



Digital finance and pawnshop lending growth: Evidence from Indonesia

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ABSTRACT

Background: This study is situated within the rapid expansion of digital finance that has reshaped financial intermediation in emerging economies, while empirical attention has remained disproportionately focused on banks and fintech firms rather than collateral-based intermediaries. Prior literature emphasizes that digitalization reduces information frictions and transaction costs, yet evidence on how digital finance transforms pawnshop lending as an alternative credit channel remains limited. This study aims to examine the role of digital finance in driving pawnshop financing growth and to assess whether its impact varies across institutional types and financing distributions. **Methods:** The study adopts a quantitative empirical approach using monthly cluster-level data on pawnshops in Indonesia over an extended period. The analysis applies Robust Ordinary Least Squares to estimate average effects and Quantile Regression to capture heterogeneity across the financing distribution, with controls for customer scale, leverage structure, capital composition, and macro-financial conditions. **Findings:** The results indicate that greater digital finance intensity is associated with a statistically significant expansion of pawnshop financing, with stronger effects observed in government and conventional private pawnshops compared to sharia private pawnshops. Distributional estimates show that the positive effect of digitalization is most pronounced at low to medium financing levels, suggesting that digital finance primarily alleviates binding access constraints rather than amplifying already high lending volumes. **Conclusion:** Overall, the study demonstrates that digital finance complements rather than replaces collateral-based financial institutions by strengthening their intermediation capacity and expanding inclusive access to liquidity. The findings highlight digitalization as a structural mechanism supporting the resilience and evolution of traditional nonbank credit institutions in developing financial systems. **Novelty/Originality of this article:** This article provides original evidence on digital adaptation within pawnshop networks by integrating digital finance indicators into collateral-based lending models and employing a distributional econometric approach to reveal heterogeneous effects across institutional contexts.

KEYWORDS: digital finance; financial constraints; financial inclusion; Indonesia; pawnshop financing.

1. Introduction

The proliferation of digital finance has revolutionized the global financial landscape, fostering unprecedented opportunities for service expansion (Brika, 2022; Khaustova et al., 2024; Ozili, 2021; Qinyuan, 2023). The integration of digital technology into traditional financial services has significantly reduced intermediation costs while catalyzing high-quality economic development (Zhang, 2022). This phenomenon transcends mere theoretical discourse, it represents a critical urgency, particularly as Southeast Asian fintech

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investment reached a record USD 3.5 billion in 2020 (Wu & Kao, 2022). Expanded financial access via digital channels remains a cornerstone for institutional resilience and economic recovery amidst global volatility (Yao, 2023). Consequently, this transformation permeates all economic sectors, fundamentally reconfiguring consumption mechanisms and financial service delivery to previously underserved segments (Khaustova et al., 2024).

Financial Constraint Theory serves as the primary framework for understanding funding access, elucidating the liquidity barriers faced by economic agents (Khan et al., 2024; Santos & Cincera, 2022; Shyla Marie Abairo Cruzado et al., 2023). This theory posits that information asymmetries and prohibitive transaction costs frequently impede households and small enterprises from entering formal credit markets (Sanga & Aziakpono, 2024). Historically, pawnshops have functioned as stabilizing institutions, providing asset-backed liquidity to those grappling with systemic financial constraints (Cui et al., 2025). Theoretical expectations suggest that, under ideal conditions, financial market efficiency should mitigate capital access barriers through transparent collateralization mechanisms (Antinolfi et al., 2022; Ji & Cai, 2025; Nabilou, 2025). Thus, alternative financial institutions like pawnshops represent a concrete response to credit rationing imposed by conventional banking (Fu & Mishra, 2022).

Literature suggests that digital finance enhances financial inclusion by alleviating information frictions and reducing effective transaction costs (Fei et al., 2024; Sanga & Aziakpono, 2024). While studies document that fintech diffusion improves capital availability for SMEs through alternative financing channels (Liu et al., 2025; Najib et al., 2021), prior research focuses predominantly on the competition between banks and fintech firms. Consequently, a fundamental knowledge gap exists regarding digital adaptation within pawnshop networks and the interaction between platform-based financing and asset-backed credit (Broussard, 2025). This study strategically argue that omitting digital penetration variables from pawnshop growth models constitutes a critical limitation. Without addressing this void, the understanding of credit market structures in emerging economies remains speculative and incomplete.

This study aims to analyze the role of digital finance in driving the growth of pawnshop lending as part of the transformation of the financial market structure in developing countries. Two research questions guide this inquiry: first, to what extent does digital finance intensity shape pawnshop lending growth across institutional types? Second, does this effect vary across the financing distribution, and if so, at which quantiles is it most pronounced? Conceptually, this study departs from the financial constraint theory that emphasizes the role of information friction and transaction costs in limiting access to financing for households and micro, small, and medium enterprises, which in practice is partly responded to by collateral-based financial institutions such as pawnshops (Cui et al., 2025; Sanga & Aziakpono, 2024).

This study employs a robust empirical strategy utilizing Robust Ordinary Least Squares (OLS) and Quantile Regression to examine the impact of digital finance on pawnshop lending growth. The data cover 282 monthly cluster-level observations from August 2017 to May 2025. The following results draw on this period of Indonesia's digital expansion, representing. This primary study results indicate that digital finance is positively associated with pawnshop lending growth, consistent with the view that digital channels expand the operational reach of collateral-based intermediaries (Cui et al., 2025). These results show that digitalization is associated with operational efficiency gains and broader market penetration across income distributions. The evidence is consistent with a gradual convergence of digital finance and collateral-based intermediation, rather than the displacement of traditional institutions by fintech competitors.

This study identified transmission mechanisms confirm that digital finance mitigates financing constraints and reduces agency costs through improved governance (Yu et al., 2024). The adoption of digital platforms is also associated with improved risk profiling and faster collateral processing (Fu & Mishra, 2022). This study provides systematic empirical evidence on digitalization as a factor associated with collateral-based financing growth in underserved markets. By situating digital finance within localized pawnshop ecosystems,

extend the boundaries of existing knowledge (Broussard, 2025). This study maintains estimation robustness through heteroscedasticity-consistent standard errors, examining whether observed associations between digital finance and pawnshop lending are consistent across specifications. The results contribute to understanding how digital finance can reinforce, rather than replace, established collateral-based financial institutions.

This study makes a theoretical contribution by expanding the Financial Constraint Theory through the integration of the role of digital finance in explaining credit growth in collateral-based financial institutions, particularly pawnshops, which have been relatively marginalized in empirical studies. Conceptually, this study confirms that digitalization functions as a mechanism to strengthen traditional financial institutions by reducing information friction and transaction costs, rather than replacing existing financing structures. Empirically, this study enriches the literature by presenting systematic evidence on the interaction between digital platform-based financing and collateral-based credit in the context of developing countries. Practically, the findings of this study provide an analytical basis for formulating policies that encourage digital financial integration to expand inclusive financing access while maintaining the stability of the local financial system. In addition, the results of this study serve as a strategic reference for pawnshop managers and financial technology players in optimizing the use of digital technology to improve operational efficiency and credit service coverage.

2. Methods

2.1 Data and samples

This study explores the population of pawnshops in Indonesia by systematically classifying entities based on their ownership characteristics and operating principles. The temporal scope of the study spans longitudinally using monthly data from August 2017 to May 2025 to ensure the sensitivity of the analysis to market fluctuations. The researchers extracted financial data from official publications of the Financial Services Authority. The sample composition integrated government pawnshops, conventional private entities, and private sharia service providers. The data selection procedure resulted in a total of 282 observations that met the inclusion criteria to support the validity of parameter estimates in econometric testing.

2.2 Operationalization of research variables

The operationalization of research variables is systematically designed to ensure conceptual clarity, empirical validity, and consistency with established financial economics literature, as summarized in Table 1. Financing and Loans (FINLOANS) is specified as the natural logarithm of total pawnshop financing disbursements, while Digital Finance (DIGFIN) is constructed as a composite index derived from correlation-based principal component analysis capturing multidimensional digital financial adoption. Control variables incorporate both firm-cluster characteristics namely customer scale, leverage structure, and capital composition and macro-financial conditions through banking sector profitability. This structured measurement framework allows the empirical model to isolate the effect of digital finance on pawnshop lending activity while adequately controlling for institutional, financial, and systemic influences, as detailed in Table 1.

Table 1. Operationalization of research variables

Variable	Operationalization
Dependent Variable	
Financing and Loans (FINLOANS)	Measured as the natural logarithm of total financing and loans disbursed by pawnshop companies in billion rupiah, constructed at the cluster level by pawnshop company type (Alif et al., 2025; Cornelli et al., 2023).

Independent Variable

Digital Finance (DIGFIN)	The composite digital finance index generated from the first principal component (PCA) using correlation-based principal component analysis (PCA) of the following variables (Almoghayer & Mahmoud, 2025; Kamenga Mapurita & Mayoukou, 2024; Oanh, 2024): • Electronic payments used to make payments (% age 15+) • Mobile phone used to pay bills (% age 15+) • Mobile phone used to send money (% age 15+) • Debit card (% age 15+) • Credit card (% age 15+) • ATMs per 100,000 adults • Credit flows by fintech and bigtech companies to GDP (%)
Control Variable	
Customer (CUSTOMER)	Measured as the natural logarithm of the total number of customers served by pawnshop companies, aggregated at the cluster level according to pawnshop company classification.
Debt-To-Assets Ratio (DAR)	Defined as the debt-to-assets ratio, calculated by dividing total liabilities by total assets of pawnshop companies at the cluster level by company type (Alsaadi, 2025; Chen et al., 2021; Jermias & Yigit, 2019).
Debt-To-Equity Ratio (DER)	Defined as the debt-to-equity ratio, calculated by dividing total liabilities by total equity of pawnshop companies, measured at the cluster level by pawnshop company type.
Banking Sector Return-on-Assets (BANK ROA)	Measured as the banking sector return on assets, representing after-tax profitability of banks at the national level, used as a macro-financial control variable.

2.3 Econometric model and estimation procedure

This study estimates the effect of digital finance on the growth of financing and pawnshop lending by setting the dependent variable *FINLOANS* as the natural logarithm of total financing and lending in billions of rupiah, constructed at the cluster level based on the type of pawnshop company. *DIGFIN* is measured as a composite index extracted from the first principal component through correlation-based PCA of seven indicators: electronic payment usage, mobile phone payment and money transfer activity, debit and credit card ownership, ATM density per 100,000 adults, and the share of fintech and bigtech credit in GDP. The first principal component was retained on the eigenvalue-greater-than-one criterion and explains the preponderance of total variance across all seven indicators, with positive factor loadings confirming that *DIGFIN* captures a coherent, unidimensional dimension of digital financial ecosystem intensity. The resulting index is standardized to enable cross-temporal and cross-cluster comparison. This study formulates the main estimation equation in the form of linear regression as follows Equation 1.

$$FINLOANS_{i,d} = \beta_0 + \beta_1 DIGFIN_{i,d} + \beta_2 \varphi_{i,d} + \epsilon \quad (\text{Eq.1})$$

The model above also includes a control variable ($\varphi_{i,d}$), such as Customer (CUSTOMER), Debt-To-Assets Ratio (DAR), Debt-To-Equity Ratio (DER), and Banking Sector Return-on-Assets (BANK ROA). This study estimates the basic model using OLS with robust standard errors to reduce inference bias due to heteroscedasticity and to obtain reliable conditional mean estimates on clustered data. Furthermore, this study uses quantile regression to test whether the effect of *DIGFIN* on *FINLOANS* is heterogeneous across different quantiles of the financing distribution, so that the analysis focuses not only on the average effect but also on the dynamics of the response of low to high financing clusters. To ensure the stability of the coefficient estimates, this study tests for multicollinearity using the variance inflation factor and interprets a VIF criterion of less than 10 as an indication

that the linear correlation between explanatory variables is not strong enough to materially inflate the variance of the estimator, so that the model maintains inferential accuracy and consistency of parameter interpretation. A relevant methodological concern is potential endogeneity, as regions with higher fintech penetration may also exhibit structurally larger pawnshop activity due to common underlying demand factors. While the observational design does not permit full causal identification through instruments or quasi-experimental variation, several features of the estimation mitigate this concern: DIGFIN is constructed from national-level indicators unlikely to be driven by individual cluster performance, heteroscedasticity-consistent standard errors are applied, and a broad set of institutional and macro-financial controls is included. Results should therefore be interpreted as conditional associations rather than causal estimates, pending future research using micro-level data and credible identification strategies.

3. Results and Discussion

3.1 Descriptive statistics and correlation coefficient

Descriptive statistics in Table 2 show that all variables were analyzed in 282 observations. The dependent variable FINLOANS has an average value of 6.471 with a minimum value of 0 and a maximum value of 10.986, indicating heterogeneity in the intensity of financing and lending between clusters during the observation period. The independent variable DIGFIN has an average value of 0.045 with a standard deviation of 0.902, and a range from -1.612 to 0.712, confirming that the PCA-based composite index captures variations in the level of digital financial ecosystem adoption in a standardized manner across time and clusters. The DIGFIN range, which crosses negative and positive values, reinforces the interpretation that some clusters are below the average intensity of digitization, while others are above the average, making this variation relevant for testing the sensitivity of FINLOANS to differences in digital financial penetration. The combination of a relatively high FINLOANS average with a wide range and substantial DIGFIN variation creates adequate data conditions for testing the influence of digital finance on pawnshop credit growth, both in terms of conditional averages and distributional heterogeneity through quantile estimation.

Table 2. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
FINLOANS	282	6.471	3.878	0	10.986
DIGFIN	282	0.045	0.902	-1.612	0.712
CUSTOMER	282	11.372	5.979	0	16.908
DAR	282	0.697	0.173	0.448	1
DER	282	1.749	0.851	0.811	3.562
BANK ROA	282	1.563	0.253	1.135	1.932

Descriptive statistics in Table 3 show that all DIGFIN indicators have 282 observations, so that the composite index construction based on principal component analysis utilizes consistent variations in each dimension of digital financial adoption. The indicator of electronic payment usage for transactions recorded an average of 28.548 with a range of 26.758 to 29.127, while the use of mobile phones to pay bills and send money had averages of 5.096 and 7.498, respectively, reflecting an increase in the use of digital channels in daily financial activities. In the formal payment instruments dimension, debit card ownership shows an average of 34.051 with a range of 30.811 to 35.101, while credit card ownership is relatively lower with an average of 1.806 and a range of 1.601 to 2.439, indicating the dominance of account-based inclusion over card-based consumer credit. Cash access infrastructure via ATMs per 100,000 adults is relatively stable with an average of 52.415 and a range of 51.66 to 55.141, while the flow of credit by fintech and bigtech companies to GDP has an average of 0.388 with quite a wide variation, so that both the usage side and

supply side indicators contribute to capturing the intensity of the digital financial ecosystem.

Table 3. Descriptive statistics of digital finance (DIGFIN) forming variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Electronic payments used to make payments (% age 15+)	282	28.548	0.769	26.758	29.127
Mobile phone used to pay bills (% age 15+)	282	5.096	0.805	3.223	5.703
Mobile phone used to send money (% age 15+)	282	7.498	1.082	6.683	10.016
Debit card (% age 15+)	282	34.051	1.393	30.811	35.101
Credit card (% age 15+)	282	1.806	0.272	1.601	2.439
ATMs per 100,000 adults	282	52.415	1.188	51.66	55.141
Credit flows by fintech and bigtech companies to GDP (%)	282	0.388	0.115	0.039	0.439

(Demirguc-Kunt et al., 2021)

The paired correlation coefficients in Table 4 provide preliminary evidence of linear relationships between the main variables in the model prior to econometric causal estimation. The FINLOANS variable shows a positive and significant correlation with DIGFIN, indicating that an increase in digital finance intensity correlates with growth in pawnshop financing distribution, in line with the argument that digitization expands the reach and efficiency of financial services. The very strong and significant relationship between FINLOANS and CUSTOMER reflects the dominant role of customer base scale in driving financing expansion, which is conceptually consistent with the transaction volume-based intermediation mechanism. Conversely, DAR has a significant negative correlation with FINLOANS and CUSTOMER, indicating that higher asset-based leverage is associated with limited financing capacity.

The DER variable shows a positive and significant correlation with FINLOANS and CUSTOMER, indicating that an equity-based capital structure is relatively more conducive to financing growth than reliance on asset-based liabilities. DIGFIN also has a negative and significant correlation with DAR, implying that the adoption of digital finance is associated with improvements in balance sheet structure through efficient liability management and reduced financing friction. The strong negative correlation between DIGFIN and BANK ROA indicates an adjustment dynamic between digital financing expansion and aggregate banking sector profitability, which may reflect a partial shift in financing demand to nonbank channels. Meanwhile, the negative but relatively weak relationship between BANK ROA and FINLOANS suggests that pawnshop financing growth does not entirely depend on the profitability of the national banking sector. The correlation between control variables is generally moderate, indicating no extreme linear relationships that could potentially cause serious multicollinearity issues.

Table 4. Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) FINLOANS	1.000					
(2) DIGFIN	0.186*** (0.002)	1.000				
(3) CUSTOMER	0.968*** (0.000)	0.176*** (0.003)	1.000			
(4) DAR	-0.576*** (0.000)	-0.352*** (0.000)	-0.648*** (0.000)	1.000		
(5) DER	0.322*** (0.000)	-0.092 (0.121)	0.459*** (0.000)	0.106* (0.075)	1.000	
(6) BANK ROA	-0.097* (0.104)	-0.736*** (0.000)	-0.084 (0.161)	0.113* (0.059)	0.002 (0.969)	1.000

*** p<0.01, ** p<0.05, * p<0.1

3.2 Multivariate statistical analysis

The results of multicollinearity testing in Table 5 show that all independent variables and control variables have variance inflation factor values well below the critical threshold of 10, so that the linear relationship between explanatory variables does not cause serious distortion in parameter estimation. The CUSTOMER variable recorded the highest VIF value of 3.37, followed by DAR and DIGFIN at 2.97 and 2.64, respectively, indicating a moderate correlation but still within econometric acceptable limits. The relatively lower VIF values for ROA and DER reinforce the indication that the model structure is not dominated by information redundancy between variables. Overall, the average VIF value of 2.66 confirms that the regression model meets the assumption of non-multicollinearity, so that the estimated coefficients can be interpreted stably and consistently in further analysis.

Table 5. Multicollinearity test

Variable	VIF	1/VIF
CUSTOMER	3.37	0.296407
DAR	2.97	0.336366
DIGFIN	2.64	0.378689
ROA	2.33	0.428885
DER	1.97	0.508754
Mean VIF	2.66	

Table 6 presents four regression models for the effect of digital finance on pawnshop financing. Model 1 on the full sample shows that DIGFIN has a positive and significant effect on FINLOANS ($B = 0.2312$, $t = 4.8725$) with a very high adjusted R^2 (0.9929) and a strong F-statistic ($F = 29537.4348$; $p < 0.01$). The high adjusted R^2 values across all models reflect the dominant role of CUSTOMER in explaining cluster-level financing volume, which is a structural feature of the data rather than evidence of overfitting; the covariates capture most of the systematic variation across cluster types and time periods.

Table 6. Regression result

	Model 1	Model 2	Model 3	Model 4
DIGITAL	0.2312*** (4.8725)	0.1418*** (12.7372)	0.4048*** (7.8689)	0.0000 (0.0000)
CUSTOMER	0.8521*** (161.1611)	0.0000 (0.0000)	1.4993*** (7.9202)	-0.2735* (-1.7044)
DAR	7.2841*** (38.9809)	-10.3622** (-2.3765)	-1.9461*** (-2.7479)	-12.5565*** (-4.6458)
DER	-1.4112*** (-32.2793)	1.4128** (2.5260)	-0.3877*** (-6.5881)	0.0000 (0.0000)
BANK ROA	0.2540*** (2.6090)	-0.0700** (-2.1479)	-0.2284 (-1.1624)	0.0000 (0.0000)
Constant	-6.2328*** (-29.4620)	15.0490*** (8.3206)	-10.2524*** (-3.8493)	12.5565*** (4.6458)
N	282	94	94	94
$R^2_{Adjusted}$	0.9929	0.9174	0.9260	0.9993
F_statistics	29537.4348	529.5173	534.2181	31222.43
P-Value	0.0000	0.0000	0.0000	0.0000

The DIGFIN coefficient is thus consistent with the argument that digitization reduces information friction and transaction costs that limit access to financing. In cluster-based estimation, Model 2 for government pawnshops maintains a significant positive influence of DIGFIN ($B = 0.1418$, $t = 12.7372$), while Model 3 for conventional private pawnshops shows a larger and still significant coefficient ($B = 0.4048$, $t = 7.8689$), indicating that the intensification of the digital financial ecosystem is associated with an increase in collateral-based financing, especially in the non-bank segment that is actively adapting to technology. Model 4 for private sharia pawnshops reports zero coefficients and test statistics for

DIGFIN, DER, and BANK ROA, while DAR and CUSTOMER retain non-zero estimates. This outcome reflects a near-collinearity condition within the 94-observation sharia cluster at the OLS level: insufficient independent variation in DIGFIN, DER, and BANK ROA relative to DAR prevents reliable separate coefficient identification in this specification. This is distinct from a genuine zero effect, and the quantile regression results in Table 9 recover statistically significant, positive DIGFIN effects for the sharia segment across all quantiles, providing more informative estimates for this cluster. Substantively, the consistency of DIGFIN significance in Models 1 to 3 reinforces the financial constraint mechanism that digital platforms expand the reach of financing and increase the efficiency of fund distribution in collateral-based institutions, especially when households and businesses face liquidity constraints and limited access to formal credit.

The quantile regression results in Table 7 show that the effect of digital finance on FINLOANS is not homogeneous across the financing distribution, because the DIGITAL coefficient is significant and relatively strong in the lower to middle quantiles, namely Q0.15 ($B = 0.2900$; $t = 2.6145$), Q0.35 ($B = 0.1544$; $t = 5.0665$), and Q0.45 ($B = 0.1468$; $t = 3.5525$), but weakens and becomes insignificant at higher quantiles up to Q0.85. This pattern indicates that digitization primarily strengthens financing growth in pawnshop clusters with low to medium distribution levels, making the mechanism of reducing information friction and transaction costs more relevant in segments that initially faced access constraints and limited service coverage.

Table 7. Regression result for full sample quantile regression — all pawnshops

	DIGITAL	CUSTOMER	DAR	DER	BANK ROA	Constant
Model 1	0.2900***	0.8770**	7.6554***	-1.6880***	-0.4890**	-5.4533***
Q=0.15	(2.6145)	(143.7384)	(38.9861)	(-39.4859)	(-2.4932)	(-24.7849)
Model 2	0.0971	0.8732***	7.5541***	-1.6139***	-0.1638	-5.7680***
Q=0.25	(1.2580)	(139.5335)	(46.7344)	(-28.5088)	(-0.8922)	(-20.2794)
Model 3	0.1544***	0.8706**	7.7498***	-1.5874***	0.1524	-6.3571***
Q=0.35	(5.0665)	(176.7155)	(48.4296)	(-37.5110)	(1.5285)	(-29.5177)
Model 4	0.1468***	0.8642***	7.5524***	-1.5166***	0.1449	-6.2208***
Q=0.45	(3.5525)	(157.8737)	(38.2867)	(-34.0326)	(1.2368)	(-24.6743)
Model 5	0.0370	0.8595**	7.0588***	-1.4744***	0.0365	-5.6310***
Q=0.55	(0.5601)	(125.4711)	(26.1431)	(-22.2653)	(0.3185)	(-21.6609)
Model 6	0.0000	0.8513**	6.7691***	-1.3688***	-0.0000	-5.4003***
Q=0.65	(0.0000)	(127.7515)	(48.9965)	(-15.9268)	(-0.0000)	(-51.8422)
Model 7	-0.0000	0.8428**	6.5505***	-1.2435***	-0.0000	-5.3070***
Q=0.75	(-0.0000)	(110.6303)	(52.1392)	(-19.0695)	(-0.0000)	(-51.4777)
Model 8	0.0529	0.8471**	6.7004***	-1.2468***	0.1240	-5.6018***
Q=0.85	(0.9838)	(94.7867)	(22.5763)	(-36.9391)	(1.0828)	(-14.3823)

The quantile regression results in Table 8 show that the DIGITAL variable has a positive and significant effect on FINLOANS across all quantiles from Q0.15 to Q0.85, with a relatively stable coefficient, indicating that digitization appears to consistently increase the distribution of conventional private pawnshop financing across the entire financing output distribution. The quantile regression results in Table 9 show that the DIGITAL variable has a positive and significant effect on FINLOANS across all quantiles Q0.15 to Q0.85 with stable coefficients in the range of 0.3401 to 0.4696. thus digitalization consistently strengthens the growth of private sharia pawnshop financing across the entire spectrum of credit distribution, in line with the view that digital channels increase service coverage and reduce information friction that limits access to financing.

Table 8. Regression result for conventional private pawnshops

	DIGITAL	CUSTOMER	DAR	DER	BANK ROA	Constant
Model 1	0.1303***	0.0000	-22.5408***	3.1221***	-0.0602	19.7218***
Q=0.15	(8.5627)	(0.000)	(-3.1590)	(3.4296)	(-1.0776)	(6.6447)
Model 2	0.1370***	0.0000	-23.0983***	3.1298***	-0.0577	20.0728***
Q=0.25	(8.7995)	(0.000)	(-5.7329)	(6.1791)	(-1.0991)	(11.8849)

Model 3	0.1352***	0.0000	-15.7172**	2.1510**	-0.0919*	17.1729***
Q=0.35	(5.8187)	(0.000)	(-2.3713)	(2.5010)	(-1.8705)	(6.2864)
Model 4	0.1319***	0.0000	-11.9907***	1.6574***	-0.0972***	15.6916***
Q=0.45	(7.3905)	(0.000)	(-2.6588)	(2.8550)	(-3.8110)	(8.3759)
Model 5	0.1416***	0.0000	-12.6567***	1.6471***	-0.0811***	16.1310***
Q=0.55	(10.5611)	(0.000)	(-3.8162)	(3.8551)	(-2.7968)	(11.5487)
Model 6	0.1486***	0.0000	-9.2590	1.1853	-0.0646	14.7662***
Q=0.65	(8.2419)	(0.000)	(-1.3869)	(1.3935)	(-1.0365)	(5.2310)
Model 7	0.1424***	0.0000	-7.7245	0.9888	-0.0934**	14.1848***
Q=0.75	(10.9233)	(0.000)	(-1.2483)	(1.2485)	(-2.0471)	(5.5411)
Model 8	0.1507***	0.0000	2.7969	-0.3580	-0.0809	9.8531
Q=0.85	(4.5236)	(0.000)	(0.1706)	(-0.1706)	(-1.0553)	(1.4424)

The regression results show that the CUSTOMER variable acts as a controller of the scale of operations because its coefficient is generally positive and significant in the full sample and in the quantile estimates in almost all segments, so that an increase in the customer base is strongly correlated with an increase in financing disbursed. This pattern is consistent with the logic of financing constraints that place intermediation capacity and service coverage as the main determinants of credit output for collateral-based financial institutions. The DER variable captures the role of liability-based funding structures on assets that tend to be contextual, as its coefficient can be positive and significant in certain models and quantiles, but also negative and significant in some cluster specifications, so that asset-based leverage can increase credit expansion when managed efficiently but can also limit distribution when it worsens balance sheet risk. The DER variable shows the role of capital discipline, which is relatively more consistent because its coefficient is often negative and significant in many specifications, so that an increase in liabilities relative to equity correlates with a decline in financing distribution through solvency pressure and funding costs. In quantile estimates, the consistency of the negative sign of DER across various quantiles indicates that the sensitivity of financing to capital resilience occurs not only at the conditional mean but also across low to high disbursement clusters, suggesting that capital structure affects credit output across the distribution.

Table 9. Regression result for sharia private pawnshops (n = 94)

	DIGITAL	CUSTOMER	DAR	DER	BANK ROA	Constant
Model 1	0.4696***	2.2917**	-4.0100*	-0.1395	-0.3259	-19.9071
Q=0.15	(4.2531)	(2.5364)	(-1.9589)	(-0.7815)	(-0.9337)	(-1.6251)
Model 2	0.3401***	2.2111***	-0.8443	-0.4270***	-0.0440	-20.5915***
Q=0.25	(3.8045)	(4.3600)	(-0.4873)	(-3.1076)	(-0.1188)	(-3.0182)
Model 3	0.3596***	1.9866***	-0.0050	-0.5064***	0.1793	-18.3449***
Q=0.35	(3.6842)	(4.4948)	(-0.0045)	(-6.5063)	(0.4825)	(-3.3147)
Model 4	0.4178***	1.4316***	-0.8678	-0.5312***	0.0813	-10.2466**
Q=0.45	(4.8998)	(3.9117)	(-0.7180)	(-6.9498)	(0.2242)	(-2.1228)
Model 5	0.3617***	1.2561***	-1.1205	-0.4810***	-0.3496	-7.1781*
Q=0.55	(3.8566)	(4.9698)	(-1.1422)	(-6.3312)	(-0.8381)	(-1.9871)
Model 6	0.4180***	1.1012***	-1.2796	-0.4345***	-0.1524	-5.4363**
Q=0.65	(5.7165)	(5.7063)	(-1.3832)	(-6.5271)	(-0.4223)	(-2.0037)
Model 7	0.3574***	1.1740***	-1.0571	-0.4632***	-0.3238	-6.1375*
Q=0.75	(5.9804)	(5.4084)	(-0.8696)	(-6.3393)	(-1.0800)	(-1.8951)
Model 8	0.3725***	0.9717***	-1.0426	-0.4477***	-0.3792	-3.4268
Q=0.85	(5.5377)	(2.9916)	(-1.1020)	(-6.1873)	(-1.4372)	(-0.7629)

3.3 Discussion

The results show that digital finance intensity is positively associated with pawnshop financing growth, consistent with the theoretical prediction that digitalization reduces information frictions and transaction costs in collateral-based credit markets. Given the observational design, these associations should not be interpreted as strictly causal without

further identification using instruments or quasi-experimental variation. That said, the direction and significance of DIGFIN are robust across multiple specifications and quantile levels, which strengthens the credibility of the findings as conditional associations. This is consistent with the literature that positions digitization as a key mechanism for reducing financial constraints, as financial technology adoption improves information search, debtor verification, and risk assessment processes (Fei et al., 2024; Sanga & Aziakpono, 2024). Previous studies also show that digital channels play a significant role in expanding nonbank institutions' credit to segments not served by formal banking, thereby strengthening the alternative intermediation function in the financial system (Liu et al., 2025; Najib et al., 2021). Thus, these results reinforce the prediction of Financial Constraint Theory which states that a reduction in information and transaction barriers will systematically increase the volume of financing distribution (Khan et al., 2024; Santos & Cincera, 2022; Shyla Marie Abairo Cruzado et al., 2023). Digitalization enables pawnshops to process debtor information more quickly and accurately, which ultimately expands the reach of services and speeds up financing decisions.

The magnitude of the estimated effect deserves attention because a one standard deviation increase in the digital finance index corresponds to a measurable expansion of cluster level financing. This transmission operates through two complementary channels. On the demand side, borrowers who already use electronic payments and mobile money face lower search costs when locating collateral based credit. Familiarity with digital transactions also lowers the psychological barrier to approaching formal intermediaries because households accustomed to mobile payment interfaces perceive application procedures as less burdensome than branch based processes. On the supply side, digital records of transaction histories allow pawnshops to price collateral more accurately and to shorten appraisal cycles, which lowers the effective cost of each loan contract. Shorter cycles compress the interval between asset submission and fund disbursement, a feature that matters most for borrowers seeking emergency liquidity. The two channels reinforce each other because faster appraisal raises borrower willingness to pledge assets while broader digital participation enlarges the pool of appraisable clients. Repeated interaction then deepens institutional knowledge of borrower behavior and compounds the initial efficiency gain over time.

Cluster-based analysis shows that the impact of digital finance is not homogeneous across all types of pawnshops, which is in line with the literature on the role of organizational incentives and institutional flexibility in technology adoption. In government pawnshops, digitization primarily strengthens public service functions by expanding financial inclusion and reaching community groups that previously faced geographical and administrative barriers, as also found by Cui et al. (2025). Conversely, in conventional private pawnshops, the influence of digitization appears stronger, as competitive pressures in market-oriented institutions create stronger incentives for technology adoption — consistent with evidence on fintech-driven efficiency gains in private financial intermediaries (see Fu & Mishra, 2022 (2023) regarding institutional responses to market dynamics. This difference confirms that the effectiveness of digital technology is highly dependent on the underlying institutional structure, organizational objectives, and governance framework. Sharia private pawnshops present a distinct case because contractual restrictions embedded in collateral based sharia financing shape the way technology is absorbed into operations. Digital onboarding must remain compatible with sharia compliance screening so adoption concentrates on distribution and customer service functions rather than on product redesign. The quantile estimates for this segment nonetheless show positive and stable coefficients on the digital finance index, which indicates that compliance constraints slow the form of adoption without blocking its financing effect. Thus, digital finance functions as a lever whose impact is mediated by the institutional context, rather than as a factor that works uniformly.

The distributional approach through quantile regression shows that the impact of digitization is most pronounced in pawnshop groups with low to medium levels of financing distribution, indicating the key role of digital finance as an instrument of financial inclusion.

This pattern is consistent with the literature emphasizing that the greatest benefits of technology arise in segments that were previously most constrained by access and information limitations (Sanga & Aziakpono, 2024; Yao, 2023). At higher financing levels, the marginal benefits of digitization tend to weaken because institutions have achieved a relatively efficient operational scale, which is in line with the argument regarding diminishing marginal returns from technology adoption in established organizations. However, in private pawnshops, both conventional and sharia, digitization consistently strengthens financing across the distribution spectrum, indicating that digital technology functions as a general technology that improves operational efficiency and market penetration regardless of the initial scale of financing. This distributional asymmetry carries a direct policy implication. Regulators seeking to widen credit access gain more from raising digital penetration among small and underserved clusters than from subsidizing technology in segments that already operate near scale efficiency. Interoperable payment systems and shared credit information infrastructure therefore function as public inputs whose returns concentrate at the lower tail of the financing distribution. Account ownership without active credit use remains common in Indonesia so digital rails shorten the step from payment participation to collateralized borrowing for households at the margin of formal finance. This evidence challenges the narrative of total fintech disruption to traditional institutions and supports the view that digital finance is complementary, as emphasized by Broussard (2025), Antinolfi et al. (2022), and Ji & Cai (2025), who show that digital technology improves collateralization mechanisms without eliminating the role of old financial institutions.

The role of customer scale and balance sheet structure further emphasizes that digitization acts as a catalyst, rather than a substitute, for traditional intermediation foundations. Digital finance accelerates customer acquisition and service by reducing search, verification, and coordination costs, enabling institutions to increase their financing capacity without a commensurate expansion of physical infrastructure. However, these benefits are highly influenced by fundamental financial conditions, as a more balanced funding structure provides greater flexibility in exploiting digital opportunities, while high dependence on asset-based liabilities can limit the scope for expansion. The macro financial control adds a further layer of interpretation. The weak and unstable coefficient on banking sector profitability suggests that pawnshop financing does not simply absorb demand released by bank contraction. The growth documented here therefore reflects genuine market deepening rather than substitution between intermediation channels because expansion in collateral based lending proceeds largely independent of cyclical movements in bank earnings. Firm level data in future work could separate these two margins more directly. Overall, these findings expand the theoretical contribution of Financial Constraint Theory by showing that digitization not only reduces information friction but also strengthens collateral-based institutions as important actors in the digital financial ecosystem. Rather than being disrupted, pawnshops are transforming and converging with technology, filling a gap in the literature that has traditionally emphasized the competitive relationship between banks and fintech, and confirming that the dynamics of digital finance in developing countries are contextual and institutional.

4. Conclusions

This study demonstrates that digital finance intensity is positively associated with pawnshop financing capacity, operating through expanded service reach and improved efficiency of collateral-based intermediation. The empirical evidence supports the central theoretical proposition of this study and offers an account of how traditional financial institutions can adapt alongside technological change. Cluster-based and distributional analysis confirms that the impact of digitization is not uniform but mediated by institutional context and operational characteristics, meaning that the effectiveness of digital transformation depends on the governance structure and incentive environment of the adopting institution.

This finding expands the theoretical basis of financing constraints by positioning digitization as a mechanism that improves the quality of information matching and coordination without negating the role of collateral as the main discipline in credit distribution. Conceptually, this study closes the gap in the literature, which has tended to emphasize the competitive relationship between banking and financial technology, by demonstrating the process of convergence between digital technology and collateral-based financing institutions. From a policy perspective, the results of this study provide a pragmatic basis for designing the integration of digital financial services that are oriented towards the expansion of inclusive financing in a measurable manner and in line with the stability of the local financial system. The main limitation of this study lies in the use of data that is still at the cluster aggregate level and has not reached the company or micro data level, so that external validity to capture the dynamics of individual institutional behavior requires caution. Further research needs to develop a micro data structure and a more sophisticated identification design in order to deepen the causal understanding of the role of digitalization in the evolution of financing institutions and the efficiency of economic resource allocation.

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