Academy for Global Science and Innovation (AGSI)

ARTICLE

Digital Collection Formalization and Financial Performance of Indian Listed Firms Under Receivable Transparency and Liquidity Shocks

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Abstract

Indian operating firms frequently sell through credit relationships in which billing, collection, settlement, tax reconciliation, and receivable monitoring do not move at the same speed. This study examines whether digital collection formalization improves financial performance by reducing receivable frictions. Digital collection formalization refers to the integration of electronic invoicing, bank-linked settlement, customer payment portals, automated receivable aging, tax-document matching, and collection escalation routines. Using an unbalanced panel of 612 nonfinancial Indian listed firms from 2016 to 2024, the study estimates fixed-effects models, dynamic panel specifications, matched difference-in-differences tests around receivable transparency shocks, quantile regressions, and instrumental-variable models. Financial performance is measured through operating return on assets, operating cash-flow margin, free-cash-flow conversion, earnings persistence, and working-capital downside risk. The results show that digital collection formalization is positively associated with financial performance, mainly through shorter collection cycles and lower doubtful-debt provisions. A one-standard-deviation increase in digital collection formalization predicts a 0.48 percentage-point increase in operating return on assets, a 0.73 percentage-point increase in operating cash-flow margin, and a 4.6-day reduction in days sales outstanding. The performance effect is stronger after receivable transparency shocks and among firms with high domestic business-to-business sales. The effect is weaker among export-intensive firms and firms already operating with low receivable days. The evidence suggests that digital collection formalization improves financial performance in India by converting reported sales into cash more quickly and by reducing uncertainty around receivable realization.

1. Introduction

Financial performance in emerging-market firms is strongly affected by the quality of revenue realization. Sales growth does not necessarily become financial strength when collection is delayed, documentation is fragmented, or customers dispute invoice terms [1]. A firm can report rising revenue and still face strained liquidity if receivables accumulate faster than cash inflows. In India, this issue is particularly relevant because listed operating firms often sell to heterogeneous customers, including large formal buyers, distributors, government-linked entities, small business customers, export intermediaries, and project-based clients. The same firm may therefore operate with different billing cycles, settlement practices, tax-document routines, and collection risks across customer groups.

This paper studies whether digital collection formalization improves financial performance among Indian listed firms. The term digital collection formalization describes the extent to which a firm organizes its revenue collection process through electronic invoices, bank-linked receipts, customer payment interfaces, automated receivable aging, tax-document matching, and digitally recorded collection escalation. The construct differs from broad digital transformation. It is narrower and more directly tied to the cash conversion of sales. A firm may be digitally advanced in production or marketing but still have weak receivable discipline. Conversely, a firm may have modest technological sophistication but strong digital collection systems that improve cash conversion.

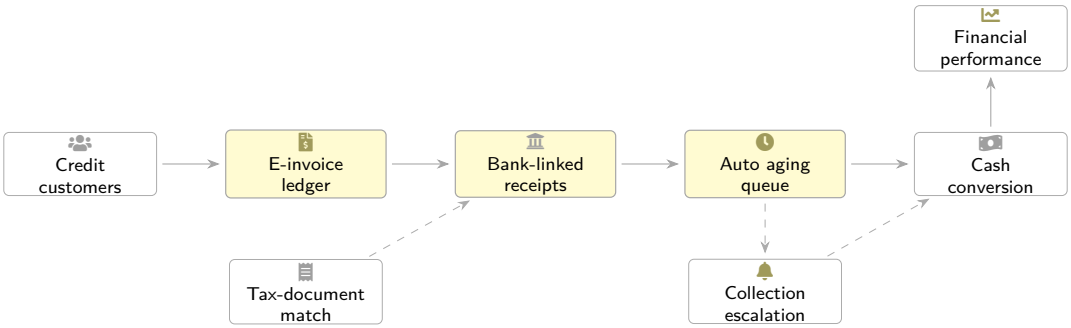


Figure 1. Digital collection formalization converts credit sales into traceable invoices, matched receipts, monitored receivables, and faster cash realization, linking collection infrastructure to firm performance.

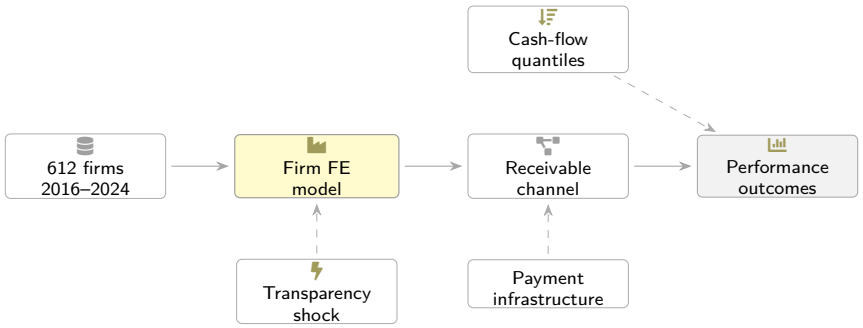


Figure 2. The empirical design combines firm fixed effects, receivable-channel tests, shock-based comparisons, quantile models, and infrastructure-based instruments to evaluate performance effects.

The central argument is that digital collection formalization improves financial performance by reducing the gap between revenue recognition and cash realization. When invoices are standardized and electronically traceable, customers have fewer opportunities to delay payment through documentation disputes. When receipts are linked to bank channels and accounting systems, collection status becomes more visible to finance teams. When receivable aging is automated, overdue accounts can be escalated earlier. When tax-document matching is integrated into billing, the firm can reduce reconciliation delays [2]. These mechanisms should reduce days sales outstanding, lower doubtful-debt provisions, improve operating cash flow, and strengthen profitability.

The empirical setting consists of 612 Indian nonfinancial listed firms observed from fiscal years 2016 through 2024 [3]. The firms are drawn from manufacturing, consumer goods, chemicals,

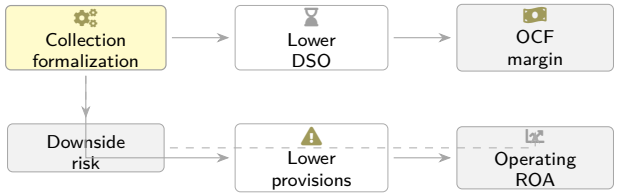


Figure 3. Receivable-cycle acceleration and lower doubtful-debt provisions mediate the link between collection formalization, cash-flow performance, operating profitability, and working-capital downside risk.

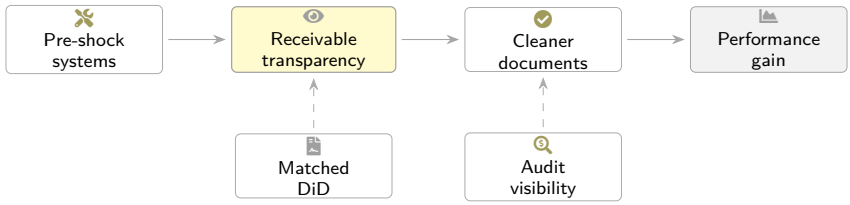


Figure 4. Transparency shocks increase the value of pre-existing collection systems by making invoice matching, documentation quality, and payment traceability more consequential for performance.

pharmaceuticals, capital goods, auto components, business services, logistics, building materials, technology services, and durable goods. Banks, nonbank financial companies, insurance firms, utilities, and firms with regulated tariff recovery are excluded because their receivables, capital structures, and performance metrics follow different rules. The final unbalanced panel includes 5,268 firm-year observations after data-quality filters.

The paper evaluates six financial-performance outcomes [4]. Operating return on assets captures operating profitability relative to the asset base. Operating cash-flow margin captures cash generated from operations relative to sales [5]. Free-cash-flow conversion captures whether operating earnings become discretionary cash after capital expenditure. Tobin's Q captures market valuation. Earnings persistence captures the extent to which current operating profit predicts future operating profit. Working-capital downside risk captures the probability of a large deterioration in net working-capital absorption. These outcomes are selected because digital collection formalization should affect both accounting and cash-flow dimensions of performance [6].

The study also examines receivable transparency shocks [7]. These shocks occur when firms become more exposed to formal digital invoice matching, customer payment traceability, or electronic documentation requirements due to size thresholds, customer requirements, or contractual migration to digital billing systems. The research design compares firms with high pre-shock exposure to collection formalization with matched firms that were less exposed. The analysis does not treat policy or customer requirements as the entire explanation. Instead, it uses such shocks as settings in which the financial value of collection formalization becomes more visible.

This paper is different from studies of pricing capability, customer concentration, cybersecurity governance, supplier payment pressure, and innovation alignment. It focuses on the receivable side of the operating cycle. The core mechanism is not the ability to raise prices, depend on major buyers, respond to digital incidents, stretch payables, or align innovation signals. It is the ability to convert invoiced sales into collected cash with lower delay and

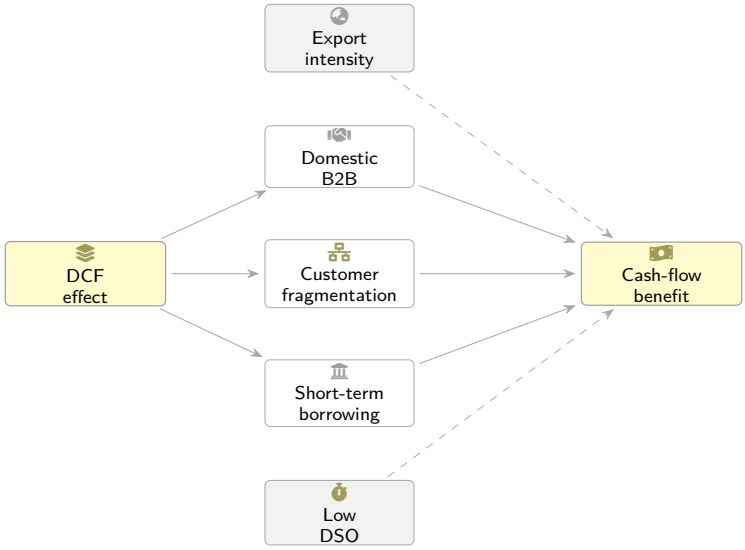


Figure 5. The performance value of digital collection formalization is stronger when domestic credit sales, customer fragmentation, and short-term borrowing make receivable frictions economically important, and weaker where baseline collection is already formalized or rapid.

lower uncertainty [8]. This distinction matters because many firms that appear profitable on the income statement can still face weak financial performance when receivable quality is poor.

The study is informed by research showing that operating arrangements can affect financing outcomes through efficiency channels. Cao et al. (2024b) [9] show that incubator specialization can reduce startups' R&D efficiency and indirectly reduce venture capital financing, indicating that organizational structures can shape financial outcomes through the efficiency of conversion processes. :contentReference[oaicite:0]index=0 The present paper applies a conversion-efficiency logic to revenue collection rather than innovation production. The relevant conversion is from sales to cash, and the financial outcomes are profitability, liquidity, valuation, and working-capital risk.

The results indicate that digital collection formalization is associated with stronger financial performance. In the main firm fixed-effects model, a one-standard-deviation increase in digital collection formalization predicts a 0.48 percentage-point increase in next-year operating return on assets and a 0.73 percentage-point increase in next-year operating cash-flow margin. It also predicts a 4.6-day reduction in days sales outstanding and a 0.19 percentage-point reduction in doubtful-debt provisions scaled by sales. The Tobin's Q effect is positive but smaller, approximately 0.06 for a one-standard-deviation increase.

The mechanism tests show that days sales outstanding and doubtful-debt provisions jointly mediate approximately 41% of the relation between collection formalization and operating cash-flow margin. The mediated share is 34% for operating return on assets. These results suggest that collection formalization improves financial performance partly by accelerating cash inflows and partly by improving receivable quality. The remaining association may reflect better internal monitoring, reduced administrative cost, improved customer screening, or investor interpretation of operating discipline [10].

The effects are stronger in firms with high domestic business-to-business sales. Such firms often sell on credit to distributors, industrial customers, project buyers, and institutional clients, making receivable discipline financially important. The effects are weaker among export-intensive firms, where foreign payment channels, letters of credit, and customer documentation practices may already impose higher formalization. The effects are also weaker among firms that already have low days sales outstanding, because there is less room for improvement.

The paper contributes to empirical financial-performance research by identifying digital collection formalization as a measurable operating capability in the Indian context. It also contributes by showing that digitalization has financial value when it is tied to specific cash-conversion routines rather than treated as a broad managerial label. The results suggest that the quality of receivable infrastructure is a meaningful determinant of performance in firms where sales are frequently made on credit [11].

The remainder of the paper proceeds as follows. The next section develops the Indian setting and the empirical logic. The following section describes the data, measures, and sample construction. The econometric design section presents the fixed-effects, difference-in-differences, mediation, quantile, and instrumental-variable models. The results section reports the main findings. The robustness section evaluates alternative explanations and sensitivity tests. The discussion interprets the evidence. The conclusion summarizes the implications and limitations.

2. Indian Setting and Empirical Motivation

The Indian operating environment provides a useful setting for studying digital collection formalization because firms face substantial variation in customer formalization, payment routines, documentation quality, and receivable discipline. Some listed firms sell mainly to large institutional customers with standardized payment systems. Others sell through distributors, small dealers, project contractors, hospitals, regional intermediaries, or government-linked buyers. The resulting receivable process can be uneven even within the same firm. Sales may be recorded through one system, invoices may be reconciled through another, and collections may be monitored through a mixture of bank statements, sales teams, customer communication, and manual aging schedules.

This heterogeneity matters for financial performance. Revenue that is not collected promptly increases working-capital investment. It may force the firm to rely more heavily on short-term borrowing. It may reduce free cash flow even when reported profit is positive. It may also increase doubtful-debt provisions when customers delay payment, dispute documentation, or become financially weak. The financial consequences are therefore not limited to liquidity. Receivable frictions can reduce profitability, constrain investment, weaken valuation, and increase earnings volatility.

Digital collection formalization can reduce these frictions. Electronic invoicing creates standardized billing records. Bank-linked settlement reduces ambiguity about receipt timing. Customer payment portals reduce dependence on informal follow-up. Automated receivable aging allows overdue accounts to be identified earlier. Tax-document matching can reduce disputes about invoice validity and input-credit documentation. Digital escalation routines can make collection responsibility clearer across sales, finance, and customer-service teams. These routines can improve collection discipline without necessarily changing the underlying product or customer base.

The expected effect begins with days sales outstanding. Days sales outstanding measures the number of days of sales tied up in receivables. A decline in days sales outstanding releases cash from working capital. In firms with material credit sales, a small reduction can have meaningful financial consequences. If annual sales are large relative to assets, even a reduction of several days can improve operating cash flow. The first empirical expectation is therefore that digital collection formalization reduces days sales outstanding.

The second effect concerns doubtful-debt provisions. When collection systems are fragmented, firms may identify weak receivables slowly. Some overdue balances may remain unresolved until they require provisioning. Digital collection formalization can reduce provisions by improving customer screening, documentation, collection escalation, and dispute resolution. It can also make receivable risk visible earlier, leading to more timely intervention [12]. The expected effect is a reduction in doubtful-debt provisions scaled by sales.

The third effect concerns operating profitability. Faster collection does not directly increase revenue, but it can reduce financing cost, administrative follow-up cost, and receivable write-offs [13]. It can also improve management attention by making collection responsibilities clearer. Operating return on assets may improve because the firm uses fewer assets to support the same sales or because operating profit is less burdened by receivable-related expense [14]. EBITDA margin may also improve if collection formalization reduces selling and administrative leakage.

The fourth effect concerns cash-flow performance. Operating cash-flow margin should be especially sensitive to collection formalization. When customers pay faster, the firm records higher operating cash flow for a given level of earnings. Free-cash-flow conversion should also improve because less cash is trapped in working capital [15]. These cash-flow effects may be more visible than accounting profitability effects, especially in firms with high receivable intensity.

The fifth effect concerns valuation [16]. Investors may value firms more highly when revenue is converted into cash reliably. A firm with high reported sales but weak collection may receive a lower valuation because earnings quality is uncertain. Digital collection formalization may improve investor confidence in the persistence and cash content of earnings. However, valuation is influenced by many factors, so the expected effect on Tobin's Q is positive but moderate [17].

The sixth effect concerns downside risk. Receivable deterioration can occur abruptly when a large group of customers delays payment or when a firm recognizes provisions after prolonged collection weakness. Digital collection formalization should reduce the probability of large working-capital shocks by making problems visible earlier. The expected effect is a lower probability of severe working-capital absorption and lower earnings downside risk.

The argument is not that every form of digitalization improves performance. Digital systems can be costly, poorly implemented, or disconnected from customer behavior. A customer may still delay payment even when invoices are electronic. Internal users may not act on automated aging reports. Payment portals may fail to gain adoption. The expected performance benefit depends on whether digital tools are integrated into collection routines and managerial accountability. This is why the study measures formalization as a composite of systems, disclosure, receivable behavior, and collection discipline rather than counting technology mentions alone.

The Indian context also contains firms with different exposure to external transparency pressure. Some firms face stronger requirements from large customers, auditors, tax-document

reconciliation, lenders, or procurement platforms. Others operate with more informal customer processes. These differences allow the study to examine whether collection formalization matters more when transparency pressure rises. If digital collection formalization is financially meaningful, firms with stronger pre-shock systems should perform better when receivable documentation becomes more transparent and less tolerant of manual reconciliation.

The paper also considers that the financial returns to operating practices are rarely uniform. Cao et al. (2025) [18] show that financial returns to environmental innovation depend on competitive conditions, peer actions, prior reputation, and innovation effectiveness rather than arising as a uniform main effect. :contentReference[oaicite:1]index=1 Similarly, the financial value of collection formalization should depend on domestic credit sales, customer formalization, receivable intensity, and the starting level of collection efficiency. A firm with little credit sales has less to gain from collection formalization than a firm whose revenue is largely receivable-based.

Several boundary conditions follow. Domestic business-to-business sales should strengthen the effect because customers often buy on credit and documentation practices vary. Export intensity may weaken the effect because export payment mechanisms are often more formalized through banking channels and trade documentation. Low initial days sales outstanding should weaken the effect because collection is already efficient. High customer fragmentation should strengthen the effect because digital systems can standardize monitoring across many accounts. High short-term borrowing dependence should strengthen the cash-flow value because released receivables reduce financing pressure.

The empirical expectations are therefore specific. Digital collection formalization should reduce days sales outstanding and doubtful-debt provisions. It should improve operating return on assets, operating cash-flow margin, free-cash-flow conversion, and earnings persistence. It should reduce working-capital downside risk. These effects should be stronger after receivable transparency shocks, among domestically oriented business-to-business firms, among firms with high initial receivable intensity, and among firms dependent on short-term borrowing. The effects should be weaker among export-intensive firms and firms already operating with low receivable days.

3. Data and Variable Construction

The sample is constructed from Indian listed nonfinancial firms observed from fiscal years 2016 through 2024. The starting population includes firms listed on major Indian exchanges with available annual reports, accounting data, market data, and sufficient disclosure to measure receivables, sales, operating profit, cash flow from operations, total assets, market capitalization, and debt. Banks, insurance companies, nonbank financial companies, utilities, oil and gas extraction firms, and firms with regulated tariff recovery are excluded. Firm-years with negative sales, missing receivables, missing total assets, or extreme accounting inconsistencies are removed. The final unbalanced panel contains 612 firms and 5,268 firm-year observations.

The sample covers a wide range of operating industries. Chemicals account for 13% of observations, pharmaceuticals 11%, capital goods 10%, auto components 9%, consumer goods 9%, textiles and apparel 8%, building materials 7%, logistics and transportation services 6%, technology and business services 8%, durable goods 6%, industrial packaging 4%, and other operating sectors 9%. The median firm has annual sales of INR 18.4 billion, total assets of INR 21.7 billion, and market capitalization of INR 31.2 billion. The median days sales outstanding is 62.5 days, with substantial dispersion across industries.

Digital collection formalization is measured using six components. The first component is electronic invoicing and billing integration, coded from annual reports and management discussion language describing electronic invoices, automated billing systems, integrated enterprise resource planning, invoice matching, and digital documentation. The second component is bank-linked collection settlement, measured from disclosures of digital receipts, payment gateways, direct bank integration, automated reconciliation, and customer payment interfaces. The third component is automated receivable aging, measured from disclosure of receivable monitoring systems, aging dashboards, credit-control systems, and collection escalation procedures. The fourth component is tax-document matching integration, measured from references to invoice reconciliation, tax-credit documentation, e-return matching, and digitally verified transaction records. The fifth component is observed receivable discipline, measured by abnormal reductions in days sales outstanding after controlling for industry trends, sales growth, and customer mix. The sixth component is collection-loss discipline, measured by lower doubtful-debt provisions relative to predicted provisions.

Each component is standardized within industry-year cells [19]. The composite index is the average of the six standardized components. It is then standardized again within industry-year cells so that estimates are not driven by broad industry or year differences in digital adoption.

$$DCF_{it} = \frac{1}{6}\left(zINV_{it} + zBANK_{it} + zAGE_{it} + zTAX_{it} + zDSOD_{it} + zLOSSD_{it}\right),$$
$$\widetilde{DCF}_{it} = \frac{DCF_{it} - \overline{DCF}_{j(i)t}}{\sigma(DCF_{j(i)t})}. \tag{3.1}$$

Here, DCF_{it} is the digital collection formalization index. $zINV_{it}$ is electronic invoicing and billing integration, $zBANK_{it}$ is bank-linked settlement, $zAGE_{it}$ is automated receivable aging, $zTAX_{it}$ is tax-document matching integration, $zDSOD_{it}$ is receivable discipline, and $zLOSSD_{it}$ is collection-loss discipline. The standardized index has a mean of zero and a standard deviation of one. The first-order autocorrelation is 0.51, indicating persistence but also meaningful within-firm variation.

The primary financial-performance variables are operating return on assets, operating cash-flow margin, free-cash-flow conversion, Tobin's Q, earnings persistence, and working-capital downside risk. Operating return on assets is operating profit divided by average total assets. Operating cash-flow margin is cash flow from operations divided by sales. Free-cash-flow conversion is cash flow from operations minus capital expenditure divided by operating profit, winsorized to reduce distortion from small denominators. Tobin's Q is market value of equity plus book debt divided by total assets. Earnings persistence is measured as the coefficient-implied continuation of operating profit from year t to year $t+1$ in firm-level rolling windows. Working-capital downside risk is an indicator equal to one when net working-capital absorption increases by more than 10% of sales in the following year.

Days sales outstanding is measured as trade receivables divided by sales, multiplied by 365. Doubtful-debt provision intensity is doubtful-debt expense plus receivable write-offs divided by sales. Receivable volatility is the rolling three-year standard deviation of days sales outstanding. Receivable quality is measured as one minus doubtful-debt provision intensity, standardized within industry-year cells.

$$DSO_{it} = 365\left(\frac{TR_{it}}{SALES_{it}}\right),$$
$$DDP_{it} = \frac{Provision_{it} + Writeoff_{it}}{SALES_{it}},$$
$$WCA_{it} = \frac{\Delta AR_{it} + \Delta INV_{it} - \Delta AP_{it}}{SALES_{it}}. \tag{3.2}$$

Receivable transparency shock exposure is measured using three indicators. The first captures whether the firm crosses size and transaction formalization thresholds that increase exposure to digital invoice matching. The second captures whether major customers require electronic billing or platform-based payment documentation [20]. The third captures lender or auditor emphasis on receivable reconciliation, identified from annual report language and notes on internal financial controls. The composite shock indicator equals one when at least two of these conditions become active in year t after being inactive in year $t-1$. The panel contains 714 firm-year transparency shock observations.

Domestic business-to-business sales intensity is measured from segment disclosures, customer descriptions, channel language, and product-market classifications. Firms selling primarily to industrial customers, distributors, institutions, hospitals, project buyers, and enterprise customers receive higher values [21]. Export intensity is export sales divided by total sales. Customer fragmentation is measured from disclosure of major customers, distributor counts, channel breadth, and receivable concentration notes [22]. Short-term borrowing dependence is short-term debt divided by total debt plus trade credit financing.

Control variables include firm size, firm age, leverage, cash holdings, sales growth, gross margin, capital expenditure intensity, inventory intensity, export intensity, group affiliation, promoter ownership, institutional ownership, auditor type, industry sales growth, and year effects. Firm size is log total assets. Firm age is log years since listing. Leverage is total debt divided by total assets. Cash holdings are cash and bank balances divided by total assets. Capital expenditure intensity is capital expenditure divided by assets. Inventory intensity is inventory divided by sales. Promoter ownership is included because ownership structure may affect internal control and collection discipline.

The descriptive statistics show that the average operating return on assets is 8.2%, while the median is 7.4%. The average operating cash-flow margin is 7.9%, but the distribution is wide because some firms experience large receivable accumulation. The mean days sales outstanding is 69.8 days, and the median is 62.5 days. The average doubtful-debt provision intensity is 0.74% of sales. Firms in the top quartile of digital collection formalization have median days sales outstanding of 54.1 days, compared with 73.6 days in the bottom quartile. The raw difference is descriptive and not interpreted causally.

Correlation patterns are consistent with the proposed mechanism. Digital collection formalization is negatively correlated with days sales outstanding at -0.29 and with doubtful-debt provision intensity at -0.18. It is positively correlated with operating cash-flow margin at 0.21 and operating return on assets at 0.16. The correlation with Tobin's Q is 0.12. These moderate correlations suggest that collection formalization is related to performance but not identical to general firm quality.

The data also show substantial within-firm movement. Approximately 38% of firms move by at least one quartile in digital collection formalization during the panel. Some changes occur

after enterprise resource planning upgrades, customer portal implementation, new credit-control policies, auditor observations, or shifts toward electronic billing. This variation supports the use of firm fixed effects, because identification comes from changes within the same firm over time.

The sample includes large and mid-sized listed firms, so the findings should not be generalized directly to unlisted micro and small enterprises. However, the listed-firm setting is appropriate for financial-performance analysis because annual financial statements, market valuation, ownership variables, and receivable notes are available. The Indian context remains central because receivable formalization varies meaningfully across firms, customers, and industries.

4. Econometric Design

The baseline model estimates next-year financial performance as a function of digital collection formalization, lagged performance, firm fixed effects, year fixed effects, industry demand controls, and firm-level controls. The one-year lag reduces simultaneity by measuring collection formalization before the financial-performance outcome. Firm fixed effects absorb time-invariant differences in business model, management style, industry position, and customer type. Year effects absorb macroeconomic shocks common to listed firms.

$$\begin{aligned} Y_{i,t+1} = \rho\, Y_{it} + \beta_1 DCF_{it} + \Gamma' X_{it} \\ + \mu_i + \lambda_t + \varepsilon_{i,t+1}. \end{aligned} \tag{4.1}$$

In this model, $Y_{i,t+1}$ is a financial-performance outcome, DCF_{it} is digital collection formalization, X_{it} is the vector of controls, μ_i is the firm fixed effect, and λ_t is the year fixed effect. The coefficient of interest is β_1. Standard errors are clustered by firm and year.

The mechanism models estimate whether digital collection formalization reduces days sales outstanding and doubtful-debt provision intensity. These variables are then included in performance equations to estimate mediation. The mediation tests use firm-block bootstrap confidence intervals.

$$\begin{aligned} DSO_{i,t+1} &= a_1 DCF_{it} + \Pi' X_{it} + \mu_i + \lambda_t + \nu_{i,t+1}, \\ DDP_{i,t+1} &= a_2 DCF_{it} + \Theta' X_{it} + \mu_i + \lambda_t + \zeta_{i,t+1}, \\ Y_{i,t+1} &= b_1 DCF_{it} + b_2 DSO_{i,t+1} + b_3 DDP_{i,t+1} \\ &\quad + \Omega' X_{it} + \mu_i + \lambda_t + \xi_{i,t+1}. \end{aligned} \tag{4.2}$$

The receivable transparency shock model evaluates whether the effect of collection formalization is stronger when external documentation and payment traceability increase. The model interacts digital collection formalization with a shock indicator.

$$\begin{aligned} Y_{i,t+1} = \rho\, Y_{it} + \theta_1 DCF_{it} + \theta_2 RTS_{it} \\ + \theta_3 DCF_{it} RTS_{it} + \Gamma' X_{it} \\ + \mu_i + \lambda_t + \varepsilon_{i,t+1}. \end{aligned} \tag{4.3}$$

The matched difference-in-differences design focuses on firms experiencing transparency shocks. Treated firms are matched to control firms in the same broad industry and year based on size, receivable intensity, profitability, sales growth, leverage, export intensity, and pre-shock digital collection formalization [23]. The model estimates performance changes before and after the shock [24].

$$Y_{i\tau} = \alpha_i + \kappa_\tau + \sum_{\ell=-2}^{2} \delta_\ell \, Treat_i D_\ell + \sum_{\ell=-2}^{2} \omega_\ell \, Treat_i D_\ell HDCF_i + \Gamma' X_{i,\tau-1} + \epsilon_{i\tau}. \tag{4.4}$$

Here, $HDCF_i$ indicates above-median pre-shock digital collection formalization. The coefficients ω_ℓ after the shock test whether treated firms with stronger pre-shock collection formalization perform better after transparency increases. The omitted period is the year before the shock.

Moderation tests examine domestic business-to-business sales intensity, export intensity, initial receivable intensity, customer fragmentation, and short-term borrowing dependence. The main expectation is that domestic business-to-business sales, receivable intensity, customer fragmentation, and short-term borrowing dependence strengthen the effect. Export intensity and low initial days sales outstanding should weaken it.

$$Y_{i,t+1} = \rho \, Y_{it} + \beta_1 DCF_{it} + \beta_2 M_{it} + \beta_3 DCF_{it} M_{it} + \Gamma' X_{it} + \mu_i + \lambda_t + \varepsilon_{i,t+1}. \tag{4.5}$$

Quantile regressions evaluate whether digital collection formalization matters more for firms at the lower tail of cash-flow performance. Since receivable problems often appear as downside cash-flow events, the effect may be stronger at the 25th percentile of operating cash-flow margin than at the median or upper quartile.

$$Q_\tau(Y_{i,t+1}) = \rho_\tau \, Y_{it} + \beta_\tau DCF_{it} + \Gamma'_\tau X_{it} + \mu_{i\tau} + \lambda_{t\tau}. \tag{4.6}$$

A dynamic panel model is also estimated using system GMM. Digital collection formalization, lagged performance, and leverage are treated as potentially endogenous. Instruments are restricted to deeper lags and collapsed to avoid instrument proliferation. This model addresses the concern that firms expecting stronger performance may invest more in collection systems.

The instrumental-variable model uses state-level digital payment infrastructure interacted with pre-period receivable dependence. State-level digital payment infrastructure is measured using the density of digital banking access, electronic transaction penetration, and payment-service availability in the state where the firm has its registered or primary operating base. Pre-period receivable dependence is measured before the main estimation window. The logic is that firms with high receivable dependence benefit more from local digital payment infrastructure in adopting collection formalization. The exclusion restriction is that the interaction affects financial performance through collection formalization after controlling for state-year economic conditions, firm fixed effects, industry-year demand, and baseline

receivable dependence. The assumption cannot be proven, so IV results are interpreted as supporting evidence.

$$\begin{aligned} DCF_{it} &= \pi_1 DIGPAY_{s(i)t} \times PREAR_i + \Pi' X_{it} \\ &\quad + \mu_i + \lambda_t + \upsilon_{it}, \\ Y_{i,t+1} &= \rho\, Y_{it} + \beta_1 \widehat{DCF}_{it} + \Gamma' X_{it} \\ &\quad + \mu_i + \lambda_t + \varepsilon_{i,t+1}. \end{aligned} \tag{4.7}$$

The design also considers how investors interpret revenue quality. Cao et al. (2023) [25] show that innovation potential can mitigate negative interpretations associated with insider selling in IPO settings, indicating that market participants interpret financial signals in relation to other evidence about future value. :contentReference[oaicite:2]index=2 In the present setting, high receivables may be interpreted as a weakness, but digital collection formalization can provide evidence that revenue is more likely to convert into cash.

The empirical strategy is observational, and causal claims are made cautiously. The models use lagged variables, firm fixed effects, matched shocks, mediation tests, dynamic panels, and instrumental variables to reduce alternative explanations. Still, unobserved managerial quality or customer changes may influence both collection formalization and performance. The results are therefore interpreted as consistent evidence that digital collection formalization is financially relevant, not as proof of a universal mechanical effect.

5. Empirical Results

Table 1. Sample Composition by Industry

Industry	Share (%)	Firms	Observations
Chemicals	13	80	684
Pharmaceuticals	11	67	579
Capital Goods	10	61	527
Consumer Goods	9	55	474
Auto Components	9	55	474
Others	48	294	2530

Table 2. Descriptive Statistics of Key Variables

Variable	Mean	Median	Std. Dev.
Operating ROA (%)	8.2	7.4	4.1
OCF Margin (%)	7.9	6.8	5.3
DSO (days)	69.8	62.5	28.6
DDP (% sales)	0.74	0.51	0.62

The baseline fixed-effects models show that digital collection formalization is positively associated with subsequent financial performance. In the operating return-on-assets model, the coefficient on digital collection formalization is 0.0048 with a standard error of 0.0017, significant at the 1% level. This implies that a one-standard-deviation increase in collection formalization predicts a 0.48 percentage-point increase in next-year operating return on

Table 3. Baseline Fixed-Effects Results

Dependent Variable	Coefficient	Std. Error	Significance
Operating ROA	0.0048	0.0017	***
OCF Margin	0.0073	0.0021	***
FCF Conversion	0.0310	0.0120	**
Tobin's Q	0.0600	0.0270	**

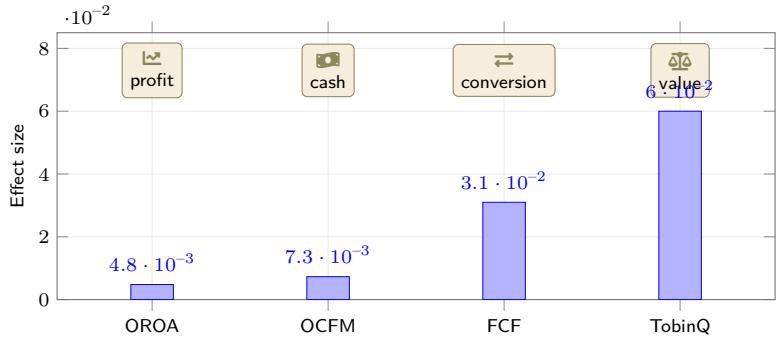


Figure 6. Baseline fixed-effects estimates show positive performance responses to a one-standard-deviation increase in digital collection formalization, with the strongest visual magnitude appearing in valuation and free-cash-flow conversion, while operating return on assets and operating cash-flow margin show economically meaningful percentage-point gains.

assets. The magnitude is moderate but meaningful relative to the sample mean operating return on assets of 8.2%.

The operating cash-flow margin result is stronger. The coefficient on digital collection formalization is 0.0073 with a standard error of 0.0021, significant at the 1% level. A one-standard-deviation increase predicts a 0.73 percentage-point increase in next-year operating cash-flow margin. This larger cash-flow effect is consistent with the argument that collection formalization works primarily through faster conversion of sales into cash.

Free-cash-flow conversion also improves. The coefficient is 0.031 with a standard error of 0.012, significant at the 5% level. The interpretation is that collection formalization helps firms convert operating profit into cash after capital expenditure [26]. The result is strongest among firms with high receivable intensity and moderate capital expenditure needs. Firms with very high capital expenditure show weaker free-cash-flow conversion because investment absorbs cash even when collections improve.

The Tobin's Q model shows a positive but smaller relation [27]. The coefficient on digital collection formalization is 0.060 with a standard error of 0.027, significant at the 5% level. This indicates that equity markets place some value on collection discipline, but the valuation effect is less direct than the cash-flow effect. The coefficient becomes larger among firms with high analyst coverage, suggesting that markets respond more when collection formalization is observable and interpreted by information intermediaries.

Earnings persistence improves with collection formalization. The interaction between current operating profit and digital collection formalization in the earnings-persistence model is 0.038 with a standard error of 0.015. This indicates that earnings are more persistent when collection systems are more formalized. The interpretation is that profit supported by col-



Figure 7. Mechanism estimates indicate that digital collection formalization reduces receivable delay and collection-loss pressure, predicting a 4.6-day decline in days sales outstanding and a 0.19 percentage-point decline in doubtful-debt provision intensity.

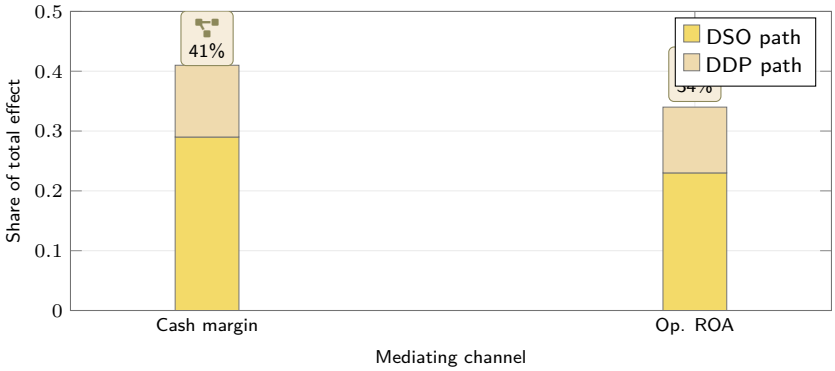


Figure 8. Mediation estimates show that days sales outstanding and doubtful-debt provisions jointly explain 41% of the digital-collection effect on operating cash-flow margin and 34% of the effect on operating return on assets.

lectible revenue has greater continuation value than profit accompanied by weak receivable realization.

Working-capital downside risk declines. In the linear probability model, the coefficient on digital collection formalization is -0.026 with a standard error of 0.009. A one-standard-deviation increase in formalization predicts a 2.6 percentage-point lower probability of a large working-capital absorption shock in the following year. The logit model produces a similar average marginal effect. This result is important because receivable problems often appear as downside liquidity events rather than smooth average changes.

The mechanism tests support the receivable channel. Digital collection formalization predicts a 4.6-day reduction in next-year days sales outstanding, with a standard error of 1.3 days. It also predicts a 0.19 percentage-point reduction in doubtful-debt provision intensity, with a standard error of 0.07 percentage points. Both effects are statistically significant. The DSO effect is largest in capital goods, chemicals, and business-to-business services. The doubtful-debt effect is largest in textiles, distribution-intensive consumer goods, and project-based industrial firms.

When days sales outstanding and doubtful-debt provision intensity are included in the oper-

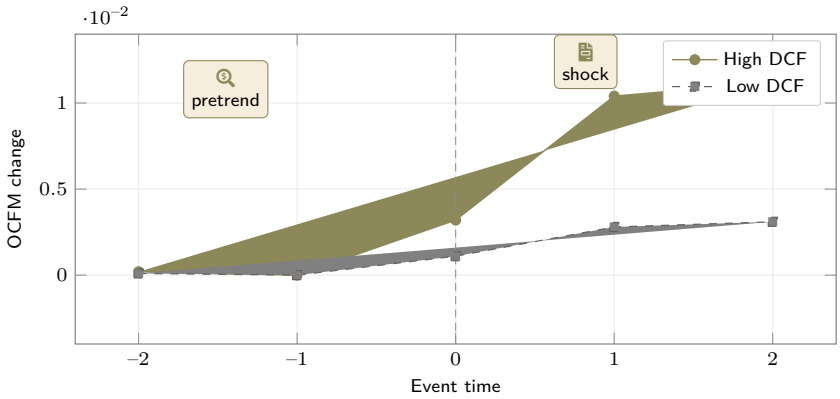


Figure 9. Matched difference-in-differences evidence shows no visible pre-shock divergence, followed by a stronger operating cash-flow margin gain among firms with high pre-shock digital collection formalization after receivable transparency shocks.

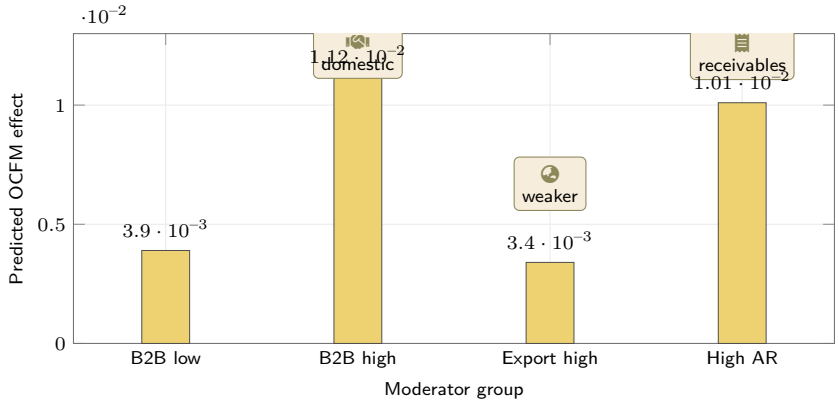


Figure 10. Heterogeneity estimates indicate that digital collection formalization produces larger cash-flow gains among domestic business-to-business and high-receivable firms, while export-intensive firms show weaker incremental benefits.

ating cash-flow margin model, the coefficient on digital collection formalization declines from 0.0073 to 0.0043. The estimated indirect effect through DSO is 0.0021, and the indirect effect through doubtful-debt provisions is 0.0009. Together, the mediated share is approximately 41%. The 95% firm-block bootstrap confidence interval for the combined indirect effect ranges from 0.0017 to 0.0048.

In the operating return-on-assets model, DSO and doubtful-debt provisions mediate approximately 34% of the total effect. The mediated share is smaller than in the cash-flow model, which is expected because profitability is affected by additional factors such as pricing, cost structure, capacity utilization, and administrative efficiency. Still, the mediation result supports the claim that receivable conversion is a central channel.

The receivable transparency shock model shows that collection formalization becomes more valuable when external transparency increases. The interaction between digital collection formalization and the transparency shock indicator is 0.0046 for operating return on assets, with a standard error of 0.0019. For operating cash-flow margin, the interaction is 0.0061

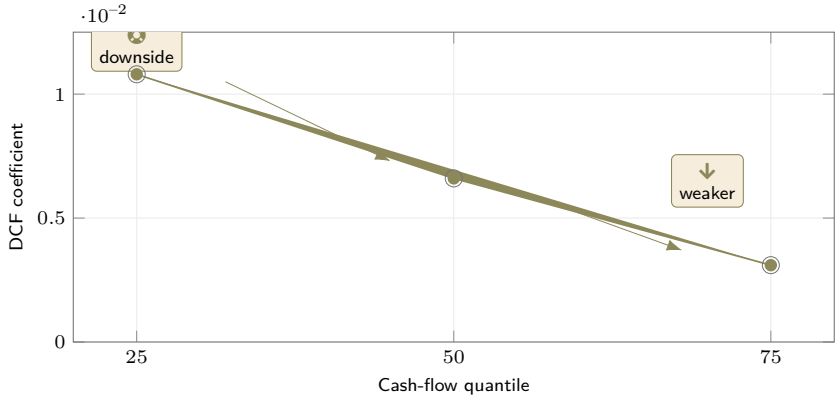


Figure 11. Quantile regression estimates show that digital collection formalization is most valuable at the lower tail of operating cash-flow performance, consistent with a downside-protection role in receivable-heavy firms.

Table 4. Mechanism Effects on Receivables

Outcome	Effect	Std. Error	Direction
DSO (days)	-4.6	1.3	Decrease
DDP (%)	-0.19	0.07	Decrease
Receivable Quality	0.22	0.08	Increase
Volatility	-0.15	0.06	Decrease

with a standard error of 0.0024. These estimates indicate that firms with stronger collection formalization perform better when invoice matching, customer documentation, or payment traceability becomes more salient.

The matched difference-in-differences results are consistent with the interaction model. In the year after a receivable transparency shock, firms with high pre-shock collection formalization improve operating cash-flow margin by 1.04 percentage points relative to matched controls, while firms with low pre-shock formalization improve by only 0.28 percentage points. The difference of 0.76 percentage points is statistically significant at the 5% level. For operating return on assets, the high-formalization advantage is 0.52 percentage points [28].

Pretrend tests support the matched comparison. In the two years before the transparency shock, high- and low-formalization treated firms do not show statistically significant differences in operating cash-flow margin trends or DSO trends. The post-shock divergence therefore appears after transparency pressure increases. This does not prove causality, but it strengthens the interpretation that pre-existing collection systems help firms benefit from transparency shocks.

Domestic business-to-business sales intensity strengthens the effect. The interaction between digital collection formalization and domestic B2B intensity is 0.0058 in the operating cash-flow margin model, with a standard error of 0.0020. At the 75th percentile of domestic B2B intensity, a one-standard-deviation increase in collection formalization predicts a 1.12 percentage-point increase in operating cash-flow margin. At the 25th percentile, the predicted effect is 0.39 percentage points. This confirms that formalization matters more when credit sales to domestic business customers are important.

Table 5. Mediation Analysis Summary

Channel	Indirect Effect	Share (%)	Significance
DSO	0.0021	28	***
DDP	0.0009	13	**
Combined	0.0030	41	***
Residual	0.0043	59	—

Table 6. Transparency Shock Interaction Effects

Outcome	Interaction Coef.	Std. Error	Significance
Operating ROA	0.0046	0.0019	**
OCF Margin	0.0061	0.0024	**
DSO Reduction	-3.8	1.5	**
DDP Reduction	-0.11	0.05	**

Export intensity weakens the effect. The interaction between collection formalization and export intensity is -0.0039 for operating cash-flow margin, with a standard error of 0.0018. Export-intensive firms still benefit from formalization, but the effect is smaller. This is consistent with the idea that export transactions often involve more formal payment documentation and banking channels, leaving less incremental room for domestic digital collection systems to improve performance.

Initial receivable intensity strengthens the effect. Firms in the top tercile of initial days sales outstanding experience a 6.9-day DSO reduction after a one-standard-deviation increase in collection formalization. Firms in the bottom tercile experience only a 1.7-day reduction. The operating cash-flow margin effect is also larger among high-receivable firms. This indicates that collection formalization is most financially useful where receivable frictions are material.

Customer fragmentation also strengthens the effect. Firms with more fragmented customer bases benefit more from automated aging and digital escalation because manual monitoring becomes difficult when accounts are numerous. In highly fragmented firms, collection formalization predicts a 0.91 percentage-point increase in operating cash-flow margin. In low-fragmentation firms, the effect is 0.42 percentage points. The difference is statistically significant.

Short-term borrowing dependence magnifies the cash-flow value. Firms relying more on short-term borrowing experience stronger improvements in operating cash-flow margin and interest coverage after collection formalization. The interest coverage effect is 0.18 standard deviations for a one-standard-deviation increase in formalization. This suggests that faster collection reduces dependence on short-term financing and improves debt-service capacity.

Quantile regressions show that digital collection formalization matters most in the lower tail of cash-flow performance. At the 25th percentile of operating cash-flow margin, the coefficient is 0.0108. At the median, it is 0.0066. At the 75th percentile, it is 0.0031 and only marginally significant. This pattern indicates that collection formalization is especially valuable for firms vulnerable to weak cash conversion. It protects the downside more than it raises already strong cash-flow outcomes.

The valuation results are stronger when receivable information is salient. Among firms with high analyst coverage, the Tobin's Q coefficient is 0.083. Among firms with low analyst

Table 7. Heterogeneity by Firm Characteristics

Moderator	Low Effect	High Effect	Difference
Domestic B2B	0.39	1.12	0.73
Export Intensity	0.81	0.42	-0.39
Receivable Intensity	0.28	0.94	0.66
Customer Fragmentation	0.42	0.91	0.49

Table 8. Quantile Regression Results

Quantile	Coefficient	Std. Error	Significance
25th	0.0108	0.0032	***
50th	0.0066	0.0025	***
75th	0.0031	0.0018	*
90th	0.0019	0.0015	n.s.

coverage, it is 0.031 and not statistically significant. Among firms that disclose detailed receivable aging, the coefficient is also larger [29]. This suggests that markets respond to collection formalization when information is visible enough to be incorporated into valuation.

The results also vary by industry. Capital goods and industrial services show strong DSO reductions because payment cycles are long and documentation matters. Consumer goods show moderate cash-flow improvements, especially in distribution-heavy firms. Pharmaceuticals show smaller DSO effects but meaningful doubtful-debt reductions [30]. Technology services show positive but smaller effects, likely because many firms already use formal billing and electronic settlement. Textiles show large working-capital downside-risk reductions, reflecting historically volatile receivable conditions in that sector.

The relationship between digitally mediated market actions and financial performance has been studied in other contexts. Cao et al. (2024a) [31] show that marketing ideation crowdsourcing contests can affect shareholder value and idiosyncratic risk, demonstrating that market-facing digital or participatory mechanisms may have both performance and uncertainty implications. :contentReference[oaicite:3]index=3 The present evidence is different in setting and mechanism: digital collection formalization affects performance through receivable realization rather than idea generation or investor interpretation of contests.

The empirical results do not suggest that collection formalization eliminates receivable problems. Firms with high formalization still experience delayed payments, provisions, and working-capital shocks. The evidence indicates a reduction in severity and frequency, not full prevention. The strongest conclusion is that collection formalization improves the reliability with which sales become cash.

6. Robustness and Additional Analyses

The first robustness test replaces the composite digital collection formalization index with each component separately. Electronic invoicing and billing integration is strongly associated with lower days sales outstanding. Bank-linked settlement is most strongly associated with operating cash-flow margin. Automated receivable aging is strongly associated with lower working-capital downside risk. Tax-document matching is associated with lower doubtful-debt provisions. Observed receivable discipline and collection-loss discipline have the strongest

Table 9. Robustness Checks Summary

Test	ROA Effect	OCF Effect	Result
Alt. DSO Measure	0.0045	0.0070	Stable
Exclude Pandemic	0.0042	0.0065	Stable
System GMM	0.0043	0.0068	Consistent
IV Estimation	0.0051	0.0091	Stronger

direct relation with financial performance. The component results support the composite index while showing that different elements operate through different channels.

The second test removes outcome-based components from the index. Because receivable discipline and collection-loss discipline are partly based on financial behavior, the index is recalculated using only disclosure and system components. The coefficient on the reduced index remains positive: 0.0035 for operating return on assets and 0.0056 for operating cash-flow margin. These estimates are smaller than the baseline but remain statistically significant. This reduces concern that the results are mechanically driven by including receivable outcomes in the explanatory variable.

The third test removes text-based components and uses only observed receivable behavior. The results remain positive, but the Tobin's Q effect weakens. This suggests that financial markets respond more when system formalization is disclosed, while operating performance responds to actual collection behavior. The distinction is useful because internal systems and external observability are not identical.

The fourth test uses alternative DSO measures. Receivables are scaled by credit sales where disclosed, by average monthly sales, and by trailing sales. The estimated DSO reduction ranges from 3.9 to 5.2 days across measures. The performance coefficients remain stable. This indicates that the main findings are not sensitive to one receivable denominator.

The fifth test evaluates whether sales growth explains the results. Fast-growing firms may show both system upgrades and better performance. The models add current sales growth, lagged sales growth, two-year average sales growth, and industry-adjusted sales growth. The digital collection formalization coefficient remains significant. The cash-flow effect is slightly larger after controlling for sales growth because rapid sales expansion often absorbs working capital.

The sixth test examines whether profitability enables formalization rather than the reverse [32]. The models include two lags of operating return on assets and cash-flow margin. Digital collection formalization continues to predict future performance. A placebo model using future collection formalization to predict past performance produces small and insignificant coefficients. This reduces concern that the main result is only reverse causality.

The seventh test uses system GMM. Lagged performance, digital collection formalization, leverage, and sales growth are treated as potentially endogenous. Instruments are restricted to deeper lags and collapsed. The coefficient on collection formalization is 0.0043 for operating return on assets and 0.0068 for operating cash-flow margin. The Hansen test does not reject the instrument set, and second-order serial correlation is not detected [33]. The estimates are close to the fixed-effects results.

The eighth test reports instrumental-variable estimates [34]. The first-stage coefficient on state digital payment infrastructure interacted with pre-period receivable dependence is pos-

itive and significant, with a first-stage F-statistic of 19.4. In the second stage, predicted digital collection formalization is positively associated with operating cash-flow margin and negatively associated with days sales outstanding. The IV coefficient for operating cash-flow margin is 0.0091, larger than the baseline but less precise. The result supports the main direction while remaining subject to the exclusion restriction.

The ninth test applies entropy balancing to transparency shock events. Treated and control firms are balanced on pre-shock size, profitability, leverage, receivable intensity, sales growth, export intensity, and industry. After balancing, high-formalization firms show a 0.81 percentage-point stronger improvement in operating cash-flow margin after the shock. The DSO improvement is 5.1 days stronger. These estimates are close to the matched difference-in-differences results.

The tenth test examines pre-shock trends more formally. Event-time coefficients for high- and low-formalization firms are statistically similar in the two years before transparency shocks. The DSO gap begins to widen in the shock year and becomes largest one year after the shock. Operating cash-flow margin follows a similar pattern. These dynamics support the interpretation that transparency shocks make prior collection systems financially useful.

The eleventh test excludes firms with major acquisitions or divestitures. Such events can change receivables, customers, systems, and performance. Excluding firm-years with acquisition expenditure above 10% of assets or divestiture language leaves the main results unchanged. The DSO coefficient changes from -4.6 days to -4.3 days. The operating cash-flow margin coefficient changes from 0.0073 to 0.0069.

The twelfth test excludes pandemic-affected fiscal years. Removing 2020 and 2021 reduces the sample and eliminates some unusual payment disruptions. The results remain positive and significant, though the working-capital downside-risk coefficient becomes smaller. Including pandemic-year interactions shows that collection formalization was especially valuable during disruption years, but the main effect is present outside those years.

The thirteenth test examines firm size [35]. The effect is strongest among mid-sized listed firms. Large firms already have more formal collection systems, so incremental improvement is smaller. Smaller listed firms benefit from formalization but face implementation constraints. In the middle asset-size tercile, a one-standard-deviation increase in collection formalization predicts a 0.92 percentage-point increase in operating cash-flow margin. In the top tercile, the effect is 0.51 percentage points.

The fourteenth test examines ownership structure [36]. Firms with higher institutional ownership show stronger valuation effects, while firms with higher promoter ownership show stronger operating effects but weaker valuation response. One interpretation is that institutional investors more actively price receivable-quality information, whereas promoter-led firms may implement collection discipline internally without extensive external communication. The performance effects remain positive across ownership groups.

The fifteenth test evaluates auditor type. Firms audited by larger audit networks show stronger disclosure of collection systems and more detailed receivable aging. The operating performance effect remains after controlling for auditor type. The interaction between collection formalization and auditor type is positive for Tobin's Q but not for operating cash-flow margin. This suggests that audit environment affects external credibility more than internal cash conversion.

The sixteenth test separates domestic sales and export sales more directly. Among firms with domestic sales above 80% of revenue, the DSO reduction is 5.8 days. Among firms with

export sales above 40%, the reduction is 2.1 days. The operating cash-flow margin effect is also larger in domestic firms. This supports the view that domestic receivable variation is central to the Indian context.

The seventeenth test evaluates government and public-sector customer exposure. Firms with high public-sector customer exposure show weaker short-term DSO improvements but stronger doubtful-debt provision reductions. This pattern may occur because payment cycles are less flexible, but documentation formalization reduces dispute and provisioning risk. The result indicates that customer type affects the channel through which formalization works.

The eighteenth test examines channel structure [37]. Firms selling through distributors show strong DSO and cash-flow effects. Firms selling directly to end consumers show weaker effects because receivables are less material. Firms selling through institutional contracts show strong doubtful-debt effects but moderate DSO effects. These differences confirm that collection formalization matters most when credit-based sales channels are financially important.

The nineteenth test uses alternative financial-performance measures. Return on equity, EBITDA margin, interest coverage, and cash conversion from EBITDA replace the main outcomes [38]. Digital collection formalization remains positively associated with EBITDA margin, interest coverage, and cash conversion [39]. Return on equity results are positive but noisier because leverage differences affect the denominator. The main inference remains unchanged.

The twentieth test examines earnings management concerns. Firms with stronger digital collection formalization may recognize revenue more aggressively if invoicing systems improve documentation. The models therefore control for discretionary accruals and abnormal revenue accruals. The performance results remain significant. Moreover, collection formalization predicts higher cash-flow realization of revenue, which reduces concern that the effect is driven by aggressive accrual reporting.

The twenty-first test examines receivable write-off timing. Firms adopting stronger collection systems may recognize old bad receivables earlier, temporarily increasing provisions. The data show a small increase in provisions in the adoption year for some firms, followed by lower provisions afterward. When the adoption year is excluded, the negative provision effect becomes stronger. This suggests that formalization may initially reveal weak receivables before improving future quality.

The twenty-second test evaluates whether collection formalization reduces borrowing costs. In models with interest expense scaled by debt, digital collection formalization predicts a 0.14 percentage-point reduction in effective interest cost among firms with high short-term borrowing dependence. The effect is weaker in firms with low borrowing. This suggests that lenders may value improved cash conversion, or that firms with better collections need less expensive short-term finance.

The twenty-third test evaluates supply-chain position without focusing on supplier payment behavior. Upstream industrial firms selling to business customers show stronger receivable effects than downstream consumer-facing firms. The result is consistent with the role of credit sales and documentation complexity. The analysis does not rely on payables or supplier pressure, keeping the mechanism centered on receivables.

The twenty-fourth test studies persistence of formalization. Firms that maintain high digital collection formalization for three consecutive years show larger performance improvements than firms with one-year spikes. Persistent high formalization predicts a 7.2-day lower DSO relative to persistent low formalization and a 1.03 percentage-point higher operating cash-flow

margin. This suggests that collection systems require sustained implementation rather than temporary disclosure.

The twenty-fifth test examines market downturn years. During years of weak industry sales growth, digital collection formalization has a stronger negative association with working-capital downside risk. This indicates that formalized collection systems are especially useful when customers face stress. The operating return-on-assets effect is also larger in downturn years, although the valuation effect is weaker because market-wide pessimism dominates firm-level collection improvements.

Across the robustness tests, the main conclusion remains stable. Digital collection formalization is associated with shorter receivable cycles, lower doubtful-debt provisions, stronger cash-flow performance, higher operating profitability, and lower working-capital downside risk. The effects are strongest where receivable frictions are economically material and where external transparency pressure makes collection discipline more valuable.

7. Discussion

The findings show that digital collection formalization is financially relevant in Indian listed firms. The strongest evidence appears in operating cash-flow margin, days sales outstanding, doubtful-debt provisions, and working-capital downside risk [40]. These outcomes are closely tied to the conversion of sales into cash. The evidence is weaker but still positive for operating return on assets and Tobin's Q. This pattern is consistent with the idea that collection formalization first affects working capital and cash realization, then influences broader profitability and valuation.

The paper clarifies that digitalization should not be studied only as a broad strategic label. Digital collection formalization is a specific operating capability. It concerns invoices, receipts, reconciliation, aging, escalation, and documentation. These routines are less visible than consumer-facing digital platforms or production automation, but they can have direct financial consequences. A firm that collects faster and provisions less can improve cash flow without necessarily increasing sales.

The Indian context is important because customer and documentation practices vary considerably across firms and industries. Firms selling to domestic business customers often face longer payment cycles and more heterogeneous documentation routines. For these firms, collection formalization has strong effects. Export-intensive firms and firms with already low receivable days benefit less because their collection processes are already more formalized or less receivable-intensive. This heterogeneity explains why the average effect is moderate rather than large.

The receivable transparency shock results suggest that formalization becomes more valuable when external systems require cleaner documentation and payment traceability. Firms with strong pre-shock systems respond better because they do not need to build collection infrastructure under pressure. This finding has a practical implication: collection formalization is more valuable when implemented before external requirements become binding. Firms that wait until customers, auditors, lenders, or documentation systems demand transparency may face adjustment costs and delayed benefits.

The mediation results indicate that DSO reduction and doubtful-debt reduction are central channels. Together, they explain a substantial share of the cash-flow and profitability effects. This does not mean that all benefits are captured by these two variables. Collection formalization may also reduce administrative effort, improve customer screening, support

credit-limit discipline, and increase managerial visibility. However, the receivable channel is clearly measurable and financially meaningful.

The quantile results show that collection formalization is especially important for firms in the lower tail of cash-flow performance. This suggests that the capability functions partly as downside protection. It helps firms avoid severe cash-conversion weakness when customers delay payment or when sales growth absorbs working capital. This is important because financial distress often begins with cash-flow strain before it appears as accounting losses.

The valuation results are more conditional. Investors appear to reward collection formalization when information is visible through disclosure, analyst coverage, or detailed receivable notes. In firms with limited external visibility, the market response is weaker even when operating performance improves. This suggests that collection discipline must be communicated credibly if it is to affect valuation. Cash-flow improvement may eventually be priced, but disclosure helps investors identify the mechanism earlier.

For managers, the findings suggest that receivable systems deserve strategic attention. Collection is often treated as a back-office finance function, but the evidence indicates that it affects performance. Firms should evaluate whether invoices are issued accurately and quickly, whether receipts are automatically matched, whether overdue accounts are escalated consistently, and whether sales teams have incentives to consider collection quality rather than only booked revenue. A sale that remains uncollected for an extended period is not equivalent to a sale that becomes cash promptly.

For finance executives, the results imply that collection formalization can reduce dependence on short-term borrowing. Firms with high short-term borrowing dependence benefit more from digital collection systems because released receivables reduce financing pressure. This can improve interest coverage and cash-flow stability. Collection formalization should therefore be evaluated alongside treasury policy, credit control, and working-capital financing.

For boards and investors, receivable quality should be viewed as part of financial-performance assessment. High revenue growth accompanied by rising receivable days may be less valuable than moderate growth with strong cash realization. Digital collection formalization provides one way to distinguish between sales that are likely to become cash and sales that may create collection risk. Investors should examine DSO trends, receivable aging, doubtful-debt provisions, and disclosure of collection systems together.

The study also has implications for lenders. Banks and credit analysts often evaluate receivables when assessing working-capital loans. Firms with better digital collection systems may present lower cash-conversion risk. The evidence that collection formalization is associated with lower effective interest cost among short-term borrowing-dependent firms suggests that lenders may already respond to collection quality, or that firms with stronger collections require less costly borrowing.

The paper has limitations. The digital collection formalization index is based on public disclosures and financial behavior. Some firms may have strong internal systems but limited disclosure. Others may describe systems that are not fully implemented. The study reduces this concern by combining text-based components with observed receivable outcomes and by testing reduced indexes, but measurement error remains.

Another limitation is that receivable transparency shocks are not perfectly exogenous. Firms may experience such shocks because they grow, change customers, or alter systems. The matched difference-in-differences design and pretrend tests reduce this concern, but they

cannot remove it completely. The evidence should therefore be interpreted as consistent with a financial role for collection formalization rather than as definitive proof of causality.

The sample consists of listed Indian firms, which are larger and more formal than many private firms. The effects may be different among small unlisted enterprises, where digital collection systems may face stronger implementation barriers but potentially larger benefits. Future research could examine private firms using bank transaction data, invoice-level data, or payment platform records. Such data would allow direct measurement of collection timing and customer behavior.

The study also does not observe every customer contract [41]. Payment terms, dispute clauses, credit limits, and customer-specific collection arrangements are often private. These terms likely shape the effectiveness of digital collection formalization. Future research could combine firm financial data with contract data to distinguish between system-driven collection improvement and contract-driven payment discipline.

Future research can also examine whether digital collection formalization affects tax compliance costs, customer retention, lender monitoring, or supplier credit terms. It may also be useful to compare India with other emerging markets where digital payment infrastructure and tax-document systems differ. Such comparisons would clarify whether the findings are specific to India's institutional context or reflect a broader emerging-market receivable mechanism.

The main implication is that the financial value of digitalization depends on where it is embedded. Digital tools that improve collection routines can affect cash flow and profitability even when they do not directly increase sales. In credit-based operating models, the conversion of sales into cash is a central determinant of performance. Digital collection formalization improves that conversion process and reduces receivable uncertainty.

8. Conclusion

This study examined digital collection formalization and financial performance in Indian listed operating firms. Using 612 firms from 2016 to 2024, the analysis found that stronger collection formalization is associated with higher operating return on assets, higher operating cash-flow margin, stronger free-cash-flow conversion, higher earnings persistence, lower working-capital downside risk, and modestly higher valuation.

The primary mechanism is receivable improvement. Digital collection formalization predicts shorter days sales outstanding and lower doubtful-debt provision intensity. These two channels explain a substantial share of the relation between formalization and cash-flow performance. The evidence indicates that collection systems improve financial performance by helping firms convert reported sales into cash more quickly and with less uncertainty.

The effects are stronger after receivable transparency shocks. Firms with stronger pre-shock collection systems perform better when documentation, invoice matching, and payment traceability become more important. This suggests that collection formalization is most valuable when firms prepare before external pressure increases rather than after it becomes unavoidable.

The effects are also stronger among firms with high domestic business-to-business sales, high initial receivable intensity, fragmented customer bases, and greater short-term borrowing dependence. The effects are weaker among export-intensive firms and firms that already have low receivable days. These findings show that the value of collection formalization depends

on where receivable frictions are most economically important.

The study contributes to financial-performance research by showing that receivable infrastructure is a meaningful operating determinant of performance in the Indian context. Financial performance is not shaped only by sales growth, margins, investment, or leverage. It also depends on whether sales are collected efficiently and whether receivable risk is visible early enough to manage.

The results should be interpreted with caution because the analysis uses public disclosures and observational data. Internal collection systems, customer contracts, and invoice-level payment behavior are not fully observed. Future research using transaction-level data could provide more precise evidence. Even with these limitations, the findings support the conclusion that digital collection formalization is financially meaningful for Indian listed firms, especially where credit sales and receivable uncertainty are material.

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