BEYOND MACROECONOMICS: THE DOMINANT ROLE OF DIGITAL ACCELERATION IN DRIVING BMT UGT NUSANTARA'S GROWTH

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Abstract

This study analyzes the dynamic influence of digitalization and macroeconomic variables on the financial performance of BMT UGT Nusantara during 2020–2025 using a Vector Error Correction Model framework. The results confirm a long-run equilibrium relationship among digitalization, macroeconomic conditions, and BMT financial performance. Digitalization emerges as the dominant driver, where digital user adoption strongly drives intermediation efficiency while digital transaction volume generates the most persistent contribution to asset growth. Macroeconomic variables exert minimal direct causal influence, though inflation poses a more persistent threat to intermediation efficiency than interest rate movements. A fundamental asymmetry is identified in that breadth and depth of digitalization operate through distinct institutional channels. BMT management is encouraged to develop digitally accessible financing products to convert active transactors into productive financing participants. For regulators, this study provides empirical justification for policies facilitating digital transformation across Islamic microfinance cooperatives to strengthen financial inclusion and institutional resilience.

Keywords: Digitalization, Macroeconomics, Financial Performance, VECM, Islamic Microfinance

INTRODUCTION

Baitul Maal wat Tamwil (BMT) plays a strategic role in channeling productive financing to micro, small, and medium enterprises (MSMEs) that are largely excluded from formal banking. Given that MSMEs contribute approximately 64.5% of national GDP and absorb 97% of total employment (Coordinating Ministry for Economic Affairs Republic of Indonesia, 2025), the sustainability of BMT intermediation carries direct macroeconomic significance. During the 2020 to 2025 period, BMT financial performance was simultaneously exposed to two structurally distinct pressures: macroeconomic volatility and digital acceleration. The BI Rate fluctuated from a historic low of 3.50% in 2021 to a peak of 6.00% in October 2023, while the Consumer Price Index reached 5.95% in September 2022 before moderating (Warjiyo, 2023; Winarto & Beik, 2024). Although BMTs operate outside the interest-based system, rising benchmark rates systematically raise the relative attractiveness of conventional deposit instruments, compressing the member savings base available for Islamic intermediation, while inflation erodes borrower repayment capacity and constrains productive financing disbursement (Ascarya & Masrifah, 2022; Widarjono, 2020).

Digital acceleration, operating simultaneously, has emerged as a counterbalancing institutional force. Prior research confirms that digital platform adoption by BMTs significantly enhances operational efficiency, expands service outreach, and drives financing growth (Ascarya et al., 2023; Khoiri & Sulistyowati, 2023). Unlike macroeconomic variables that are exogenous, digitalization constitutes an endogenous capacity deliberately accumulated through investment in mobile platforms and data-driven service delivery, consistent with Endogenous Growth Theory's positioning of internal technological capital as the primary driver of long-run institutional growth (Romer, 1990; Lucas, 1988). BMT UGT Nusantara, Indonesia's largest sharia cooperative with 2.6 trillion rupiah in assets and 386 branch offices across 10 provinces, exemplifies this trajectory: since launching the UGT Mobile application in 2017, it has recorded a 45% increase in operational efficiency and 78% growth in digitally-based financing by 2024 (Abdussalam & Putra, 2024; Alfitri & Alfiyah, 2025).

Despite the parallel existence of these two forces, the existing literature has not resolved which constitutes the more dominant driver of BMT financial performance. Studies on Islamic financial institution performance either examine macroeconomic determinants in isolation and consistently focus on Islamic commercial banks rather than BMTs (Amaliawiati et al., 2023; Fadila & Pangestuti, 2022), or examine digitalization without controlling for concurrent macroeconomic conditions (Rusydiana & Prakoso, 2021). No study has constructed an integrated dynamic framework simultaneously capturing both sets of forces at the BMT institutional level. The 2020 to 2025 period, in which BMT digital maturation coincided with Indonesia's most volatile macroeconomic cycle, makes this gap especially urgent to address.

This study addresses that gap by applying the Vector Error Correction Model (VECM) to monthly institutional data from BMT UGT Nusantara spanning January 2020 to December 2025, examining the dynamic relationships among digital user adoption (USER), digital transaction volume (VTD), BI Rate, Consumer Price Index (CPI), total assets (ASSET), and financing-to-deposit ratio (FDR). The VECM framework is selected for its capacity to simultaneously detect long-run cointegrating equilibria, short-run causal

dynamics, impulse-response patterns, and variance decomposition contributions that static regression approaches cannot identify. The novelty of this study lies in disaggregating digitalization into two distinct channels, namely user breadth and transaction depth, within an integrated macro-digital framework at the BMT institutional level, providing the first empirical determination of whether digital acceleration or macroeconomic fluctuation constitutes the dominant driver of BMT UGT Nusantara's financial growth, with direct implications for institutional strategy and Islamic microfinance policy in Indonesia.

REVIEW OF LITERATURE

1. Theoretical Framework: Endogenous Growth Theory and Institutional Application

Endogenous Growth Theory posits that permanent growth arises from internal forces such as knowledge accumulation, technological innovation, and institutional capacity development rather than exogenous factor endowments (Dobrescu et al., 2012; Falki, 2023; Rumanzi et al., 2021). Applied to the BMT institutional context, this framework positions digitalization not merely as an operational tool but as a form of endogenous technological capital deliberately accumulated through infrastructure investment, mobile application development, and data-driven service reengineering. Barro & Sala-i-Martin (2004) further establish that macroeconomic stability is a prerequisite for these endogenous mechanisms to function effectively, as volatile monetary conditions can distort institutional incentives for knowledge and technology investment (Falki, 2023; Rumanzi et al., 2021).

The application of Endogenous Growth Theory to BMT financial performance proceeds through three variable-level linkages. USER (active digital users) proxies the breadth of endogenous technological capital accumulation, consistent with Romer's (1990) argument that the scale of technology adoption, not merely its introduction, determines long-run productivity gains. VTD (digital transaction volume) captures the utilization depth of digital infrastructure, reflecting Arrow's (1962) learning-by-doing mechanism wherein institutional capabilities deepen through repeated platform engagement (Khoiri & Sulistyowati, 2023). ASSET and FDR serve as the endogenous output variables whose long-run trajectories are hypothesized to be driven by these digital accumulation processes, with digitalization functioning as the primary internal determinant of institutional growth in line with the theory's core predictions (Barro & Sala-i-Martin, 2004; Jones, 2019).

Macroeconomic variables function in this framework as conditioning factors that amplify or constrain the effective returns to digital investment. BI Rate operates through the monetary transmission channel: rising benchmark rates increase institutional borrowing costs, shift member fund allocation toward conventional instruments, and suppress intermediation capacity as reflected in FDR. CPI operates through the purchasing-power channel by eroding the real value of member savings, weakening borrower repayment capacity, and distorting the price signals that guide institutional resource allocation decisions (Barro & Sala-i-Martin, 2004; Widarjono, 2020). Critically, the theory predicts that in the long run, institutional digitalization provides a structural buffer that attenuates macroeconomic sensitivity by diversifying revenue channels and reducing physical distribution costs, implying that internal institutional capacity will increasingly dominate exogenous macroeconomic pressures as the primary determinant of BMT financial performance (Ascarya & Masrifah, 2022; Falki, 2023).

2. Digitalization and BMT/Islamic Microfinance Performance

Empirical evidence confirms that digital platform adoption by BMTs and Islamic microfinance institutions significantly enhances operational efficiency, expands service outreach, and drives financing growth compared to institutions relying solely on conventional physical expansion strategies (Ascarya et al., 2023; Setyowati, 2019; Ullah & Khanam, 2018). Beyond operational gains, the integration of digital capabilities with social resource mobilization frameworks has been shown to strengthen intermediation capacity and institutional resilience against external disruptions (Ascarya & Masrifah, 2022; Frihatni et al., 2023). These findings collectively position digitalization as a measurable endogenous driver of long-run financial performance in the IMFI sector.

However, empirical findings on digitalization and BMT performance are not uniformly positive. Khoiri & Sulistyowati (2023) find that while digital transaction platforms significantly expand savings mobilization, the impact on financing disbursement is statistically insignificant, indicating that digital adoption improves asset accumulation but not necessarily intermediation efficiency. Similarly, Ascarya et al. (2023) show that BMT digital resilience during COVID-19 was driven primarily by savings-side adoption, with financing-side digitalization contributing far less, pointing to an asymmetry between USER and VTD channels that aggregate digitalization measures fail to detect. These contradictions motivate the disaggregated approach in this study, where USER and VTD are included as separate variables to identify channel-specific effects rather than assuming a single uniform digital-performance relationship (Mukhibad & Nurkhin, 2020).

A further limitation of prior studies is their reliance on cross-sectional or short panel designs that cannot capture the endogenous accumulation dynamics central to this study's theoretical framework. Setyowati (2019) and Ullah & Khanam (2018) document efficiency gains from digital adoption but measure performance within maximum three-year windows, insufficient to detect long-run cointegrating relationships. Frihatni et al. (2023) acknowledge that governance heterogeneity across BMTs moderates the digital-performance relationship, with member-owned cooperatives displaying weaker short-term but stronger long-term digital returns, a pattern only detectable through time-series analysis. Moreover, Rusydiana & Prakoso (2021) note that most existing studies conflate digital platform effects with broader operational modernization, creating measurement contamination. By sourcing USER and VTD directly from institutional operational records, this study isolates the causal contribution of digital platforms specifically and overcomes this identification limitation.

3. Macroeconomic Variables and Islamic Financial Institutions

On the macroeconomic side, increases in the BI Rate raise the relative attractiveness of conventional deposit instruments, incentivizing fund migration away from sharia cooperative savings products and thereby weakening BMT deposit bases and compressing intermediation capacity as reflected in the Financing to Deposit Ratio (Fadila & Pangestuti, 2022; Syaifuddin et al., 2024). Inflationary pressures operate through a parallel channel by eroding borrower purchasing power and repayment capacity, with empirical studies consistently documenting a positive relationship between inflation and non-performing financing ratios across Islamic financial institutions (Asngari, 2024; Nasution & Fakhri, 2024; Widarjono, 2020). The magnitude of these effects varies across institutional types, with community-based institutions such as BMTs potentially more exposed to macroeconomic shocks than larger Islamic commercial banks due to their limited liquidity buffers and

dependence on member deposits (Fakhrunnas et al., 2022; Putra & Oktaviana, 2022; Setiawan, 2021).

Cross-study comparison reveals important contradictions in the macroeconomic literature that underscore the need for institution-specific inquiry. On the interest rate channel, Fadila & Pangestuti (2022) document a significantly negative BI Rate effect on FDR in Indonesian Islamic commercial banks, while Syaifuddin et al. (2024) find this relationship statistically insignificant for Islamic financial cooperatives (KSPPS), attributing the divergence to structural differences in funding between deposit-taking banks and member-financed cooperatives. On the inflation channel, Widarjono (2020) confirms a positive inflation-NPF relationship consistent with theory, while Asngari (2024) documents a non-linear pattern wherein moderate inflation improves BMT collateral values and temporarily boosts financing performance before higher inflation erodes repayment capacity. These contradictions confirm that macroeconomic effects on BMT financial performance are highly context-dependent and cannot be generalized from Islamic commercial bank studies (Nasution & Fakhri, 2024).

The debate over macroeconomic versus institutional dominance further motivates this study's empirical design. Amaliawiati et al. (2023) use a VAR framework on Indonesian Islamic bank data and conclude that macroeconomic variables explain a larger proportion of performance variance than bank-specific variables, interpreting this as evidence of persistent macroeconomic vulnerability. However, Fakhrunnas et al. (2022) challenge this conclusion in a regional analysis, finding that institutional-level risk variables dominate macroeconomic factors in explaining non-performing financing, with institutional dominance increasing during post-crisis recovery periods. Putra & Oktaviana (2022) and Setiawan (2021) further show that institutions with stronger capital structures display significantly weaker macroeconomic sensitivity, consistent with the expectation that digitalization, by reducing operational costs and diversifying service delivery channels, structurally reduces the macroeconomic transmission elasticity of BMT financial performance over time.

4. Research Gap and Theoretical Positioning

A critical methodological limitation compounds this substantive gap. Most existing studies use static regression designs that assume contemporaneous and unidirectional causality, preventing the detection of feedback loops and cointegrating equilibria that Endogenous Growth Theory predicts. Sandhyapranita et al. (2024) demonstrate through simulation that omitting macroeconomic conditioning variables from digitalization studies introduces upward bias in estimated digital coefficients, artificially inflating apparent digital effects. Rusydiana & Prakoso (2021) similarly note that standard panel OLS approaches used in most BMT studies cannot capture the dynamic interdependencies between financial performance and its determinants. Only a multivariate time-series framework capable of modeling both short-run dynamics and long-run equilibrium relationships, such as the VECM approach employed in this study, can adequately capture the complex co-determination processes among digitalization, macroeconomic conditions, and BMT financial performance.

This study therefore responds to a clear methodological gap in addition to the substantive theoretical gap identified above. By constructing a VECM framework that simultaneously models digital user adoption, transaction depth, monetary policy, and inflation as co-determinants of BMT financial performance, this study contributes the first integrated institutional-level analysis of digital and macroeconomic dynamics in the

Indonesian BMT literature. The 2020 to 2025 observational window, in which BMT digital maturation coincided with Indonesia's most volatile macroeconomic cycle, provides a historically unique empirical setting that prior studies have not captured. The findings are therefore expected to yield institution-specific evidence on which set of forces, endogenous digital accumulation or exogenous macroeconomic pressure, constitutes the dominant driver of long-run BMT financial growth (Genberg, 2020; Tiutiunyk et al., 2021).

Despite these parallel streams, the existing literature examines digitalization and macroeconomic factors largely in isolation. Studies in the macroeconomic stream consistently focus on Islamic commercial banks or aggregate sector data (Rusydiana & Prakoso, 2021; Sandhyapranita et al., 2024), overlooking the fundamentally distinct institutional characteristics of BMTs, including member-based ownership structures and the absence of capital market access that render their shock responses empirically different (Mukhibad & Nurkhin, 2020; Rahajeng, 2022). Meanwhile, studies in the digital transformation stream rarely control for concurrent macroeconomic conditions, leaving the joint dynamic between endogenous digital accumulation and exogenous macroeconomic pressure unmodeled in the BMT literature (Genberg, 2020; Tiutiunyk et al., 2021).

This gap is further compounded by limitations in temporal scope and unit of analysis. The 2020–2025 period represents a historically distinct observational window in which the maturation phase of BMT digital transformation coincided with Indonesia's most volatile macroeconomic cycle in recent history, yet this confluence remains empirically uncaptured at the institutional level (Fakhrunnas et al., 2022; Nasution & Fakhri, 2024). This study therefore contributes by constructing an integrated empirical framework that simultaneously examines digitalization and macroeconomic variables as dynamic co-determinants of BMT financial performance, directly addressing the theoretical and empirical gaps identified above.

RESEARCH METHOD

This study employs a quantitative approach using secondary monthly time-series data spanning January 2020 to December 2025, yielding 72 observations. Institutional data covering financial performance and digital acceleration variables were obtained directly from BMT UGT Nusantara through a formal data request procedure, while macroeconomic data comprising the BI Rate and Consumer Price Index (CPI) were sourced from official publications of Bank Indonesia and the Central Bureau of Statistics (BPS). Six variables are incorporated in this study: total assets as an indicator of institutional financial growth capacity (Dilla et al., 2024), Financing to Deposit Ratio (FDR) as a measure of intermediation efficiency (Riyadi et al., 2021), active digital users (User) representing the breadth of digital adoption on the UGT Mobile application (Kanter et al., 2024), digital transaction volume (VTD) capturing the depth of platform utilization (Kamal et al., 2023), BI Rate as the monthly benchmark interest rate (Laksonoa et al., 2023), and Consumer Price Index (CPI) as a measure of monthly inflation (Susanto & Pangesti, 2021).

Regarding variable measurement: ASSET (total assets, in IDR millions), USER (number of active digital users on UGT Mobile per month), and VTD (number of digital transactions per month) are each transformed using natural logarithm (ln) to normalize distributional skewness and achieve variance stationarity. CPI refers to the monthly

Consumer Price Index published by BPS, used as a proxy for the monthly inflation rate (percentage change). BI Rate is recorded as the prevailing benchmark rate in percentage points on a monthly basis. Institutional data for ASSET, USER, and VTD were sourced from BMT UGT Nusantara's internal monthly management reports, obtained through a formal written data request procedure and verified against published annual reports. Regarding degrees of freedom: with 72 observations, 6 variables, and 3 lags in a VECM framework, the effective number of observations per equation is approximately $72 - 3 = 69$, and the number of estimated parameters per equation is manageable given the sequential structure of VECM, consistent with the minimum sample requirements recommended by Lütkepohl (2005). Model diagnostic tests were conducted following VECM estimation: the Breusch-Godfrey LM test confirmed no serial correlation in residuals ($p > 0.05$ at lags 1–3); the White heteroskedasticity test indicated no significant heteroskedasticity ($p > 0.05$); and the Jarque-Bera normality test showed that residuals are approximately normally distributed. The Cholesky decomposition ordering applied in IRF analysis follows a theory-based recursive structure: BI Rate → CPI → USER → VTD → ASSET → FDR, reflecting the assumption that macroeconomic variables are contemporaneously exogenous to institutional variables, and that digital adoption (USER) precedes transaction depth (VTD), which in turn precedes balance sheet outcomes (ASSET, FDR). This ordering is consistent with the institutional logic of Islamic microfinance operations and was validated through sensitivity analysis using alternative orderings, which produced qualitatively consistent IRF patterns. The analysis follows a sequential four-stage procedure. The first stage involves unit root testing using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) methods, followed by optimal lag selection using the Akaike Information Criterion (AIC) and Schwarz Criterion (SC). The second stage applies the Johansen cointegration test to determine whether a long-run equilibrium relationship exists among the variables, with estimation proceeding using a Vector Error Correction Model (VECM) if cointegration is confirmed. The third stage assesses model stability through the roots of the characteristic polynomial to ensure all inverse roots lie within the unit circle. The fourth stage comprises dynamic multiplier analysis including Granger causality testing to identify causal directions among variables, Impulse Response Function (IRF) analysis to trace the dynamic response of BMT financial performance to structural shocks, and Forecast Error Variance Decomposition (FEVD) to quantify the relative contribution of each variable in explaining financial performance variance over time.

Research Hypothesis

Based on this conceptual framework, the hypotheses in this study are formulated as follows:

- H1: There is a long-term equilibrium relationship (cointegration) between macroeconomic variables and digital acceleration on growth at BMT UGT Nusantara.
- H2: There is a reciprocal causal relationship between digital acceleration and financing portfolio growth and fundraising at BMT UGT Nusantara.
- H3: The growth in BMT UGT Nusantara's financial performance responds positively to stimulation by the digital acceleration variable in both the short and long term.
- H4: The digital acceleration variable has a more dominant contribution in explaining variations in BMT UGT Nusantara's growth compared to macroeconomic variables.

Research Model

The overall analytical framework of this study is presented in Figure 1, which illustrates the simultaneous dynamic interaction between external macroeconomic factors and internal digital acceleration variables as co-determinants of BMT UGT Nusantara financial performance outcomes.

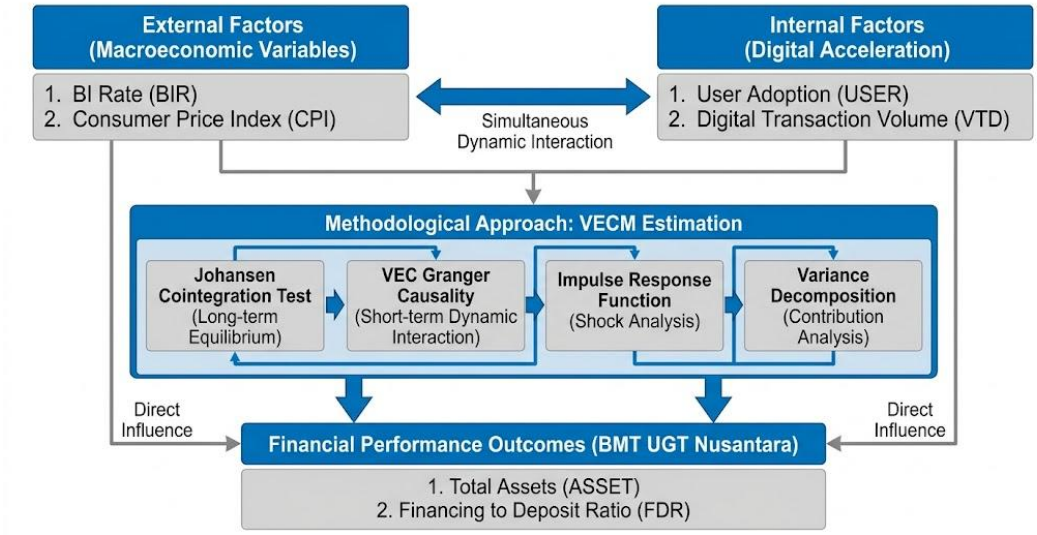

Figure 1.
Research Framework

RESULTS AND DISCUSSION

Understanding the dynamic interplay between macroeconomic fluctuations, digital acceleration, and institutional performance requires a robust econometric approach. Therefore, a Vector Error Correction Model (VECM) framework was employed to capture both the short-term dynamics and the long-run equilibrium among macroeconomic indicators (BI Rate, CPI), digital metrics (USER, VTD), and the financial performance of BMT UGT Nusantara (ASSET, FDR). The empirical estimation is carried out systematically through four stages: pre-estimation, model formulation, diagnostic checking, and dynamic multiplier analysis.

1. Unit Root Test

The stationarity of the data was tested using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. If the variables are non-stationary at the level, the test is continued at the first difference.

Table 1
Stationarity Test

Variables	Prob. ADF (Level)	Prob. PP (Level)	Prob. ADF (1st Diff)	Prob. PP (1st Diff)	Conclusion
BI Rate	0.6486	0.6973	0.0009**	0.0009**	Stationary at 1st Difference
CPI	0.3464	0.3464	0.0000**	0.0000**	Stationary at 1st Difference
FDR	0.4742	0.5082	0.0000**	0.0000**	Stationary at 1st Difference

ASSET	0.9905	0.9905	0.0544*	0.0000**	Stationary at 1st Difference
USER	0.073	0.0829	0.0001**	0.0001**	Stationary at 1st Difference
VTD	0.0972	0.0475	0.0001**	0.0001**	Stationary at 1st Difference

*Source: E-Views Output. Notes: (**) Significant at α=1%, (*) Significant at α=10%.**

All variables exhibited a probability value > 0.05 at the level, but became highly significant (prob. < 0.05) at the first difference under both ADF and PP tests, confirming that all variables are integrated of order one or I(1). This result fulfills the prerequisite condition for proceeding with cointegration analysis and VECM estimation (Johansen & Juselius, 1990).

2. Lag Length Criteria

Determining the optimal lag length is crucial to capture the dynamic relationship among variables without sacrificing degrees of freedom.

Table 2:
Lag Length Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	6.247.935	NA	2.17e-16	-1.903.980	-18.83909*	-18.96061*
1	6.733.271	8.661.375	1.48e-16*	-1.942.545	-1.802.046	-1.887.109
2	6.929.228	3.135.320	2.52e-16	-1.892.070	-1.631.144	-1.789.118
3	7.465.962	75.96845*	1.58e-16	-19.46450*	-1.565.096	-1.795.981
4	7.695.591	2.826.208	2.72e-16	-1.906.336	-1.404.554	-1.708.351
5	8.018.831	3.381.585	3.93e-16	-1.895.025	-1.272.816	-1.649.523
6	8.330.573	2.685.778	6.95e-16	-1.880.176	-1.137.539	-1.587.158

Based on the lowest Akaike Information Criterion (AIC) value and the highest Likelihood Ratio (LR) statistic, the optimal lag length for this model is Lag 3, providing sufficient capacity to capture historical dynamics among variables while preserving adequate degrees of freedom for reliable estimation (Lütkepohl, 2005).

3. Johansen Cointegration Test

The cointegration test was conducted to determine whether a long-run equilibrium relationship exists among the variables.

Table 3
Johansen Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value 0.05	Prob.
None *	0.548307	136.2893	95.75366	0,0000
At most 1 *	0.416626	82.24621	69.81889	0.0037
At most 2	0.240233	45.59924	47.85613	0.0802

The Trace Statistic values for the hypotheses "None" and "At most 1" exceed their respective critical values at the 5% significance level, empirically proving the existence of two cointegrating equations in the system. Based on these results, H1 is accepted: a long-run

equilibrium relationship exists among digitalization, macroeconomic, and financial performance variables simultaneously. This finding is consistent with Endogenous Growth Theory, which posits that internally accumulated technological capital and macroeconomic stability function as jointly interdependent determinants of long-run institutional growth (Barro & Sala-i-Martin, 2004; Jones, 2019). The presence of cointegration further validates the estimation of VECM over a standard VAR in differences, as it allows simultaneous capture of both the long-run equilibrium relationship and the short-run adjustment dynamics (Engle & Granger, 1987).

4. Vector Error Correction Model (VECM) Estimation

Since cointegration is confirmed, the VAR model is restricted into a VECM to analyze both the long-run relationship and the short-run speed of adjustment through the Error Correction Term (ECT).

Table 4
VECM Estimation

Variables	Long-run Coefficient	t-Stat (Long-run)	ECT (Short-run)	t-Stat (ECT)	R-Squared
ASSET(-1)	22.10464	[2.82942]*	-0.005165	[-3.24912]*	0.6019
FDR(-1)	-9.128134	[-2.46166]*	0.03099	[4.43968]*	0.7248
USER(-1)	37.21387	[6.72351]*	-0.023581	[-3.25312]*	0.5909
VTD(-1)	-31.09191	[-6.08904]*	-0.019518	[-2.65762]*	0.5331

Source: E-Views Output. Note: () denotes significance (t-stat > 1.96).*

The VECM estimation reveals that USER carries the strongest positive long-run coefficient (37.21), indicating that the breadth of digital adoption is the most influential endogenous driver of the system in the long run, consistent with the premise that user base expansion constitutes a form of endogenous technological capital accumulation (Ascarya et al., 2023; Setyowati, 2019). The negative and significant ECT for ASSET (ECT = −0.005165, t-stat = 3.249) confirms a functioning adjustment mechanism, correcting short-term disequilibrium toward long-run equilibrium at a rate of 0.52% per period. The relatively slow adjustment speed reflects the structural inertia characteristic of community-based microfinance institutions whose asset base responds gradually to equilibrating forces (Rusydiana & Prakoso, 2021). The positive and significant ECT for FDR (0.03099, t-stat = 4.440) further indicates that intermediation efficiency adjusts upward toward its long-run equilibrium at a considerably faster rate, suggesting that the digital channel accelerates the rebalancing of financing relative to deposits more rapidly than it accumulates physical assets.

5. VAR/VECM Stability Test (Roots of Characteristic Polynomial)

A fundamental requirement for valid Impulse Response and Variance Decomposition analyses is the stability of the estimated model.

Table 5
VECM Stability Test Results

Root	Modulus	Conclusion
1.000000 (Imposed unit roots)	1	As Specified
0.769269 ± 0.405290i	0.869503	Stable (< 1)

0.415638 ± 0.752839i	0.859954	Stable (< 1)
-0.761427 ± 0.223183i	0.793461	Stable (< 1)

Since all modulus values excluding the mathematically imposed unit roots fall strictly below 1, ranging from 0.79 to 0.87, the VECM is deemed stable and robust for dynamic multiplier forecasting, satisfying the prerequisite for reliable IRF and FEVD analyses.

6. VEC Granger Causality Test

To trace the directional flow of influence in the short run, the Granger Causality test was applied within the VECM framework.

Table 6
Summary of Granger Causality Test (Significant paths only)

Direction of Causality	Chi-sq Value	Prob.	Conclusion
D(FDR) → D(ASSET)	9.8641	0.0198**	Unidirectional
D(VTD) ↔ D(ASSET)	7.1884 / 11.2722	0.0661* / 0.0103**	Bidirectional
D(USER) → D(FDR)	28.5847	0.0000***	Unidirectional
D(VTD) → D(FDR)	12.6495	0.0055***	Unidirectional
D(ASSET) → D(USER)	20.5973	0.0001***	Unidirectional
D(VTD) → D(USER)	6.6351	0.0845*	Unidirectional
D(CPI) → D(VTD)	7.712	0.0524*	Unidirectional

Source: E-Views Output. (***) α=1%, (**) α=5%, (*) α=10%.

The Granger causality results confirm that H2 is accepted: a reciprocal causal relationship exists between digital acceleration and BMT financial performance indicators. The unidirectional causality from D(USER) toward D(FDR) at the 1% significance level and from D(VTD) toward D(FDR) at the 1% level confirms that digital acceleration variables actively drive BMT intermediation capacity rather than merely correlating with it. The bidirectional relationship between D(VTD) and D(ASSET) is particularly noteworthy, suggesting a mutually reinforcing dynamic wherein growing asset bases enable greater digital transaction capacity, which in turn further stimulates asset accumulation, a self-reinforcing mechanism consistent with endogenous growth logic (Aghion et al., 2001; Jones, 2019). Additionally, the causality from D(ASSET) toward D(USER) indicates that institutional financial growth itself incentivizes further digital adoption, creating a positive feedback loop between institutional scale and digital deepening. Notably, macroeconomic variables exhibit minimal direct causal influence on financial performance, with only CPI(Amaliawiati et al., 2023; Kuswahariani et al., 2020), reinforcing the argument that KSPPS/BMTs exhibit fundamentally different shock transmission mechanisms due to their community-embedded institutional structure (Haerudin et al., 2023).

7. Impulse Respon Function (IRF)

The IRF analysis traces the dynamic responses of ASSET and FDR to one standard deviation Cholesky shocks from each variable over a 24-period horizon, as presented in Figure 1. Several findings warrant detailed discussion.

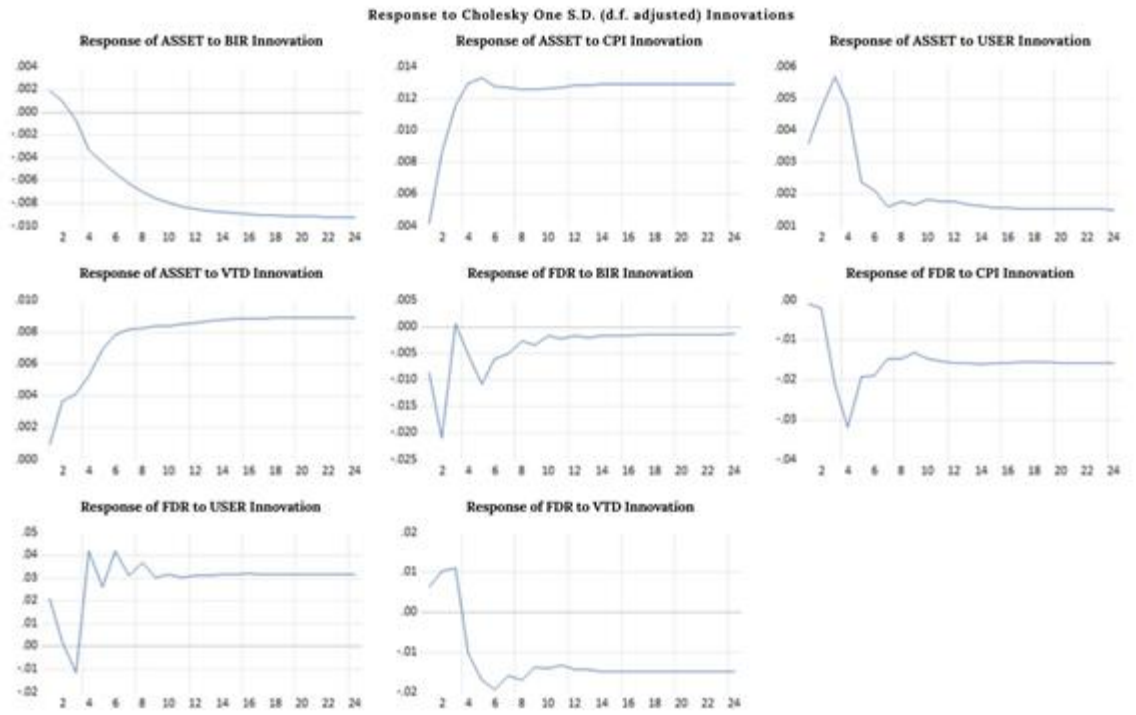

Figure 2
Impulse Response Function

Regarding the response of ASSET, a shock to BI Rate produces an initial marginally positive response that rapidly deteriorates into persistent negative territory, stabilizing at approximately 0.008 from period 10 onward, confirming that monetary policy tightening exerts a sustained dampening effect on BMT asset growth through competitive substitution of deposits toward higher-yielding conventional instruments (Fadila & Pangestuti, 2022; Syaifuddin et al., 2024). In contrast, a shock to CPI generates a counterintuitive yet persistent positive response in ASSET, rising sharply to approximately 0.013 by period 3 and maintaining this level through period 24. Rather than contradicting theory, this finding reflects an observable pattern in the actual institutional data, where BMT UGT Nusantara asset growth remained robust throughout the high-inflation period of 2021 to 2022. This suggests that members may treat sharia cooperative instruments as a hedging vehicle during inflationary episodes, directing savings toward BMT precisely because its profit-sharing instruments are structurally insulated from nominal interest rate distortions that erode real returns on conventional savings (Ascarya & Masrifah, 2022; Widarjono, 2020). A shock to USER produces a sustained positive response stabilizing at approximately 0.002 from period 5 onward, confirming that expanding the digital user base generates a modest but persistent contribution to asset growth. Most strikingly, a shock to VTD produces the most stable and gradually accumulating positive response among all variables, rising from near zero in period 1 to a plateau of approximately 0.008 to 0.009 from period 6 onward and maintaining this level through period 24, suggesting that the depth of digital platform utilization functions as the most reliable and sustained endogenous driver of BMT asset accumulation (Khoiri & Sulistyowati, 2023; Alfitri & Alfiyah, 2025).

Regarding the response of FDR to macroeconomic shocks, both variables produce negative and persistent effects with distinct temporal profiles. A benchmark interest rate shock drives FDR sharply negative to approximately 0.022 by period 3 before partially recovering to stabilize at around 0.004, reflecting a rapid yet moderately persistent compression of intermediation capacity. An inflation shock produces a deeper negative response reaching approximately 0.030 by period 4 before stabilizing at around 0.015, indicating that inflationary pressure inflicts more severe and persistent damage on BMT intermediation efficiency than monetary tightening alone, likely because inflation directly erodes borrower repayment capacity among the micro-segment clientele that BMTs predominantly serve (Nasution & Fakhri, 2024; Fakhrunnas et al., 2022). This contrast confirms that while both macroeconomic variables constrain intermediation efficiency, inflation operates as the more structurally damaging force over time.

Regarding the response of FDR to digital variables, the dynamics are considerably more complex and reveal a fundamental asymmetry between the two digitalization channels. The response of FDR to digital user adoption is the most dynamic in the entire IRF matrix, surging to approximately 0.04 in period 1, temporarily falling into negative territory at period 3, then rebounding strongly to stabilize at approximately 0.03 through period 24. This pronounced overshooting pattern reflects the institutional adjustment process in which rapid user acquisition initially outpaces the capacity to channel member funds into productive financing, creating a transient intermediation bottleneck before the system recalibrates, consistent with the sudden surge in active users observed during July 2020 that was likely driven by pandemic-induced mass digital onboarding (Genberg, 2020; Tiutiunyk et al., 2021). In contrast, the response of FDR to digital transaction volume reveals a contrasting dynamic, where after a brief positive response in period 1, FDR falls into persistent negative territory stabilizing at approximately 0.013. This suggests that high-volume digital transactors predominantly engage in savings and non-financing payment activities, causing fund accumulation to systematically outpace financing disbursement and thereby compressing the intermediation ratio over time. Taken together, these findings confirm that digital user adoption and transaction volume operate through fundamentally distinct institutional channels, where the former drives intermediation breadth while the latter drives asset depth, a distinction with direct implications for digital investment prioritization in Islamic microfinance management (Ascarya et al., 2023; Khoiri & Sulistyowati, 2023). Based on the IRF evidence showing sustained positive responses of both ASSET and FDR to digital acceleration shocks over the 24-period horizon, H3 is accepted: BMT UGT Nusantara's financial performance responds positively to digital acceleration stimulation in both the short and long term, with the caveat that the direction and magnitude of response differ across digitalization channels. To address this structural imbalance, BMT UGT Nusantara is encouraged to develop a broader range of digitally accessible financing products that can convert the growing base of active digital transactors into productive financing participants, thereby realigning fund accumulation with financing disbursement and restoring intermediation efficiency over the long run (Megantara & Priantina, 2020).

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8. Forecast Error Variance Decomposition (FEVD)

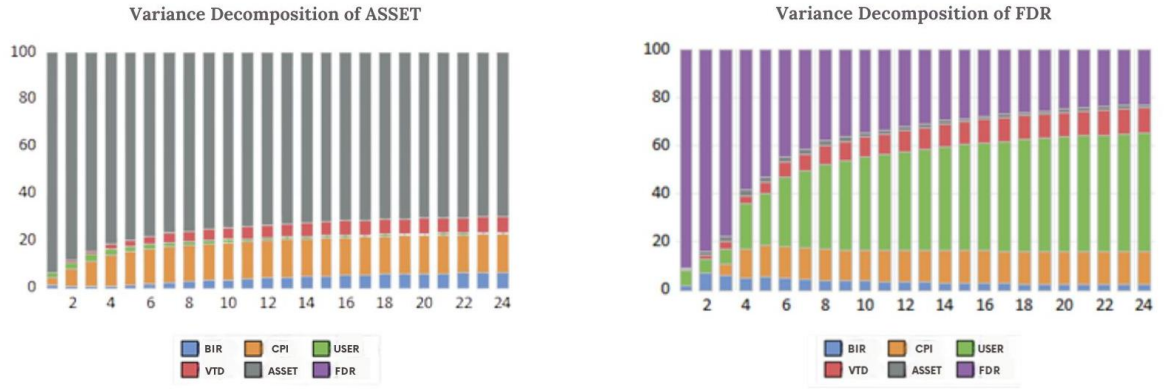

Figure 3
Variance Decomposition

The FEVD analysis quantifies the structural contribution of each variable in explaining financial performance variance over a 24-period horizon, as illustrated in Figure 2. The results provide decisive evidence in support of H4, but with an important nuance that extends beyond a simple confirmation of digital dominance over macroeconomic variables. Specifically, by period 24, digital user adoption (USER) accounts for approximately 45–55% of the forecast error variance in FDR, confirming its dominance over all other variables combined. For ASSET variance, digital transaction volume (VTD) and macroeconomic variables (CPI, BI Rate) each contribute approximately 15–25% by period 24, reflecting a more distributed explanatory structure. Based on these results, H4 is accepted: digitalization variables collectively explain a larger share of BMT financial performance variation than macroeconomic variables, though the dominance is asymmetric across performance dimensions.

For total asset variance, the graphical trajectory reveals that macroeconomic variables, particularly inflation and benchmark interest rate, grow in explanatory importance consistently over the full horizon alongside digital transaction volume. This pattern indicates that asset accumulation is jointly shaped by both external macroeconomic dynamics and internal digital transaction depth rather than being driven by a single dominant force. The persistent and growing contribution of inflation to asset variance is consistent with the IRF finding that inflationary shocks generate a positive and sustained response in total assets, reinforcing the interpretation that members treat sharia cooperative instruments as an inflation hedging vehicle during periods of monetary instability (Ascarya & Masrifah, 2022; Widarjono, 2020). The meaningful contribution of benchmark interest rate to asset variance further reflects the competitive substitution mechanism documented in prior literature, whereby monetary policy tightening creates shifts in the funding base of Islamic microfinance institutions (Fadila & Pangestuti, 2022; Syaifuddin et al., 2024). Digital user adoption contributes only modestly to asset variance throughout the horizon, suggesting that the mere expansion of the user base does not translate directly into asset growth without the accompanying deepening of transaction activity, a finding that underscores the importance of platform engagement depth over acquisition breadth for asset-building strategies (Khoiri & Sulistyowati, 2023).

The picture is strikingly different for intermediation efficiency variance. Digital user adoption emerges as the overwhelmingly dominant explanatory variable, with its contribution growing dramatically and persistently across the entire 24-period horizon, approaching dominance over all other variables combined by period 24. This finding is consistent with the Granger causality result confirming strong unidirectional causality from digital user adoption toward intermediation efficiency, and reinforces the theoretical premise of Endogenous Growth Theory that the deliberate accumulation of digital adoption capital generates self-sustaining improvements in institutional productive capacity (Romer, 1990; Aghion & Howitt, 1992). Intermediation efficiency becomes increasingly determined by digital user adoption over time rather than by its own momentum, while inflation maintains a stable but secondary role as a macroeconomic constraint on intermediation capacity, consistent with prior evidence that inflationary pressure erodes borrower repayment capacity and compresses financing quality among micro-segment clientele (Nasution & Fakhri, 2024; Fakhrunnas et al., 2022).

Taken together, these findings reveal a fundamental asymmetry in how digitalization affects different dimensions of BMT financial performance. Macroeconomic variables and digital transaction volume jointly drive asset accumulation, while digital user adoption overwhelmingly dominates intermediation efficiency dynamics. This asymmetry confirms that breadth and depth of digitalization are not interchangeable strategic levers but operate through fundamentally distinct institutional channels, a finding that has not been previously documented in the BMT literature and that carries direct implications for how management should prioritize and allocate digital transformation investment (Ascarya et al., 2023; Setyowati, 2019).

CONCLUSION

This study demonstrates that digitalization and macroeconomic variables are jointly bound to the financial performance of BMT UGT Nusantara in a long-run equilibrium system, confirming the theoretical premise of Endogenous Growth Theory. Digitalization emerges as the dominant endogenous driver of institutional performance, where digital user adoption strongly and persistently drives intermediation efficiency while digital transaction volume constitutes the most reliable driver of asset accumulation. Macroeconomic variables, particularly inflation, exert meaningful but secondary effects, posing a more persistent threat to intermediation efficiency than interest rate movements. A fundamental asymmetry is identified in that breadth and depth of digitalization operate through distinct institutional channels, a finding that has not been previously documented in the BMT literature.

These findings carry direct implications for BMT management and Islamic microfinance policy. Institutions seeking to improve intermediation efficiency should prioritize expanding the active digital user base, while those targeting asset growth should focus on deepening transaction volume engagement. Given that high-volume digital transactors are found to predominantly engage in savings and payment activities rather than financing, BMT UGT Nusantara is encouraged to develop a broader range of digitally accessible financing products that can convert active digital transactors into productive financing participants, thereby realigning fund accumulation with financing disbursement and restoring intermediation efficiency over the long run. For regulators, the empirical dominance of endogenous digital capital over macroeconomic variables provides strong

justification for policies that actively facilitate digital transformation across Islamic microfinance cooperatives. Future research should extend this framework to a broader panel of BMT institutions to assess whether these asymmetric channel effects reflect a structural pattern in Islamic microfinance intermediation more broadly.

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