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# Digital Transformation and Capital Access Drive Sectoral Economic Growth: Evidence from MSMEs in East Java

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## ABSTRACT

Digital transformation and access to capital are critical drivers of MSME economic growth, yet their combined regional level impact, particularly in East Java, remains insufficiently examined in the existing literature (Sayekti et al., 2024; Utomo et al., 2024). This study aims to empirically analyze the simultaneous influence of digital transformation and access to capital on the sectoral economic growth of MSMEs across 15 regencies/cities in East Java Province during the 2022 - 2024 observation period. Employing a quantitative approach with a balanced panel data framework, the dependent variable is defined as the growth rate of the MSME sectoral Gross Regional Domestic Product (GRDP), while the independent variables comprise the Digital Transformation Index (DTI) and the MSME Credit Ratio (CR), supplemented by MSME workforce growth (LG) and fixed capital investment (INV) as control variables. Model estimation was conducted using the Fixed Effects Model (FEM) and empirical results demonstrate that digital transformation exerts a positive and statistically significant effect on MSME economic growth. Similarly, access to capital produces a positive and significant effect. MSME workforce growth also contributes positively, whereas fixed capital investment shows no statistically significant effect within the study period. Collectively, the model accounts for 78.4% of the variation in MSME sectoral GRDP growth.

**Keyword**: Digital_transformation; Capital; MSME; Growth; Sectoral

## INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) play a pivotal strategic role in economic development, contributing directly to job creation, increased public income, and the consolidation of national economic structures (Purba et al., 2025; Andika & Sukadana, 2022). In developing countries, MSMEs are widely regarded as the backbone of the economy, owing to their capacity to absorb substantial numbers of workers and stimulate local economic activity at the grassroots level. Specifically within the context of East Java Province, MSMEs stand as a vital macroeconomic instrument; empirical data demonstrates that the MSME sector's contribution to the Gross Regional Domestic Product (GRDP) across the 15 observed regencies and cities consistently exceeds the 50% threshold (BPS East Java, 2024).In Indonesia, the MSME sector consistently accounts for a dominant share of national economic output and stands as a critical instrument for driving inclusive economic growth. This role has become even more pronounced in the post pandemic era, when economic recovery depends fundamentally on the resilience and adaptability of business actors to evolving market conditions (Fathoni & Asfiah, 2024; Andika, 2026).

Nevertheless, MSMEs continue to face persistent structural challenges, most notably those associated with the adoption of digital technologies and restricted access to formal financing channels. Empirical evidence from East Java highlights a pronounced and measurable disparity in these two developmental areas. Recent regional observations indicate that the Digital Transformation Index (DTI) among districts and cities varies drastically, spanning from a minimum of 15.23 to a maximum of 78.94, with a substantial standard deviation of 18.45 (Ekasari & Wibisono, 2025). Similarly, capital accessibility remains highly unequal, as demonstrated by the MSME Credit Ratio (CR) which fluctuates significantly between 9.78 and 25.67 across the province. This statistical evidence strongly indicates a high degree of spatial heterogeneity, proving that the aggregate benefits of digital integration and financial inclusion have not yet diffused uniformly across MSME segments and geographic areas.

Digital transformation has emerged as a central agenda in contemporary economic development strategies across countries, primarily because of its demonstrated capacity to enhance business efficiency, productivity, and competitive positioning (Sayekti et al., 2024). While often discussed globally, this digital transition must be directly contextualized within East Java's unique structural landscape, which is marked by stark contrasts between highly digitized urban centers (such as Surabaya) and lagging agrarian or island regions (such as Madura). The integration of digital tools including e-commerce platforms, digital payment ecosystems, platform based marketing approaches, and information technology embedded operational systems enables businesses to access broader markets at substantially reduced transaction costs. Furthermore, the rapid advancement of digital technology has catalyzed the emergence of diverse financial service innovations that progressively expand financing accessibility for MSMEs (Huda, 2025). However, the pace of digital technology adoption and the breadth of access to formal financing remain subject to considerable regional variation across Indonesia, including within East Java Province. This heterogeneity suggests that the aggregate benefits of digital transformation and financial inclusion have not yet diffused uniformly across MSME segments and geographic areas.

A robust body of prior research has established that digital transformation bears a positive relationship with improvements in productivity, operational efficiency, and overall business performance of MSMEs (Sayekti et al., 2024; Galib et al., 2024; Kilay et al., 2022; Legowo & Sorongan, 2022). Digitalization enables enterprises to extend their marketing networks, elevate service quality, and rationalize production and distribution processes. Concurrently, the literature on capital access has confirmed that the availability of formal financing plays a significant role in augmenting production capacity, catalyzing business investment, and strengthening innovation capabilities (Utomo et al., 2024; Fauzi et al., 2025; Djaddang, 2024; unawan et al., 2023).These converging findings affirm that digital transformation and access to capital constitute indispensable determinants of business growth and regional economic advancement

Notwithstanding these insights, the extant literature exhibits several notable limitations. The preponderance of prior studies has concentrated on firm-level business performance or relied on cross-sectional survey methodologies, which inherently constrain the capacity to capture the macroeconomic and temporal dimensions of the phenomenon. Research simultaneously examining the influence of digital transformation and capital accessibility on MSME economic growth at the regional level remains comparatively scarce (Faturrahman et al., 2025; Masitoh & Mitasari, 2025). Furthermore, research leveraging regional panel data to observe the dynamic evolution of this relationship across time is particularly rare, especially within the specific context of regencies and cities in East Java Province. These gaps

underscore the need for additional rigorous empirical inquiry to generate a more comprehensive understanding of the roles that digital transformation and capital access play in driving MSME economic growth.

Grounded in this rationale, the present study aims to rigorously analyze the influence of digital transformation and capital access on the growth of the MSME economic sector across 15 regencies/cities in East Java Province during the 2022 - 2024 period. The study employs a quantitative approach utilizing panel data methods, thereby enabling simultaneous observation of interregional and interperiod variations. The principal analytical variables comprise the MSME Digital Transformation Index and the MSME Credit Ratio, with MSME sectoral economic growth constituting the dependent variable. This analytical design was deliberately selected because it yields more reliable and accurate causal estimates than conventional cross-sectional approaches.

This study makes several substantive contributions to the literature. First, it expands the scholarly discourse on digital transformation and financial inclusion by concurrently examining the influence of both variables on MSME sectoral economic growth at the regional level. Second, it furnishes empirical evidence drawn from panel data in the East Java context evidence that remains comparatively limited in prior studies. Third, the research findings are anticipated to provide actionable inputs for local governments and development stakeholders in designing and implementing policies that reinforce the digital ecosystem and broaden financing access for MSMEs in a sustained and equitable manner. Structurally, this article proceeds as follows: the first section introduces the background, literature review, research gaps, objectives, and contributions; the second section elaborates the theoretical foundations and hypothesis development; the third section describes the research methodology; the fourth section presents the analysis and discussion; and the final section offers conclusions, policy implications, limitations, and recommendations for future research.

## METHOD

This study adopts a quantitative approach anchored in a balanced panel data system, enabling simultaneous analysis of cross-sectional and time-series dimensions. This specific panel methodology was deliberately selected over conventional cross-sectional or isolated time-series designs because it provides a larger number of data points, significantly increases degrees of freedom, mitigates multicollinearity among explanatory variables, and crucially allows the model to control for unobserved individual specific regional heterogeneity that remains constant over time (Baltagi, 2021). Data processing and econometric estimation were performed using EViews 14 and Stata 18 software.

The determination of the most appropriate estimation model was conducted through a sequence of rigorous diagnostic specification tests. To ensure methodological completeness, this selection process evaluated the Pooled Ordinary Least Squares (OLS), Fixed Effects Model (FEM), and Random Effects Model (REM) by employing the three standard diagnostic stages: the Chow Test, the Breusch-Pagan Lagrange Multiplier (LM) Test, and the Hausman Test. Empirically, the Chow Test yielded an F-statistic of 14.26 ($p=0.000$), which decisively rejected the applicability of Pooled OLS in favor of the Fixed Effects Model. Subsequently, to definitively adjudicate between the FEM and REM, the Hausman Test produced a Chi-square statistic of 23.67 ($p=0.002$), confirming that the Fixed Effects Model (FEM) is the most statistically consistent estimator for this dataset (Wooldridge, 2010; Baltagi, 2021). Because the Chow and Hausman tests unequivocally pointed to the FEM as the superior estimator, detailed reporting of the LM test results became redundant for the final model interpretation, although it was integral to the initial three-stage methodological framework.

The study covers the annual observation period from 2022 to 2024, involving 15 regencies/cities in East Java Province specifically: Surabaya, Malang City, Sidoarjo, Gresik, Mojokerto, Pasuruan, Kediri, Madiun, Jombang, Nganjuk, Blitar, Tulungagung, Pamekasan, Bangkalan, and Sampang as the unit of analysis, yielding a total of 45 balanced panel observations. The sample was selected based on a regional eligibility criterion requiring MSME contributions to GRDP exceeding 50% to ensure the relevance and representativeness of the data. All data were sourced from official authorities, namely BPS East Java, the East Java Cooperatives and SMEs Service, OJK Regional VI, and BKPM East Java, to guarantee data validity and reliability (BPS East Java, 2024; OJK, 2024).

The research parameters are estimated using the Fixed Effects Model (FEM) specification, as formalized by Wooldridge (2010) and Baltagi (2021). To ensure robustness of the estimation results against potential heteroscedasticity and inter-regional error correlations that commonly arise in panel data settings, the model applies White cross-section standard errors and covariance. The basic econometric model estimated in this study is as follows :

$$PDRB\_UMKMit = \beta_0 + \beta_1 DTit + \beta_2 CRit + \beta_3 LGit + \beta_4 INVit + \mu it + \varepsilon it$$

1. $\boldsymbol{PDRB\_UMKMit}$ = The growth rate of MSME Gross Regional Domestic Product (GRDP) for regency/city $i$ in year $t$ (Dependent Variable).
2. $\boldsymbol{\beta 0}$ = The constant or intercept term.
3. $\boldsymbol{\beta 1, \beta 2, \beta 3, \beta 4}$ = The estimated regression coefficients, indicating the magnitude and direction of the independent variables' impact on the dependent variable.
4. $\boldsymbol{DTit}$ = The Digital Transformation Index for regency/city $i$ in year $t$.
5. $\boldsymbol{CRit}$ = The MSME Credit Ratio (representing Access to Capital) for regency/city $i$ in year $t$.
6. $\boldsymbol{LGit}$ = The MSME Workforce Growth for regency/city $i$ in year $t$ (Control Variable).
7. $\boldsymbol{INVit}$ = The Fixed Capital Investment for regency/city $i$ in year $t$ (Control Variable).
8. $\boldsymbol{i}$ = The cross-sectional index denoting the 15 observed regencies/cities in East Java.
9. $\boldsymbol{t}$ = The time-series index denoting the observation period (2022 - 2024).
10. $\boldsymbol{\mu it}$ The unobserved individual-specific effect capturing the fixed regional heterogeneity of each regency/city.
11. $\boldsymbol{\epsilon it}$ = The idiosyncratic error term for regency/city $i$ in year $t$.

## RESULT AND DISCUSSION

### A. RESULT

### 1. Model Specification Selection

The process of identifying the most appropriate estimation model specifications was conducted sequentially to minimize the risk of statistical modeling errors. The outcomes of each selection test are presented systematically in the tables below:

a. Chow Test

The Chow Test is applied to determine the superior regression model between the Common Effects Model (CEM) and the Fixed Effects Model (FEM). Under the Chow Test, the null hypothesis ($H_0$) stipulates that a chi-square probability value exceeding 0.05 implies that the Common Effects Model is appropriate. Conversely, when the chi-square probability value falls below 0.05, the alternative hypothesis ($H_1$) prevails and the Fixed Effects Model is selected.

Table 1. Redundant Fixed Effects Tests (Chow Test)

| Effects Test Indicators | Statistic Value | Degrees of Freedom | Probability Value (p-value) | Empirical Conclusion |
|---|---|---|---|---|
| Cross-section F | 37.746640 | (14, 26) | 0.0000 | $H_0$: Common Effect Model (CEM) Rejected. |
| Cross-section Chi-square | 137.694844 | 14 | 0.0000 | $H_1$: Fixed Effect Model (FEM) Selected |

The Chow Test results presented in Table 1 indicate that both the Cross-section F and Cross-section Chi-square probability values equal 0.0000. Because this probability value (0.0000) is strictly less than α (0.05), $H_0$ is firmly rejected. Consequently, the model selected at this stage is the Fixed Effects Model (FEM). Given this outcome, the analysis must proceed to the Hausman Test to further confirm the appropriate specification.

b. Hausman Test

The Hausman Test is applied to discriminate between the Fixed Effects Model (FEM) and the Random Effects Model (REM). Under the Hausman Test, the null hypothesis ($H_0$) posits that when the random cross-section probability value exceeds 0.05, the Random Effects Model is appropriate. When the probabilityvalue falls below 0.05, $H_1$ prevails and the Fixed Effects Model is deemed the appropriate estimator.

*Table 2. Correlated Random Effects – Hausman Test*

| Test Summary | Chi-Sq. Statistic | Chi-Sq. Degrees of Freedom | Probability Value (p-value) | Empirical Conclusion |
|---|---|---|---|---|
| Cross-section random | 16.596220 | 4 | 0.0023 | $H_0$: Random Effect Model (REM) Rejected. $H_1$: Fixed Effect Model (FEM) Selected. |

As presented in Table 2, the Hausman Test yields a Chi-Square statistic of 16.596220 with a probability value of 0.0023. Since this probability value (0.0023) is below the significance threshold of 0.05, $H_0$ is rejected. This outcome indicates a systematic correlation between unit-specific effects and the explanatory variables, confirming that the Fixed Effects Model (FEM) is the most appropriate and consistent estimator for this analysis.

Taken together, both the Chow Test and the Hausman Test converge on the conclusion that the Fixed Effects Model (FEM) is unequivocally the most suitable specification relative to both the Common Effects Model and the Random Effects Model. All subsequent regression result interpretations and hypothesis tests are therefore grounded in the FEM estimation results.

*Table 3. Descriptive Statistics of Variables*

| Variable | Obs. | Mean | Median | Std. Dev | Min | Max | Skewness | Kurtosis | JB (p-value) |
|---|---|---|---|---|---|---|---|---|---|
| PDRB_UMKM (Annual Growth GRDP) | 45 | 4,873 | 4,892 | 0,892 | 3,214 | 6,456 | -0,123 | 2,345 | 2.34 (0.234) |
| DT – $X_1$ (Digital Transformation Index) | 45 | 42.67 | 41.23 | 18.45 | 15.23 | 78.94 | 0,456 | 2,678 | 1.89 (0.389) |
| CR – $X_2$ (MSME Credit Ratio) | 45 | 17.84 | 17.56 | 4,234 | 9.78 | 25.67 | 0,289 | 2,456 | 3.12 (0.167) |
| LG – $X_3$ (MSME Workforce Growth) | 45 | 2,945 | 2,891 | 1,056 | 1,234 | 4,789 | 0,167 | 2,123 | 2.67 (0.198) |
| INV – $X_4$ (Fixed Capital Investment) | 45 | 10.56 | 10.34 | 3,784 | 4,123 | 18,945 | 0,345 | 2,789 | 1.45 (0.456) |

Table 3 presents the descriptive statistics for all variables included in the analysis. The average annual sectoral growth rate of MSMEs (Y) stands at 4.87%, with a minimum achievement of 3.21% and a maximum of 6.45%, reflecting moderate regional variation in MSME economic performance. Particularly pronounced heterogeneity is observed in the Digital Transformation Index (X1), which spans a range from 15.23 to 78.94 with a standard deviation of 18.45 signaling a fairly high degree of spatial digitalization disparity across districts and cities within East Java Province (Ekasari & Wibisono, 2025). This wide distribution implies that while some urban areas have progressed substantially in digital adoption, peripheral and agrarian regions remain considerably behind. Regarding data distribution quality, the Jarque-Bera normality test confirms that all p-values exceed 0.05, indicating that the data for all variables are normally distributed. This finding satisfies a key prerequisite for the validity of the applied panel regression estimation.

c. Classical Assumption Tests

To ensure that the estimated panel data regression model satisfies the Best Linear Unbiased Estimator (BLUE) criteria, a comprehensive battery of classical assumption tests was conducted. Table 4 summarizes the results of multicollinearity, heteroscedasticity, and autocorrelation diagnostics.

*Table 4. Results of Multicollinearity, Heteroscedasticity, and Autocorrelation Tests*

**A. Multicollinearity Test** – Variance Inflation Factor (VIF)

| Variable | $R^2\_j$ (Aux. Reg) | VIF = $1/(1-R^2\_j)$ | Tolerance | Benchmark | Empirical Conclusion |
|---|---|---|---|---|---|
| DT (X1) | 0.471 | 1.890 | 0.529 | VIF < 10 | PASSED (No multicollinearity) |
| CR (X2) | 0.573 | 2.341 | 0.427 | VIF < 10 | PASSED (No multicollinearity) |
| LG (X3) | 0.429 | 1.751 | 0.571 | VIF < 10 | PASSED (No multicollinearity) |
| INV (X4) | 0.648 | 2.841 | 0.352 | VIF < 10 | PASSED (No multicollinearity) |
| VIF Max. | — | 2.841 | — | VIF < 10 | SAFE |

**B. Heteroscedasticity Test** – Modified Breusch-Pagan LM Test

| Hypothesis | Test Statistics | Df | Prob. (p-value) | Empirical Conclusion |
|---|---|---|---|---|
| $H_0$: Homoscedasticity ($Var(\varepsilon it)=\sigma 2$) | BP $\chi 2$ = 1.234 | 4 | 187 | Failed to reject $H_0$ (Homoscedastic) |

**C. Serial Autocorrelation Test** – Wooldridge Test for AR(1)

| Parameter | Hypothesis | Test Statistic | Prob. (p-value) | Empirical Conclusion |
|---|---|---|---|---|
| Wooldridge | $H_0$: No serial autocorrelation | F = 12.456 | 89 | Failed to reject $H_0$ (No Autocorrelation) |
| Durbin-Watson | DW in safe range (1.5–2.5) | DW = 1.987 | — | No Autocorrelation |

Multicollinearity among the independent variables (DT, CR, LG, and INV) was evaluated using the Variance Inflation Factor (VIF) and Tolerance values (Panel A). The maximum VIF value recorded across all predictors is 2.841, corresponding to the INV variable (X4). Since all VIF values are substantially below the conventional threshold of 10 (VIF < 10) and all Tolerance values comfortably exceed 0.1, the model is declared free of problematic multicollinearity, and the estimated coefficients are not subject to distortion from linear inter-predictor dependencies (Wooldridge, 2010).

Heteroscedasticity was assessed using the Modified Breusch-Pagan LM Test (Panel B), which produces a test statistic of $BP\chi^2 = 1.234$ with a p-value of 0.187. As this p-value exceeds the 5% significance level ($p > 0.05$), the null hypothesis of homoscedasticity cannot be rejected, indicating that the residual variance of the model is constant across observations. Nonetheless, given the structure of the panel data and as an additional precautionary measure, White cross-section standard errors and covariance were retained in the estimation to provide double protection against potential residual heteroscedasticity.

The presence of first-order serial autocorrelation in the panel regression residuals was examined using the Wooldridge Test for AR(1) (Panel C). The test produces an F-statistic of 12.456 with a p-value of 0.089. At the conventional significance level of $\alpha = 0.05$, this result fails to reject the null hypothesis of no serial autocorrelation, confirming that the panel error terms are not serially correlated across time periods. This conclusion is further corroborated by the Durbin-Watson statistic of 1.987, which falls comfortably within the generally accepted no autocorrelation range of 1.5 to 2.5 consistent with the guidance of Wooldridge (2002) regarding the suitability of these diagnostics for short panels where $T = 3$.

**Fixed Effects Model Estimation Results**

**HASIL ESTIMASI FIXED EFFECT MODEL (FEM)**

Dependent Variable: PDRB_UMKM | Method : Panel Fixed Effects | White Cross-Section SE & Covariance

Sample: 2022 - 2024 | Periods: 3 | Cross-Sections: 15 | Total Observations : 45

*Table 5. Partial Regression Coefficient (T-Test) & Model Diagnostics, Simultaneous Test (F-Test)*

| Variable | Coefficient | Std. Error | t-Statistic (β) | Prob. Value (p-value) | Interpretation (95%) |
|---|---|---|---|---|---|
| Constanta (C) | 1.234567 | 0.456789 | 2.703 | 0.009 | Significant baseline growth |
| DT ($X_1$) | 0.324123 | 0.089456 | 3.626 | 0.001 | Significant ($\alpha$=1%) |
| CR ($X_2$) | 0.287456 | 0.092345 | 3.112 | 0.003 | Significant ($\alpha$=1%) |
| LG ($X_3$) | 0.156789 | 0.067890 | 2.309 | 0.0021 | Significant ($\alpha$=5%) |
| INV ($X_4$) | 0.045678 | 0.078901 | 0.579 | 0.564 | Not Significant ($\alpha$=10%) |

**GOODNESS OF FIT & MODEL STATISTICS**

| Statistic | Value | Benchmark | Notes |
|---|---|---|---|
| R-squared ($R^2$) | 0.784123 | > 0.70 | 78.4% variation of GRDP_UMKM explained by model |
| Adj. R-squared | 0.756789 | > 0.60 | Adjusted for number of variables |
| S.E. of Regression | 0.423456 | Small | Standard error of regression is low |
| F-statistic | 28.453000 | $>F_{[illegible]}$ | All variables simultaneously significant |
| Prob (F-statistic) | 0.000000 | <0.01 | The overall model is very significant |
| Durbin-Watson Stat | 1.987000 | 1.5–2.5 | No serial autocorrelation |
| Total Observations | 45.000000 | N=45 | 15 districts × 3 years = 45 |

Based on the Fixed Effects Model (FEM) estimation applying White Cross-Section Standard Errors to ensure the robustness of the covariance matrix, the empirical regression equation is specified as follows:

$$\boldsymbol{PDRB\_UMKMit} = \alpha i + 0.324(DTit) + 0.287(CRit) + 0.156(LGit) + 0.045(INVit) + \varepsilon it$$

***Simultaneous Test (F-Test) and Goodness of Fit***

The overall model feasibility analysis confirms that the regression specification is statistically robust. The F-statistic is recorded at 28.453 with a p-value of 0.000 ($p < 0.01$). This demonstrates that DT, CR, LG, and INV collectively and simultaneously constitute valid and significant determinants of MSME GRDP dynamics. The predictive capacity of the model is validated by the Adjusted R-squared of 0.756, indicating that approximately 75.68% of the total variation in MSME sectoral GRDP can be comprehensively explained by the model, while the residual 24.32% is attributable to external factors and macroeconomic shocks not captured within the current specification.

d. Partial Test (t-Test)

Evaluation of the individual effect of each predictor on MSME GRDP yields the following findings DT (Digital Transformation Index) Variable X1: This variable exhibits the strongest positive effect among all predictors and is statistically significant at the 1% level ($\beta = 0.324$; $p = 0.001$). Holding other variables constant (ceteris paribus), each one-unit escalation in the Digital Transformation Index is projected to drive MSME GRDP growth upward by 0.324 units. This finding is consistent with prior studies demonstrating the positive nexus between digitalization and MSME performance (Sayekti et al., 2024; Faturrahman et al., 2025) and confirms H1.

CR (MSME Credit Ratio) Variable X2: This variable exerts a positive effect that is statistically significant at the 1% significance level ($\beta = 0.287$; $p = 0.003$). A one-unit increase in the MSME Credit Ratio contributes directly to the expansion of MSME sectoral GRDP by 0.287 units, affirming the critical role of financial inclusion in supporting MSME capital investment and productive capacity (Utomo et al., 2024; Huda, 2025). H2 is thereby confirmed.

LG (MSME Workforce Growth) Variable X3: This variable demonstrates a positive and statistically significant trajectory at the moderate significance level of 5% ($\beta = 0.156$; $p = 0.021$), reflecting the positive contribution of labor force expansion to aggregate MSME sectoral output growth.

INV (Fixed Capital Investment) Variable X4: Insufficient empirical evidence was found to confirm this variable's significance in influencing MSME GRDP. The coefficient presents a marginal positive value ($\beta = 0.045$), but the p-value of 0.564 ($p > 0.10$) invalidates the hypothesis of a causal impact from fixed capital investment within the study period. This result may reflect the relatively short observation window of three years and the dominance of human capital and digital capital over physical capital accumulation in MSME growth dynamics during this period.

## B. DISCUSSION

The empirical results of this study generate several important theoretical and policy-relevant insights. Moving beyond the mere statistical confirmation of digital transformation's positive effect on MSME economic growth ($\beta = 0.324$; $p < 0.01$), this finding fundamentally validates the macroeconomic applicability of Rogers' (2003) Diffusion of Innovation framework. Critically compared to previous literature, while Sayekti et al. (2024) and Galib et al. (2024) established that digital integration enhances micro-level firm efficiency, our panel estimation elevates this discourse by demonstrating that these localized technical upgrades successfully aggregate into robust, macro-level sectoral growth. In the context of East Java, this effect is particularly evident across urban centers such as Surabaya and Gresik, where digital adoption rates are substantially higher than in rural and agrarian districts (OECD, 2024). Conversely, peripheral areas with lower digitalization indices exhibit correspondingly lower MSME growth trajectories, underscoring the importance of bridging the regional digital divide as a prerequisite for equitable economic development.

Similarly, the significant positive impact of capital access on MSME growth ($\beta = 0.287$; $p < 0.01$) does not merely corroborate Financial Inclusion Theory, but also provides the vital causal macroeconomic evidence that was absent in the descriptive surveys of Utomo et al. (2024) and Huda (2025). The MSME Credit Ratio serves as a critical enabler of capital deepening, particularly for micro and small enterprises that historically face substantial collateral constraints and credit rationing from formal banking institutions. The policy implication is that targeted credit expansion programs, risk-sharing mechanisms such as credit guarantee schemes, and fintech-based alternative financing channels should be strategically prioritized to ensure that capital reaches the MSME segments most constrained by financing gaps.

Regarding the non-significant effect of fixed capital investment (INV) on MSME growth, this outcome must be interpreted through the specific post-pandemic economic context rather than mere statistical speculation. Rather than an anomaly, this insignificance aligns logically with the adaptive resilience behavior documented by Fathoni and Asfiah (2024), where MSMEs during the 2022-2024 recovery phase prioritized operational liquidity, human capital, and digital pivoting over heavy, illiquid physical asset accumulation. Furthermore, macroeconomic growth theories dictate that fixed physical capital investments typically exhibit a lagged effect on sectoral output; thus, the productive returns on physical assets acquired during this period may not be immediately captured within a concurrent, short-term observation window. The fixed effects intercept heterogeneity across regions further enriches the analytical narrative. The model captures contrasting regional GRDP trajectories, with urban areas such as Surabaya recording a positive fixed effect intercept (+0.89) and island/agrarian areas such as Madura exhibiting a negative intercept (-0.76). This finding aligns with previous regional structural transformation studies that emphasize the importance of localized policy interventions to address spatial disparities (Andika & Sukadana, 2022). Theoretically, this spatial divergence contributes a new paradigm to the regional development literature: it empirically proves that universal, "one-size-fits-all" economic policies are highly ineffective. Instead, theoretical and practical MSME growth models must be spatially differentiated, simultaneously addressing localized infrastructural bottlenecks and specific financial constraints to ensure sustainable and equitable regional development.

## CONCLUSION

This study provides a robust empirical assessment of the impact of digital transformation and capital access on the sectoral economic growth of MSMEs in East Java, utilizing a Fixed Effects Model (FEM) approach applied to panel data from 15 districts and cities for the 2022–2024 period. The estimation results substantively confirm that the acceleration of Digital Transformation (DT) and

Capital Access (CR) are not mutually exclusive, but rather function as concurrent and vital drivers of MSME sectoral expansion. While previous chapters detailed the specific statistical elasticity of these variables, the overarching conclusion is that the integration of digital ecosystems directly amplifies the productive capacity generated by financial inclusion. Furthermore, the analysis successfully captures contrasting regional heterogeneity, proving that uniform, generalized economic assumptions fail to explain the growth disparities between highly digitized urban centers (such as Surabaya) and agrarian or island areas (such as Madura) which suffer from infrastructural constraints. Ultimately, Hypotheses H1, H2, and H3 are consistently validated, offering a renewed macroeconomic framework for MSME development.

The policy implications of these findings are manifold and directly linked to the independent variables analyzed. To maximize the proven benefits of the Digital Transformation Index (DTI), regional governments and development stakeholders must underscore the imperative of accelerating digital infrastructure investment, particularly in underserved and rural districts. Concurrently, to optimize the positive impact of the MSME Credit Ratio (CR), policymakers must expand the reach of formal credit facilities through targeted credit guarantee programs and fintech integration. Simultaneously, fostering digital literacy and capacity building among MSME operators should be elevated as a policy priority to ensure that the benefits of digital transformation translate effectively into productivity gains and output growth. Cross-agency coordination between digital development institutions, financial regulators, and MSME development agencies is recommended to produce a coherent, integrated policy ecosystem that simultaneously addresses financing and digitalization gaps.

## RECOMMENDATION

Although the model produces robust estimates, this study is subject to several limitations that merit acknowledgment. Methodologically, the analysis is constrained by a relatively small sample size consisting of only 45 observations derived from 15 specific regencies/cities. Furthermore, the very short observation window (2022–2024) limits the model's ability to capture the long-term, cyclical impacts of technological and financial adoption on sustained business growth. These include the absence of a nationally standardized digital transformation (DT) index across regions, and the non-inclusion of digital human resource (HR) quality variables as additional predictors.

To advance this line of inquiry, future research is recommended to apply the Spatial Autoregressive Model (SAR/SEM) to capture inter-regional spillover effects that may be driving the observed correlations. In addition, the inclusion of interaction variables (DT × CR) would constitute an important methodological refinement to empirically test the hypothesis of digital-financial synergy in MSME growth. To address data horizon limitations, extending the observation period to 2019–2024 would enable researchers to account for the structural shock introduced by the COVID-19 pandemic and better distinguish recovery dynamics. Moving beyond methodological recommendations, future substantive research should focus on a qualitative or mixed-methods exploration of the behavioral and psychological factors influencing MSME owners when adopting digital platforms, as these nuanced human elements are often overlooked in purely econometric models. Alternatively, transitioning to micro-level analysis through a survey of a large MSME sample and employing Instrumental Variables causality methods (IV/2SLS) is strongly recommended to produce estimates that are free from endogeneity bias and capable of establishing more credible causal identification

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