion. At lower quantiles, its impact is relatively small and stable, but increases progressively at medium and higher levels. This suggests that digital literacy is a key factor in enhancing digital financial inclusion, particularly in regions that already have adequate digital infrastructure. Well-structured technological infrastructure forms the foundation for improving digital literacy (Sulianta et al., 2024). Therefore, digital literacy enhancement programs should focus on strengthening public understanding and utilization of digital financial services, especially in regions with reliable and high-speed internet access.

Interestingly, this finding contrasts with Castells' Network Society theory, which posited that access to and the ability to manipulate information networks were a primary source of power in the digital age. In the context of this study, individuals skilled in accessing, understanding, and utilizing digital technology are better able to capitalize on opportunities within the digital economy, including digital financial inclusion. The findings also diverge from the study of Anindito & Faturohhman, (2023) found a significant effect of digital literacy on digital financial inclusion. Digital literacy enables individuals, particularly those from vulnerable groups or those without access to traditional financial services, to use technology effectively and integrate into the financial system. (Anindito & Faturohhman, 2023).

CONCLUSION

Indonesia must pursue the equitable development of digital infrastructure to foster inclusive digital financial growth. While baseline panel data analysis indicates that internet access does not have a statistically significant relationship with the growth of digital financial inclusion, quantile regression reveals a more nuanced picture. Specifically, the number of internet access points demonstrates an increasingly positive effect at higher quantiles, suggesting that internet access has a more substantial impact in regions with higher levels of financial inclusion. A similar pattern emerges with digital literacy. Although it is not statistically significant in the overall panel analysis, quantile regression reveals that its impact, while relatively small and stable in lower quantiles, increases progressively in middle to higher quantiles. These findings indicate that digital literacy becomes more influential in regions that already benefit from established digital infrastructure.

Internet speed, on the other hand, shows a consistently significant and positive relationship with digital financial inclusion across all quantiles, with a slight increase at the upper end. This reinforces the importance of fast and reliable internet connectivity as a foundational driver of inclusive access to digital financial services. The number of Base Transceiver Stations (BTS) also shows a significant relationship with digital financial inclusion. Its effect is relatively stable in the lower to middle quantiles but exhibits a substantial increase at higher quantiles. This suggests that BTS infrastructure development has a greater impact in regions with higher financial inclusion, while its effects are still limited in less developed areas.

Given these findings, the government must formulate targeted digital infrastructure policies that prioritize expanding internet access and digital literacy in regions with low levels of financial inclusion. This can be achieved through incentivizing BTS development in underserved areas, coupled with community-based digital literacy programs and efforts to ensure equitable improvements in internet speed nationwide. Since the effectiveness of digital infrastructure is more pronounced in high-inclusion regions, affirmative policy interventions are essential in lagging regions to accelerate convergence in digital financial inclusion across provinces, ensuring that such growth is both equitable and sustainable.

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