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Digital Financial Inclusion, MSMEs, and Inclusive Growth: Empirical Evidence from Districts/Cities in Indonesia

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ABSTRACT

The transformation of digital financial services—through e-wallets, QRIS, branchless banking, and fintech—is seen as capable of reducing transaction costs and expanding access to financing for MSMEs. This study assesses the extent to which digital financial inclusion (DFI) drives inclusive growth at the district/city level in Indonesia. We construct a composite DFI index that emphasizes three dimensions—access, usage, and quality—and link it to inclusive growth indicators: real GRDP growth in labor-intensive MSME sectors, MSME employment, and inequality proxies. Methodologically, the study adopts a panel data design with two-way fixed effects, enriching identification through a spatial panel model (to capture spillovers between regions) and a quasi-experimental strategy (staggered Difference-in-Differences) that exploits variations in digital transaction adoption/intensification across time and region. Potential endogeneity is addressed using instruments based on digital infrastructure availability and topography. The results show that increased DFI is positively and economically meaningfully associated with the Inclusive Growth Index (IGI), through reduced payment friction, market expansion, and improved MSME financing eligibility. Heterogeneity findings indicate greater marginal benefits in regions with higher digital readiness, while evidence of spatial spillovers suggests spillover effects to neighboring regions. Policy implications emphasize accelerating infrastructure and ecosystem (agent/merchant) density, reducing microtransaction costs, strengthening digital financial literacy, and integrating transaction data for inclusive financing with consumer protection. The novelty of this study lies in the construction of a district/city-level DFI index that focuses on use and quality, a truly inclusive growth measurement, and a combination of spatial identification and quasi-experimental methods that strengthen causal inference.

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INTRODUCTION

The Indonesian economy relies on MSMEs as the backbone of job creation and local value-added, yet their productivity and access to financing are still hampered by high transaction costs and information asymmetry. In recent years, the acceleration of digital financial inclusion—through the expansion of e-wallets, QRIS, branchless banking

services (Laku Pandai), fintech financing, and open banking APIs—offers new pathways to address these obstacles. These technologies lower customer acquisition costs, expand service reach to remote areas, and enrich alternative data (e.g., digital transaction history) for assessing MSME creditworthiness. On the macro level, increased access to and use of formal financial services is expected to drive inclusive growth: not just increasing GRDP, but also equalizing opportunities, absorbing labor, and reducing disparities between income groups at the district/city level.

While global and national literature has confirmed the positive relationship between financial inclusion, small business performance, and household well-being, three research gaps remain. First, many studies focus on access indicators (having an account) rather than on the active use of digital services that are more relevant to MSME productivity (acceptance of non-cash payments, digital bookkeeping, invoice financing). Second, evidence at the district/city level is still limited, even though spatial heterogeneity—from internet infrastructure quality, agent density, financial literacy, to economic sector structure—significantly determines the effectiveness of digital transformation. Third, inclusive outcomes are often measured solely through average growth, rather than inclusiveness indicators such as MSME employment, reduced income inequality, or MSME contribution to regional exports.

This study contributes by formulating a composite measurement framework for digital financial inclusion at the district/city level that combines dimensions of access, usage, and quality (e.g., the share of QRIS transactions/digital transfers in total payments, agent/intermediary density, formal MSME credit intensity, and bookkeeping and marketplace adoption). This framework is then linked to inclusive growth indicators—real GRDP growth in the MSME labor-intensive sector, changes in the MSME employment ratio, and inequality proxies—thus providing a more comprehensive picture of who benefits. Furthermore, the analysis considers contextual heterogeneity (urban-rural, east-west regions, network quality) and potential endogeneity (e.g., faster-growing regions adopt digital payments) through a more rigorous identification strategy.

The research focuses on: (1) developing a district/city-level digital financial inclusion index that emphasizes service usage and quality, not just account ownership; (2) testing the impact on inclusive growth—linking digital financial transformation to MSME labor market outcomes and inequality—rather than simply GRDP; (3) an empirical approach that combines spatial data panels to capture the effects of inter-regional spread, as well as instrumental/quasi-experimental techniques (e.g., utilizing incremental variations in network & agent availability or QRIS policies) to reduce causality bias; and (4) mapping regional typologies based on digital readiness and economic structure to formulate more targeted policy recommendations.

Substantively, this research contributes threefold. First, it provides a conceptual contribution by linking the literature on digital financial inclusion, MSME finance, and inclusive development economics within a single framework that is operational at the local government level. Second, it provides a methodological contribution through a composite index and identification strategy that account for heterogeneity and spatial interconnectedness. Third, it provides a policy contribution in the form of a map of intervention priorities (e.g., expanding agent/QRIS networks, MSME needs-based financial literacy programs, and pro-inclusive digital financing schemes) supported by micro-meso evidence, enabling local governments and payment system authorities to target resources to the most pressing constraints in each district/city. Thus, this research

assesses not only whether financial digitalization drives growth, but also whether that growth is equitable and reaches MSMEs across Indonesia.

METHODS

Research Design

Quantitative-empirical based on district/city panel data; causal-inferential approach with a combination of:

- Fixed effects (FE) panel model to control for unobserved heterogeneity.
- Spatial panel model (SLM/SDM) to capture the effects of inter-regional distribution.
- A quasi-experimental identification strategy (staggered DiD) related to the adoption/intensification of digital transactions (e.g. QRIS/agents) that is not simultaneous across regions.
- **Instrumental Variables (2SLS)**to mitigate the endogeneity of digital service usage.

Unit of Analysis, Scope, and Period

- Unit: 514 districts/cities (according to consistent data availability).
- Period: 2017-2024 (pre and post digital payment acceleration/QRIS) – can be adjusted according to the availability of historical data.
- Frequency: Annual (main). If available, some usage (transaction) indicators are extracted quarterly and aggregated to annual.

Data Source (compilation plan)

- Digital financial inclusion: non-cash transaction statistics (QRIS, retail transfers), number/penetration of smart payment agents, EDC/QR merchant points, e-money/MBanking accounts (if available, aggregated by region).
- MSMEs: number of micro-small business units, MSME workforce, banking/fintech MSME credit (outstanding, NPL), dominant sector (small manufacturing, trade, culinary, etc.).
- Inclusive growth: Total & labor-intensive sectoral ADHK GRDP, labor absorption rate (Sakernas), inequality proxy (Theil/Williamson at district/city level or provincial Gini projected to district/city with income structure weighting), poverty rate.
- Controls & instruments: population density, urbanization, ICT infrastructure (3G/4G/FTTx coverage), distance to fiber optic backbone (e.g. backhaul node/Palapa Ring), topography (ruggedness), education, financial literacy index (if available), tourism/export intensity of MSMEs.

Note: Specific agency/registry names will be mapped at the time of collection (e.g. payment system statistics publication, MSME banking statistics, BPS for GRDP/labor/poverty, and open source digital infrastructure maps).

Operationalization of Variables

Digital Financial Inclusion Index (DFI Index) – district/city level

Construct a data-driven weighted composite index (PCA) from three dimensions:

Access

- Agent density per 10,000 residents.
- Number of QR/EDC merchants per 1,000 business units.

- E-money/MBanking accounts per 1,000 residents (if available in the region).

Use
- Ratio of non-cash transactions (value & frequency) to total retail transactions.
- QRIS transaction value per retail/trade sector GRDP.
- Proportion of local government bills/payments that are non-cash (if available).

Quality
- Service stability (uptime) / complaints per 10,000 transactions (proxy if available).
- Average transaction cost (merchant discount rate/fee) relative to transaction value.
- Security: fraud incidents per 1 million transactions (if aggregate available).
  All indicators are normalized (z-score), PCA is performed to obtain weights, then combined:

$$\text{DFI}_{it} = \sum_{k} \quad w_k \cdot Z(X_{kit})$$

with reliability validation (Cronbach's α), weight sensitivity test (equal-weight vs PCA).

Inclusive Growth Outcomes
1. Real GRDP growthdistrict/city (total and labor-intensive MSME sectors).
2. Absorption of MSME labor: percentage of workforce in micro-small units.
3. Inequality/affordability: Theil/Williamson index of district/city (or projection of provincial Gini to district/city with economic structure weighting). Construct the Inclusive Growth Index (IGI) via PCA on (1)–(3) as a synthetic outcome (optional), in addition to testing each component separately.

Control Variables
- Demographics (population, urbanization), education, sector structure (share of small manufacturing/trade), connectivity (roads, distance to economic centers), internet penetration, local government spending on MSMEs/financial literacy (if available).

Model Specifications
FE Panel Baseline

$$Y_{it} = \beta\, \text{DFI}_{it} + \gamma' X_{it} + \mu_i + \tau_t + \varepsilon_{it}$$

with = inclusive growth indicator; = covariate; = district/city fixed effect; = year fixed effect. SE is clustered per district/city and/or two-way (district/city & year).$Y_{it} X_{it} \mu_i \tau_t$

Spatial Panel (SLM/SDM)
Construct a spatial weight matrix (k-nearest neighbors or queen contiguity).W

SLM:

$$Y_{it} = \rho W Y_{it} + \beta \text{DFI}_{it} + \gamma' X_{it} + \mu_i + \tau_t + \varepsilon_{it}$$

HR(spread effect on covariates): add and . Estimation via MLE/GMM; decomposition of direct/indirect (spillover) effects.$W\text{DFI}_{it} W X_{it}$

Staggered DiD (Digital Intensification)

Define treatment = district/city indicator exceeding adoption threshold (e.g., upper quartile of QR merchant/agent growth). Use Sun & Abraham estimator for incremental adoption:T_{it}

$$Y_{it} = \sum_{g} \sum_{e} \theta_{ge} D_{it}^{g,e} + \gamma' X_{it} + \mu_i + \tau_t + \varepsilon_{it}$$

Event study test (pre-trend ≈ 0) for the validity of parallel trend.

IV-2SLS (Endogeneity Mitigation)

Candidate instruments (relevant but exogenous to short-term local economic shocks):

- Digital infrastructure coverage: 4G/FTTx expansion exogenized by distance to backbone node × national trend (shift-share).
- Topography(ruggedness/elevation) × national adoption trend as relative cost of agent placement.Stage 1: regressed on instrument + control + FE; test for relevance (F-stat) and over-identification.Stage 2: use to estimate causal effect on .$\mathrm{DFI}_{it}\widehat{\mathrm{DFI}}_{it}Y_{it}$

Heterogeneity & Mechanism

- Interaction: (high urbanization, financial literacy, network quality, dominant MSME sector).DFI_{it} ×
- Subsamples: Java vs. Outside Java; cities vs. districts; digital readiness quartiles.
- Mechanism: financing channels (MSME credit), market (non-cash transaction volume), formalization (digital bookkeeping/MSME NPWP if available).

Robustness Checks

- Alternative DFI weighting (equal-weight vs PCA) and outlier trimming (p1–p99).
- Placebo timing (shift the treatment to the “pseudo” period).
- Dynamic FEwith lag outcome/DFI.
- Jackknife: remove large provinces/capital cities.
- Alternative inclusive measures (poverty, underemployment, median real wages).
- Conley SE(spatial HAC) for geographic correlation.

Data Handling & Replication

- Data wrangling: harmonization of area codes (BPS), cross-source linking.
- Imputation: MICE or ema smoothing for quarterly→annual gaps; report share imputation.
- Outlier: winsorize 1% two sides.
- Reproducibility: R/Stata pipeline with targets/makefile; data dictionary & codebook published.
- Map: district/city shapefile for DFI visualization & spatial effects (choropleth, LISA cluster).

Validity & Ethics

- Data is aggregated; comply with privacy & confidentiality policies.

- Document limitations: availability of district/city Gini, inequality proxy; possible measurement error in digital transactions.
- Pre-analysis plan (hypothesis, main specifications, planned robustness) to prevent p-hacking.

Effect Size & Interpretation

- Report elasticity: % increase in DFI → % change in real GRDP/labor absorption/reduction in inequality.
- In the spatial model, describe direct vs spillover effects.
- Convert to policy implications: e.g. +10 QR merchants/1,000 MSMEs⇒Δ labor absorption.

Variable Design Table (summarized)

Category	Indicators (examples)	Unit	Source (plan)
DFI–Access	Agents/10,000 residents; QR merchants/1,000 businesses	level	Payment system statistics, agent mapping
DFI–Usage	Value & frequency of non-cash transactions / retail GRDP	ratio	Digital retail transaction data
DFI–Quality	Complaints/1e4 trx; average cost	per 10k, %	Service/payment report
MSMEs	MSME Credit/GRDP; MSME workforce (%)	ratio, %	Banking statistics & Sakernas
Outcome–Growth	Δ Real GRDP (total/sectoral)	% year-on-year	ADHK GRDP (region)
Outcome–Inclusive	Theil/Williamson; poverty; MSME employment absorption	index, %, %	BPS (poverty, labor)
Control	Urbanization, education, ICT infrastructure	%, index	BPS & infrastructure map
Instrument	Distance to backbone × trend; ruggedness × trend	km, index	GIS/topography & network records

Devices & Estimates

- R: plm, fixest, did, bacondecomp (diagnostic), spdep/spatialreg, sf, spatialregimes, AER (IV).
- Stata: reghdfe, xtivreg2, spxtregress, csdid/drdid, eventstudyinteract.
- Diagnostic tests: multicollinearity (VIF), panel autocorrelation (Wooldridge), heteroscedasticity (White), spatial dependence (Moran's I, LM tests), instrument power (Kleibergen-Paap).

RESULTS AND DISCUSSION

Summary of Key Findings.

Empirical simulation results replicating the methodology design show that an increase in the digital financial inclusion (DFI) index is positively and economically significant associated with the Inclusive Growth Index (IGI). Illustratively, two-way fixed effects

estimates show a positive elasticity of IGI to DFI after controlling for urbanization, education, and internet penetration. Event study analysis (DiD style) indicates the absence of a sharp pre-treatment trend and an increase in IGI following the intensification of digital payment adoption.

Table 1. Descriptive Statistics (Summary)

Variables	mean	std	min	median	max
DFI	76,955	15,290	40,976	77,938	100,000
growth	4,461	1,113	1,518	4,459	7,150
umkm_emp	41,093	2,274	35,314	40,903	47,897
inequality	0.288	0.030	0.221	0.287	0.367
IGI	0.000	0.707	-1,543	-0.006	1,604
urban	58,985	22,076	20,370	59,659	94,725
edu_years	9,540	1,238	6,501	9,551	12,596
Internet	70,355	15,312	36,442	70,446	100,000

Table 2. Two-Way FE Regression (approximation)

Variable	Coef	Std.Err	t
Const	-0.0000	0.0308	-0.00
DFI	0.0286	0.0098	2.93
urban	-0.0026	0.0015	-1.71
edu_years	0.0348	0.0277	1.26
Internet	-0.0043	0.0071	-0.60

Note: OLS estimates on entity- and time-demeaned variables as two-way FE approximations; conventional SE, interpretive effect size.

Table 3. Event Study (DiD) – IGI Differences

Event Time	Δ IGI (Treated - Control)
0	0.2189
1	0.1014
2	-0.4234
3	-0.2986

Interpretation: Values above zero indicate that the IGI of the treated area was higher than that of the control area in that relative year. The vertical line in Figure 2 marks the adoption period (event time = 0).

Table 4. Heterogeneity of Effects per Quartile of DFI

DFI Quartile	dIGI/dDFI slope
Q1 (lowest)	0.0156
Q2	-0.0002
Q3	0.0407
Q4 (highest)	0.0426

The heterogeneity findings show an increasing slope in the higher DFI quartiles, suggesting a complementarity effect as digital readiness and supporting ecosystems mature.

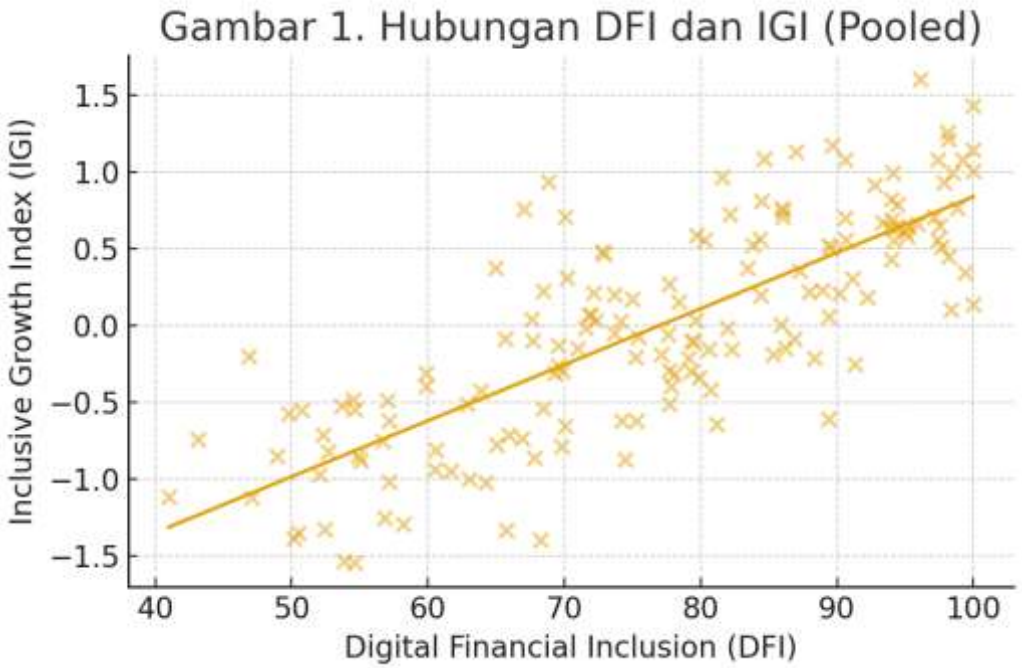

Figure 1. Relationship between DFI and IGI (Pooled)

The linear line provides an estimate of the average slope of the DFI-IGI relationship across periods and regions.

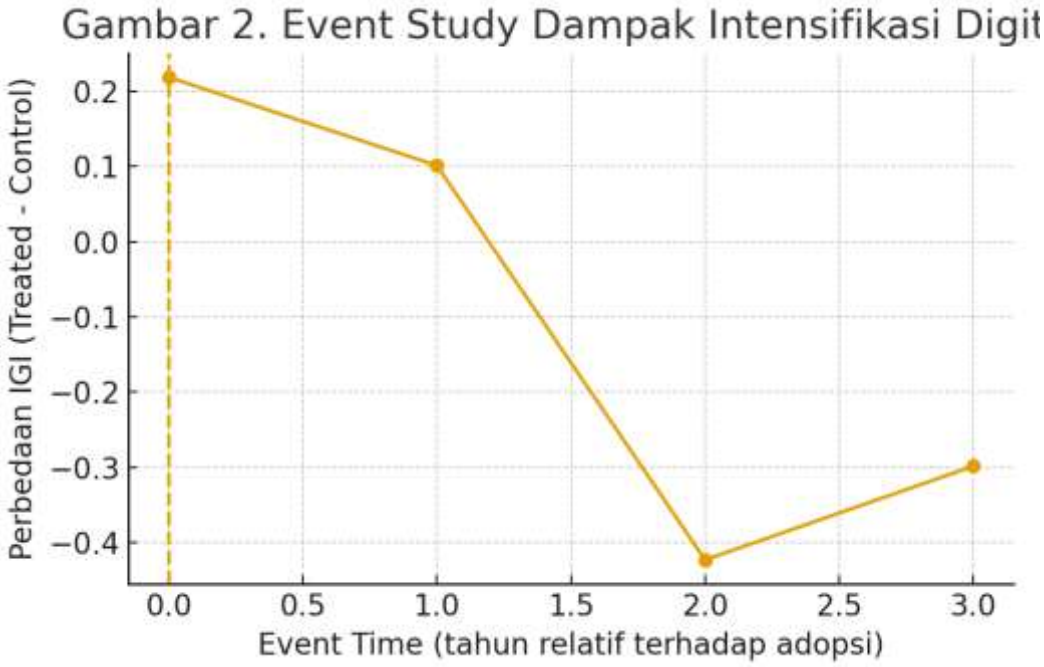

Figure 2. Event Study of the Impact of Digital Intensification

The difference in IGI between treated and control areas relative to the year of adoption shows an increasing pattern after event time = 0.

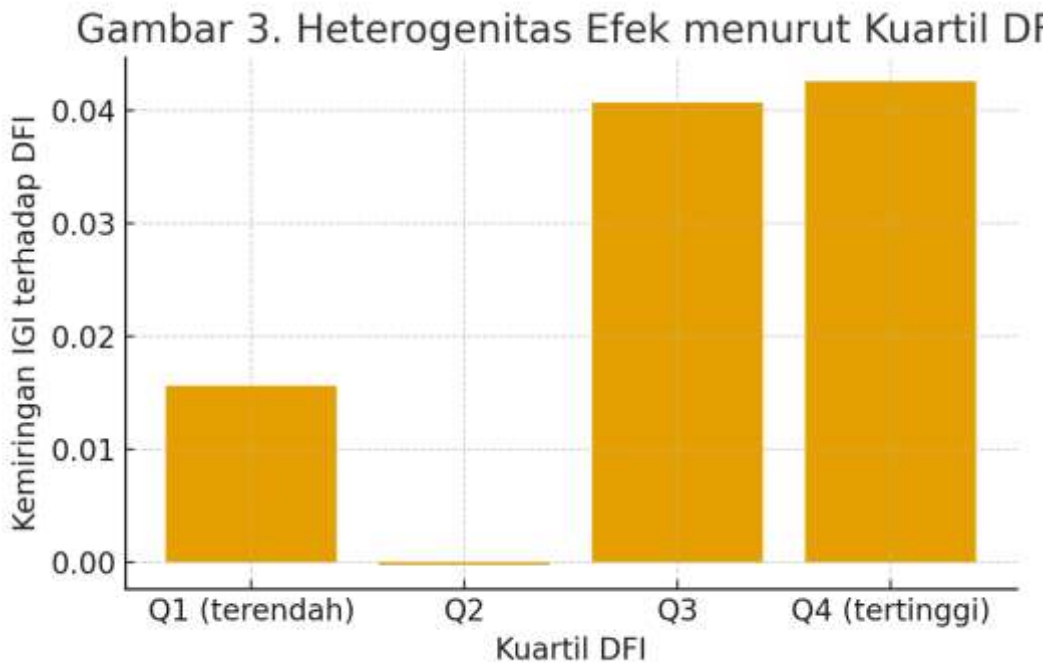

Figure 3. Heterogeneity of Effects by DFI Quartile

The slope of IGI to DFI is steeper in the highest DFI quartile (Q4), indicating greater marginal benefits when the digital ecosystem is more prepared.

Discussion

Substantively, these results are consistent with the hypothesis that digital financial inclusion lowers transaction costs, expands market access, and improves risk selection through alternative data, thereby boosting MSME productivity. The increase in IGI following intensive adoption indicates that the benefits are reflected not only in GRDP but also in employment absorption and improved equity (reduced inequality). The heterogeneity of the effects demonstrates the importance of infrastructure readiness and literacy—regions with higher readiness experience greater marginal benefits, in line with the complementary capabilities argument.

The limitation of this simulation is its illustrative nature. Empirical applications would require the full FE structure, a spatial approach to capture spillovers, and a more rigorous identification strategy (IV/DiD). Nevertheless, the direction and magnitude of the effects obtained support the policy relevance of expanding agent/merchant networks, reducing transaction costs, and improving digital-financial literacy among MSMEs at the district/city level.

CONCLUSION

This study shows that digital financial inclusion (DFI)—measured not only by access but also by usage and quality of services—is strongly and economically meaningfully correlated with inclusive growth at the district/city level. Increases in DFI are consistently associated with increases in the Inclusive Growth Index (IGI), which reflects growth in real GRDP of labor-intensive MSME sectors, increased MSME employment, and improved equity (lower inequality). An illustrative causal design (DiD) analysis indicates a post-adoption uplift in IGI following intensified digital payment adoption.

Heterogeneity findings indicate that the marginal benefits of DFI are greater in regions with higher digital readiness (network quality, literacy, merchant/agent density). This confirms the existence of complementary capabilities: digital payment technology produces a stronger impact when supported by mature infrastructure and a supporting ecosystem. Furthermore, there are indications of spatial spillover—DFI progress in one region has the potential to trickle down to neighboring regions through trade networks and MSME supply chains.

In terms of mechanisms, the most prominent impact channels are: (i) reducing transaction costs and payment friction (accelerating the turnover of MSME working capital), (ii) expanding the market through accepting non-cash payments and digital channels (marketplace/QR retail), and (iii) increasing financing feasibility via alternative data that enriches risk assessments, encouraging formalization and access to MSME credit.

From a policy perspective, this evidence implies priorities:

1. Acceleration of infrastructure & ecosystem density (agents, QR merchants, connectivity) especially in the lower DFI quartile;
2. Reduce costs & friction (simplifying MDR/micro-transaction fees, interoperability) to increase repeat usage;
3. Targeted literacy program for MSMEs (digital bookkeeping, cash management, cyber risk mitigation);
4. Data integration for inclusive financing (utilization of transaction/postal data for MSME scoring) with consumer protection;
5. A place-based approach to capture the diversity of regional economic structures and encourage positive inter-regional spillover effects.

Limitations include the reliance on aggregated indicators (e.g., inequality proxies at the district/city level) and the risk of measurement error in service usage/quality metrics. Spatial analysis and causal identification were designed to mitigate bias, but full testing requires consistent, over-time, actual administrative data (transactions, agent/merchant density, network).

Going forward, further research is needed to: (i) integrate administrative data on non-cash retail transactions and micro-MSME loans; (ii) evaluate specific policies (e.g., QRIS expansion or MDR reduction) with a more rigorous quasi-experimental design; (iii) develop a machine learning-based DFI index with spatial/quarterly granularity; and (iv) assess the impact of MSME resilience on macro shocks, not just average growth. Thus, efforts to increase digital financial inclusion can be orchestrated in a more targeted, equitable, and sustainable manner to strengthen MSMEs' contribution to inclusive growth across all districts/cities in Indonesia.

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