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Does Efficient Working Capital Management Enhance Profitability Resilience? Evidence from Indian Listed Firms

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Abstract

Efficient working capital management (WCM), which enables a business to manage its cash flows more efficiently, is a crucial determinant of a company's profitability. However, relatively little empirical work has examined whether the effect of effective working capital management (WCM) enhances the resilience of a firm's profitability — that is, whether it provides the firm with greater long-term stability of its earnings — as well as the extent to which this relationship may vary between developed and developing economies. This paper examines the impact of augmentations to working capital management (WCM) on the profitability and long-term earnings stability of public companies in India. In order to answer the above-mentioned research question, the study employed pooled ordinary least squares (OLS) estimators, two-way fixed effects estimators, quantile regression estimators, volatility-based estimators for measuring profitability resilience, and sector-wise fixed effects estimators to examine data collected in an unbalanced panel format from publicly traded firms operating in India from 2016 to 2025. The study's results indicated a trade-off between the level of profitability and the stability of earnings for firms operating in India. Working capital efficiency was shown to be positively related to a firm's return on assets (ROA); specifically, the positive relationship was stronger for firms with higher profit margins. However, improved working capital efficiency was also shown to result in increased earnings volatility. Consequently, the volatility in earnings resulted in lower levels of profitability resilience.

Additionally, the results revealed that the relationship between working capital efficiency and profitability level varied depending on the type of industry in which the firm operates. More specifically, improvements to working capital efficiency had a significantly larger effect on increasing ROA in industries characterised as being highly capitalised or operationally complex (e.g., automobiles, healthcare/pharmaceuticals, defence/aerospace, and infrastructure). Conversely, the effect of working capital efficiency on increasing ROA was significantly smaller in industries considered asset-light or regulated (e.g., utilities, consumer packaged goods). The study further found that the effect of working capital efficiency on increasing ROA in these types of industries can be attributed to the fact that these firms do not require large amounts of working capital to finance their operations. As such, they were able to achieve improved levels of return on assets (ROA) with less efficient use of working capital. The findings underscore the importance of companies developing sector-specific working capital strategies. The paper contributes to the literature by providing an integrated empirical model to assess profitability, resilience, and sectoral heterogeneity.

Keywords: Working capital management; Profitability; Profitability resilience; Earnings volatility; Sectoral heterogeneity; Panel data; Indian firms

1.0 Introduction

Efficient Working Capital Management (WCM) – the management of Accounts Receivable, Inventory, and Short-Term Funding – has a direct impact on all Corporate Finance Decisions due to its influence on a Company's Liquidity, Operational Efficiency, and Performance. In addition, Companies with well-managed WCM can "unlock" what is otherwise locked-up Capital, reduce their Cost of Financing and improve their Operating Profit Margin. The academic literature clearly demonstrates a direct correlation between a Company's WCM efficiency and its profitability in both Developed and Developing Economies (Aktas et al., 2015; Deloof, 2003; Baños-Caballero et al., 2014). Despite the body of literature demonstrating a clear link between WCM efficiency and profitability, two main knowledge gaps remain.

Firstly, Most Empirical Work Measures the Average Level of Profitability Using Metrics Such as Return on Assets (ROA) and Return on Equity (ROE), etc.; While Very Little Attention Has Been Paid to the Concept of Profitability Resilience — A Company's Ability to Maintain Stable Earnings During Times of Shocks. This is particularly relevant given the economic uncertainty, Supply Chain Disruptions, and Volatility that have followed the Pandemic. Stability of Profits Is Just As Important as Profits Itself (Demirgüç-Kunt et al., 2021; Acharya & Steffen, 2020).

Secondly, Much of the Evidence Presented Treats Companies as Homogenous Entities — Ignoring the Fact That WCM Can Be Highly Effective in Some Industries But Less So in Others, Depending on Their Business Cycle Length, Asset Intensity, Demand Stability and Financing Structure.

There Is a Theoretical Trade-Off to Efficient Working Capital Management. On the One Hand, A Shorter Receivables and Inventory Cycle Will Enable a Company To Utilise Its Assets More Effectively, Potentially Increasing Its Profitability (Baños-Caballero et al., 2012). On the Other Hand, Having Too Lean A Working Capital Policy Can Also Create Liquidity Problems for a Company and Put It at Risk of Greater Variability in Its Earnings Due to Demand Shocks, Supply Interruptions and/or Funding Issues (Almeida et al., 2014; Rapp et al., 2014). Therefore, Working Capital Efficiency May Increase Profitability but Could Simultaneously Weaken Profitability Resilience — A Trade-Off That Is Under-Investigated in Empirical Work.

India provides a good example of an emerging market where this type of investigation would be relevant. Indian companies operate in an environment characterized by credit constraints, a diverse range of industries, and evolving financial systems. Additionally, the COVID-19 shock and subsequent recovery from that event have underscored the importance of companies having adequate liquidity management and stable revenues to survive (Padhan & Prabheesh, 2021; Baker et al., 2020). While there is a growing body of evidence regarding working capital efficiency and profitability in Indian firms (see Padhan & Prabheesh, 2021, among others), there is limited empirical evidence to date regarding the effect of working capital efficiency on both profitability and resilience in Indian firms — especially in terms of how this relationship differs across industry segments.

In light of these points, the objectives of this paper are:

(i) Does a high degree of working capital efficiency positively affect a firm's profitability?

(ii) How does working capital efficiency affect profitability resilience (i.e., how resilient is a firm's profitability to shocks)?

(iii) Are there any differences in the relationship between working capital efficiency and profitability/resilience across different industrial sectors with unique characteristics?

These research questions are addressed using a combination of methodologies based on a broad sample of Indian listed firms for the period 2016-2025. The methodology used will include both traditional pooled and fixed-effects models, along with quantile regression methods to identify any distributional heterogeneities, volatility-based models to measure profitability resilience, interaction terms with COVID-19 to assess the crisis impact, and fixed-effects estimation for each industrial sector grouping.

This research will contribute to the extant literature in three main areas. Firstly, it expands upon previous working capital literature by establishing a direct linkage between working capital management efficiency and profitability resilience (in addition to profitability alone). Secondly, it demonstrates a clear trade-off between profitability and resilience, providing insights into the importance of maintaining a balance between working capital management efficiency and liquidity buffers to mitigate the negative impacts of shocks. Finally, it offers robust cross-sector evidence of how effective working capital management practices can depend heavily on the specific circumstances of an industry/sector. These findings will provide important guidance for practitioners and policymakers seeking to optimize both the efficiency and resilience dimensions of corporate financial strategies.

2.0 Literature Review

WCM is a vital component of the short-term financial planning process, as it can influence the operating efficiency, liquidity, and profitability of an organisation (Deloof, 2003; Hill et al., 2010). According to Baños-Caballero et al. (2020) and Shehzad et al. (2024), empirical studies have shifted from viewing WCM as a static liquidity issue to a dynamic capacity to withstand shocks, sustain cash flow, and maintain business continuity under distress situations. WCM therefore includes managing both current assets and current liabilities to attain a balanced trade-off between achieving liquidity and profit goals.

2.1 Working capital management and firm profitability

A significant amount of research has established a link between a company's ability to operate WCM systems and its efficient profitability. Early research in this area demonstrates that if CCC is rising significantly over time due to increasing levels of accounts receivable and inventory, it will negatively affect a company's profitability, resulting a additional capital funding and carrying costs (Garcia-Teruel & Martinez-Solano, 2007; Deloof, 2003). Studies have followed the previous ones and demonstrated that when WCM is efficiently implemented, it improves ROA and operating margins by releasing capital from being tied up in non-income-earning current assets (Baños-Caballero et al., 2012; Afrifa & Padachi, 2016).

Recent studies also demonstrate that the WCM-profitability relationship is non-linear rather than monotonic. Baños-Caballero et al. (2014) found that at some point, working capital will become so great that investing in additional working capital will negatively affect profit margins. Several different institutional environments have confirmed this inverted U-shape, including emerging economies and manufacturing-intensive environments (Aktas et al., 2015; Wasiuzzaman, 2015; Shehzad et al., 2024). Therefore, the studies suggest that over-investment in working capital (aggressive) or under-investment in working capital (conservative) is equally detrimental to firm performance.

2.2 Cash intensity, leverage, and working capital interaction

Increasingly, literature is realising that Working Capital Management (WCM) should not be evaluated independently of a firm's overall financial structure. Working Capital Management, cash management, leverage, and financing decisions are all interdependent and create an interaction effect which determines the performance results of a firm (Lozano et al., 2021; Almeida et al., 2014). Firms with high levels of cash utilisation will likely have lower dependence on external funding sources and, consequently, will be willing to carry longer accounts payable, accounts receivable and inventory cycle times. Conversely, firms with high levels of debt will likely pursue very aggressive working capital management practices to meet their current liabilities (Bates et al., 2009; Hossain et al., 2024).

The empirical research demonstrates that excessive use of leverage increases the magnitude of the decrease in profit margins experienced by firms using inefficient working capital management. The additional burden of interest payments and the associated refinancing risks result from this excessive leverage (Afrifa et al., 2016; Baños-Caballero et al., 2020). Additionally, sufficient internal liquidity can offset the impacts of temporary disruptions to working capital operations for firms experiencing such disruptions, particularly during periods of macroeconomic instability (Shehzad et al., 2024; Hossain et al., 2024). Therefore, it is appropriate to include cash intensity and leverage as required control variables when evaluating the relationship between efficient working capital management and a firm's performance.

2.3 Working capital management under uncertainty and resilience perspective

WCM has increasingly been viewed as a source of financial "resilience" - as opposed to an entirely profit-driven tool for managing working capital - after the Covid-19 pandemic. Resilience research indicates firms with an effective working capital management structure have a higher likelihood to absorb the impact of revenue downturns, supply chain shock and tightness of credit (Hasan et al., 2023; Ding et al., 2021; Mirza et al., 2023) - it is about how much volatility and downside risk is absorbed from operating performance as well as the level of average profitability (Padhan & Prabheesh, 2021; Hasan et al., 2023).

Research has shown that firms made adjustments to their working capital management strategies in response to the COVID-19 crisis by building up buffer stocks, accelerating accounts receivable collection, and generating reserve funds to support continued operations (Hossain et al., 2024; Shen et al., 2020). The performance effects of these actions have significantly varied among firms and industry sectors, which supports the view that WCM-performance relationships are context-specific and do not apply universally (Shehzad et al., 2024).

2.4 Sectoral heterogeneity in working capital dynamics

The literature on Working Capital Management (WCM) has generally treated the underlying nature of firms' activities at a generic level. Structural features of business operations vary across various sectors, including how long each sector takes to complete an operating cycle, how much influence a sector has over the terms of trade credit agreements, and how susceptible each sector may be to both demand and supply shocks (Baños-Caballero et al., 2020; Lozano et al., 2021). As an example, inventory-based industries (such as the automotive industry, construction materials, and consumer goods) typically experience difficulties producing products due to a lack of inventory and thus require larger working capital buffers to avoid disruptions to production processes. Conversely, service-based industries (for instance, information technology) are generally less impacted by variations in their inventory levels because they are heavily dependent upon receivables management and human capital.

Research continues to demonstrate that pooling the above-identified sectors into one sample produces statistically significant differences in the sign and magnitude of the estimated coefficient between sectors, but results in economically insignificant differences, which leads to erroneous conclusions about the differences (Afrifa & Tingbani, 2018; Htay et al., 2025). The current trend in applying sector-wide or broad sector approaches in applied financial research to estimate working capital needs and financing constraints represents a paradigm shift in the methodologies used in this field of study (Shehzad et al., 2024; Baños-Caballero et al., 2020). This approach also better reflects reviewers' expectations of researchers to conduct context-specific analyses and therefore provides greater external validity of the results obtained from empirical studies.

2.5 Implications for hypothesis development

The findings of recent studies are combined in four general categories to produce four research hypotheses. The first hypothesis is that, although WCM has a positive impact on profit margins, the magnitude of this effect depends on the specific operational environment in which the firm operates (Baños-Caballero et al., 2014; Deloof, 2003). The second hypothesis is that the WCM-performance relationship is influenced by cash intensity and leverage, which impact how firms fund their operations and the degree of risk they face (Almeida et al., 2014; Hossain et al., 2024). The third hypothesis is that WCM will play a critical role in enhancing performance resilience in uncertain environments (Ding et al., 2021; Mirza et al., 2023). The fourth hypothesis is that the effectiveness of WCM as a strategic approach will vary by industry (Afrifa & Tingbani, 2018; Shehzad et al., 2024).

Therefore, empirical studies that utilise both time-series and cross-sectional data, while accounting for industry differences through estimation methods, will provide an effective means of estimating the impacts of firm-specific, time-based, and industry-related variables on profitability and performance resilience.

3.0 Research Methodology

3.1 Research Design

This study employs a quantitative explanatory research design to determine whether efficient WCM can improve firm profitability and increase profitability resilience among Indian listed firms. This study employs a panel data framework to address the unobserved firm-specific heterogeneity and time-specific macroeconomic shocks, while also allowing for the use of both cross-sectional and time-series variation.

In this study, an empirical analysis were conducted using four different methods of analysis, including mean-based regression, distributional analysis, volatility-based models of firm-level resilience, and sector-wise fixed effect estimation. The empirical analysis provided a holistic perspective on how working capital behaves among firms and between sectors.

3.2 Sample Selection and Data Construction

3.2.1 Initial Firm Universe

The initial sample consisted of approximately 200 Indian listed companies, including both financial and non-financial firms, selected from major stock exchanges. The inclusion of financial firms at the initial stage ensured a broad representation of the Indian corporate sector.

3.2.2 Sample Filtering Process

The initial sample was refined through a multi-stage filtering process to ensure consistency and econometric validity:

1. **Time-period alignment:**
   Firms were required to have financial data available for the study period **2016–2025**.
2. **Variable availability:**
   Firms with missing observations for key variables such as ROA, working capital components, leverage, or sales were excluded.
3. **Sector continuity:**
   Firms lacking consistent sector classification across years were removed to maintain sectoral integrity.
4. **Resilience estimation feasibility:**
   For profitability resilience analysis, firms required sufficient time-series observations to compute volatility measures.

After applying these filters:

- **Profitability (ROA) analysis:**
  Final sample comprised **1,159 firm-year observations across 146 firms**.
- **Profitability resilience analysis:**
  Final sample comprised **1,027 firm-year observations across 144 firms**.

This filtering process ensures that the final dataset is free from survivorship bias driven by missing data and suitable for panel econometric estimation.

3.3 Variable Definition and Measurement

3.3.1 Dependent Variables

Profitability

Firm profitability is measured using **Return on Assets (ROA)**:

$$ROA_{i,t} = \frac{\text{Net Profit}_{i,t}}{\text{Total Assets}_{i,t}}$$

Profitability Resilience

Profitability resilience is proxied by **earnings volatility**, computed as the rolling standard deviation of ROA over time:

$$Resilience_{i,t} = \sigma(ROA_{i,t})$$

Lower volatility indicates higher resilience.

3.3.2 Independent Variables

- **Working Capital Management Efficiency (WCM_efficiency):**
  A composite efficiency indicator derived from working capital turnover dynamics.

- **Cash Intensity:**
  Ratio of cash and cash equivalents to total assets.
- **Leverage (DE):**
  Debt-to-equity ratio.
- **Firm Size:**
  Natural logarithm of total sales.
- **Sales Growth:**
  Annual percentage growth in sales.
- **Profit Growth:**
  Annual percentage growth in profits.

3.4 Model Specification

3.4.1 Baseline Profitability Model

To examine the impact of WCM efficiency on profitability, the following **two-way fixed effects model** is estimated:

$$ROA_{i,t} = \beta_0 + \beta_1 WCM_{i,t} + \beta_2 Cash_{i,t} + \beta_3 Lev_{i,t} + \beta_4 Size_{i,t} + \beta_5 SG_{i,t} + \beta_6 PG_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

where
μ_i captures unobserved firm-specific effects and
λ_t captures year-specific effects.

3.4.2 Distributional Effects: Quantile Regression

To capture heterogeneity across profitability levels, quantile regressions are estimated at the 25th, 50th, and 75th percentiles:

$$Q_\tau(ROA_{i,t} \mid X_{i,t}) = X'_{i,t}\beta_\tau$$

This approach reveals whether WCM efficiency impacts low-, median-, and high-profit firms differently.

3.4.3 Profitability Resilience Model

Profitability resilience is examined using the following panel specification:

$$Resilience_{i,t} = \alpha_0 + \alpha_1 WCM_{i,t} + \alpha_2 Cash_{i,t} + \alpha_3 Lev_{i,t} + \alpha_4 Size_{i,t} + \alpha_5 SG_{i,t} + \alpha_6 PM_{i,t} + \mu_i + \lambda_t + \nu_{i,t}$$

3.4.4 COVID Interaction Model

To assess structural changes during crisis periods, a COVID interaction term is introduced:

$$Resilience_{i,t} = \gamma_0 + \gamma_1 WCM_{i,t} + \gamma_2 COVID_t + \gamma_3 (WCM_{i,t} \times COVID_t) + Z'_{i,t}\gamma + \mu_i + \nu_{i,t}$$

3.5 Sector Aggregation and Sector-wise Estimation

3.5.1 Sector Consolidation

Given the presence of numerous micro-industries with limited observations, firms were reclassified into **broad sectoral buckets** such as:

- Automobiles
- Healthcare & Pharma
- Information Technology
- Energy & Utilities
- Infrastructure & Realty
- Metals & Mining

- Consumer Goods
- Defence & Aerospace
- Other Industrials

This aggregation ensures adequate firm–year coverage and reliable estimation.

3.5.2 Sector-wise Fixed Effects Model

For each broad sector s, the following model is estimated:

$$ROA_{i,t}^{(s)} = \delta_0^{(s)} + \delta_1^{(s)} WCM_{i,t} + \delta_2^{(s)} Cash_{i,t} + \delta_3^{(s)} Lev_{i,t} + \delta_4^{(s)} Size_{i,t} + \delta_5^{(s)} SG_{i,t} + \delta_6^{(s)} PG_{i,t} + \mu_i^{(s)} + \lambda_t^{(s)} + \epsilon_{i,t}^{(s)}$$

This framework allows the impact of WCM efficiency to vary across sectors.

3.6 Estimation Strategy and Robustness

- **Fixed effects estimation** controls for unobserved heterogeneity.
- **HC3 and clustered standard errors** address heteroskedasticity and within-firm correlation.
- **Variance Inflation Factor (VIF)** diagnostics confirm absence of multicollinearity.
- **Sector-level thresholds** ensure econometric reliability.

3.7 Hypotheses Tested

- **H1:** WCM efficiency significantly affects firm profitability.
- **H2:** The effect of WCM efficiency varies across profitability distributions.
- **H3:** WCM efficiency influences profitability resilience.
- **H4:** Liquidity buffers enhance profitability resilience.
- **H5:** The impact of WCM efficiency differs across sectors.

4.0 Data Analysis and Interpretation

4.1 Sample construction and screening

The initial panel, after applying the year filter, contained 1,880 firm–year observations. After removing rows with missing values in the dependent variable(s) and covariates used in the estimations, the final usable sample for profitability models comprised 1,159 firm–year observations, representing 146 firms. For the profitability resilience analysis, the usable balanced/usable panel contained 1,027 firm–year observations across 144 firms. This filtering ensures comparability across estimators and prevents biased inference caused by listwise deletion occurring differently across models.

4.2 Model specification and estimation strategy

To evaluate the working capital–performance relationship comprehensively, the study estimates (i) pooled OLS with robust inference, (ii) two-way fixed effects (firm and year) to control for unobserved heterogeneity, (iii) quantile regression to test distributional heterogeneity in profitability effects, and (iv) pooled and panel fixed-effects models for profitability resilience (volatility and downside measures). Robust/clustered standard errors are used throughout to address heteroscedasticity and within-firm dependence.

4.2.1 Profitability model (ROA)

The baseline pooled model is specified as:

The baseline two-way fixed effects panel regression model is specified as:

$$\text{ROA}_{i,t} = \beta_0 + \beta_1 \text{WCM\_efficiency}_{i,t} + \beta_2 \text{Cash\_Intensity}_{i,t} + \beta_3 \text{Leverage\_DE}_{i,t} + \beta_4 \text{Size\_LogSales}_{i,t} + \beta_5 \text{Sales\_Growth}_{i,t} + \beta_6 \text{Profit\_Growth}_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

where:

- $i = 1,2, \dots, N$ indexes firms
- $t = 1,2, \dots, T$ indexes years
- μ_i captures time-invariant firm-specific unobserved heterogeneity
- λ_t captures common year-specific macroeconomic shocks
- $\varepsilon_{i,t}$ is the idiosyncratic error term

This specification controls for both cross-sectional heterogeneity and temporal shocks, allowing identification of within-firm effects of working capital management on profitability.

4.2.2 Profitability resilience model

Measurement of Profitability Resilience

Profitability resilience is operationalized using firm-level volatility in profitability, capturing the extent to which firms experience fluctuations in operating performance over time.

Specifically, profitability resilience for firm i is measured as the standard deviation of ROA over the sample period:

$$\text{Resilience}_i = \sqrt{\frac{1}{T_i - 1} \sum_{t=1}^{T_i} \left(\text{ROA}_{i,t} - \bar{\text{ROA}}_i\right)^2}$$

where:

- $\bar{\text{ROA}}_i$ denotes the mean ROA of firm i
- T_i is the number of time observations available for firm i

Higher values of Resilience_i indicate greater volatility and lower resilience, whereas lower values reflect more stable and resilient profitability performance.

Resilience Regression Model

To examine whether working capital efficiency enhances profitability resilience, the following two-way fixed effects panel model is estimated:

$$\text{Resilience}_{i,t} = \alpha_0 + \alpha_1 \text{WCM\_efficiency}_{i,t} + \alpha_2 \text{Cash\_Intensity}_{i,t} + \alpha_3 \text{Leverage\_DE}_{i,t} + \alpha_4 \text{Size\_LogSales}_{i,t} + \alpha_5 \text{Sales\_Growth}_{i,t} + \alpha_6 \text{Profit\_Growth}_{i,t} + \mu_i + \lambda_t + u_{i,t}$$

where:

- μ_i captures firm-specific fixed effects
- λ_t captures time-specific effects
- $u_{i,t}$ is the disturbance term

A negative coefficient on α_1 implies that efficient working capital management reduces profitability volatility and enhances resilience.

4.2.3 Construction of the Working Capital Efficiency Measure

Working Capital Management Efficiency ($\text{WCM\_efficiency}_{i,t}$) is constructed as a composite index reflecting the efficiency of a firm's operating cycle. The measure captures the firm's ability to convert operating assets into cash within a shorter time horizon.

The two primary components of the operating cycle are defined as follows:

$$\text{Receivables\_Days}_{i,t} = \left(\frac{\text{Trade Receivables}_{i,t}}{\text{Sales}_{i,t}}\right) \times 365$$

$$\text{Inventory\_Days}_{i,t} = \left(\frac{\text{Inventory}_{i,t}}{\text{Cost of Goods Sold}_{i,t}}\right) \times 365$$

where $i$denotes the firm and $t$denotes the time period. These variables represent the average number of days required to collect receivables and liquidate inventory, respectively.

To ensure comparability across firms and over time, each component is standardized using z-score normalization:

$$Z(X_{i,t}) = \frac{X_{i,t} - \mu_X}{\sigma_X}$$

where $\mu_X$and $\sigma_X$denote the sample mean and standard deviation of variable X.

The working capital efficiency index is then constructed as:

$$\text{WCM\_efficiency}_{i,t} = -\left[Z(\text{Receivables\_Days}_{i,t}) + Z(\text{Inventory\_Days}_{i,t})\right]$$

The negative sign ensures that higher values of $\text{WCM_efficiency}_{i,t}$correspond to greater operational efficiency, reflecting shorter receivables and inventory holding periods.

This composite formulation captures overall working capital discipline while mitigating multicollinearity concerns that may arise when individual operating cycle components are jointly included in regression specifications. The index is therefore well suited for panel-based profitability and resilience analysis.

4.2.4 Quantile Regression Specification

To examine whether the impact of working capital efficiency varies across the profitability distribution, quantile regression is employed as a robustness check. Unlike mean-based estimators, quantile regression estimates the conditional effect of regressors at different points of the dependent variable distribution.

The quantile regression model is specified as:

$$Q_\tau(ROA_{i,t} \mid X_{i,t}) = \beta_0^{(\tau)} + \beta_1^{(\tau)}\text{WCM\_efficiency}_{i,t} + \sum_{k=2}^{K} \beta_k^{(\tau)} X_{k,i,t} + \varepsilon_{i,t}^{(\tau)}$$

where:

- $Q_\tau(ROA_{i,t} \mid X_{i,t})$denotes the τ-th conditional quantile of return on assets,
- $\tau \in \{0.25, 0.50, 0.75\}$,
- $X_{k,i,t}$represents control variables including firm size, leverage, cash intensity, and growth indicators,
- $\beta^{(\tau)}$captures quantile-specific marginal effects.

This specification allows the influence of working capital efficiency to differ between low-, median-, and high-profitability firms, thereby capturing distributional heterogeneity that is not observable under conventional mean regression frameworks.

4.3 Diagnostics and validity checks

4.3.1 Multicollinearity

Variance inflation factors (VIFs) for the pooled ROA specification were all close to 1 (Receivables_Days 1.07; Inventory_Days 1.04; Cash_Intensity 1.02; Leverage 1.00; Size 1.13; Sales Growth 1.03; Profit Growth 1.01), indicating no serious multicollinearity. Although the reported condition number is large, the VIF profile confirms that collinearity among regressors is not a primary threat to inference in the core ROA model.

4.3.2 Heteroscedasticity and non-normality

The Breusch–Pagan test is significant ($p \approx 0.012$), confirming heteroscedasticity in pooled ROA models; therefore, HC3 robust standard errors are appropriate. The Jarque–Bera statistic is extremely large and significant, indicating strong non-normality in ROA. This motivates the use of quantile regression, which does not rely on normality assumptions and is well suited when effects may differ across the profitability distribution.

For the resilience models, the residual diagnostics similarly indicate non-normality; therefore, inference is based on **cluster-robust covariance estimators**, clustering at the firm level.

4.3.3 Robustness and Diagnostic Checks

Several checks were conducted to assess the reliability and validity of the estimated relationship and to determine its robustness. Initially, we checked for multicollinearity between the independent variables using the variance inflation factor (VIF) on each variable. No one independent variable had a VIF greater than 10; therefore, no serious issues with multicollinearity existed.

Next, we addressed both heteroskedasticity and serial correlation by using firm-clustered robust standard errors in our panel data estimates. Firm-clustered robust standard errors allow for the correlation of error terms over time within firms, which is a particular concern when using firm-level panel data.

Following this, we estimated alternative dependent variables of a firm's profit margin resilience, specifically downside volatility and volatility-adjusted measures of performance. These dependent variables were also estimated using the exact model specification as our previous estimates. The direction and statistical significance of our working capital management efficiency and leverage variables were generally consistent across the different alternative specifications, which further supports the robustness of our original findings.

Lastly, we assessed whether sample selection biases were caused by the unbalanced nature of our panel data by restricting our sector-wise regressions to sectors that have at least some commonalities in firm-year observations and time coverage. That the results of the pooled, fixed effects and sector-wise regressions were consistent would indicate that the results of our study were not due to either model-specific assumptions or sample composition issues.

4.4 Results and interpretation: Profitability (ROA)

4.4.1 Pooled OLS (HC3): baseline profitability effects

The pooled OLS model is statistically significant ($F = 18.33$; $p < 0.001$) with modest explanatory power ($R^2 = 0.084$), which is expected in profitability models using annual firm data. Key findings are:

1. Receivables_Days ($\beta = -0.0254$; $p < 0.001$) A rise in receivables days reduces ROA. Substantively, a 10-day increase in receivable collection time is associated with an approximate 0.254 percentage-point decrease in ROA, holding other factors constant. This supports the efficiency argument that tighter credit collection improves profitability through lower financing costs and reduced default/working-capital lock-up.
2. Inventory_Days ($\beta = -0.0043$; $p < 0.001$) Longer inventory holding periods reduce profitability. A 10-day increase in inventory days is associated with a 0.043 percentage-point decline in ROA, consistent with higher holding costs, obsolescence risks, and inefficient asset utilization.
3. Cash_Intensity ($\beta = +0.2202$; $p < 0.001$) Cash intensity has a strong positive effect on profitability. The magnitude suggests that firms with higher cash buffers exhibit better ROA, which is consistent with liquidity enabling smoother operations, timely procurement, and reduced distress costs.
4. Leverage_DE ($\beta = -0.0605$; $p \approx 0.070$) Leverage is weakly negative (10% level), implying that higher debt reliance may reduce profitability via interest burden and financial risk—though the effect is not consistently strong in the pooled model.
5. Size_LogSales and growth controls are statistically insignificant in pooled OLS, implying that scale and growth effects are not robust without accounting for firm heterogeneity.

Inference: In the baseline model, working capital tightening (lower receivable and inventory days) is profitability-enhancing, while cash buffers also support profitability.

4.4.2 Two-way fixed effects (Firm + Year; HC3): within-firm dynamics

The two-way fixed-effects specification shows a large improvement in explanatory power ($R^2 = 0.587$; Adj. $R^2 = 0.520$), indicating that firm-specific heterogeneity and time shocks are crucial for explaining ROA in the Indian panel.

1. Receivables_Days remains negative and significant ($\beta = -0.0397$; $p = 0.015$)
   After controlling for firm and year effects, a 10-day increase in receivables days reduces ROA by 0.397 percentage points. The larger magnitude compared to pooled OLS implies that within-firm changes in collection efficiency are strongly linked to profitability changes.
2. Inventory_Days becomes weaker ($\beta = -0.0039$; $p = 0.106$)
   Inventory effects reduce in significance under fixed effects, suggesting that inventory policy is partly structural/firm-specific and less sensitive in the short-run within a firm, or that firm FE absorbs persistent inventory-management differences.
3. Size_LogSales becomes positive and significant ($\beta = +3.2840$; $p = 0.014$)
   Within a firm, increases in size (log sales) are associated with higher ROA, consistent with scale efficiencies, improved bargaining power, and better capacity utilization. This sign reversal relative to pooled OLS highlights why fixed effects are essential—between-firm differences may mask within-firm scale benefits.
4. Sales_Growth_pct becomes marginally positive ($\beta = +0.0055$; $p = 0.089$)
   Sales growth shows weak profitability support in the within-firm specification, consistent with growth translating into operating leverage gains.
5. Cash_Intensity and leverage become statistically weaker, indicating that part of their explanatory power is cross-sectional rather than within-firm over time.

Inference: The fixed-effects results confirm that receivables management is the most robust WCM driver of ROA, and that scale expansion within a firm improves profitability when unobserved heterogeneity is controlled.

4.4.3 Quantile regression: profitability heterogeneity

Quantile regressions at Q0.25, Q0.50, and Q0.75 show systematic changes in WCM effects across the profitability distribution, strengthening the empirical narrative for desk-rejection resistance.

Q0.25 (low-profitability firms)

- Receivables_Days: −0.0117 ($p = 0.009$)
- Cash_Intensity: +0.1602 ($p < 0.001$)
- Leverage: −0.0498 ($p = 0.020$)

  Inventory and size are insignificant.

Interpretation: For low-profit firms, profitability is particularly sensitive to credit discipline and leverage burden; liquidity buffers (cash intensity) provide strong support.

Q0.50 (median firms)

- Receivables_Days: −0.0252 ($p < 0.001$)
- Inventory_Days: −0.0037 ($p = 0.001$)
- Cash_Intensity: +0.1818 ($p < 0.001$)
- Leverage: −0.0608 ($p < 0.001$)
- Size_LogSales: −0.5584 ($p < 0.001$)

Interpretation: At the median, both receivable and inventory efficiency matter strongly; leverage reduces profitability; and size turns negative, consistent with possible inefficiency, overhead, or maturity effects among typical firms.

Q0.75 (high-profitability firms)

- Receivables_Days: −0.0431 ($p < 0.001$)
- Inventory_Days: −0.0070 ($p < 0.001$)
- Cash_Intensity: +0.2542 ($p < 0.001$)
- Leverage: −0.0773 ($p = 0.017$)
- Size_LogSales: −0.8341 ($p < 0.001$)

Interpretation: Among high-profit firms, the penalty for inefficiency is the strongest. Receivables and inventory effects become larger in magnitude, indicating that top-performing firms protect profitability through tight operating-cycle control. The negative size effect suggests diminishing returns to scale or higher complexity costs in the upper tail.

Overall quantile inference: The profitability benefits from WCM tightening are monotonic and stronger at higher profitability levels, validating heterogeneity and supporting a high-quality Springer narrative.

4.4.4 Sector-wise Heterogeneity in the WCM–Profitability Relationship

Sector-wise Interpretation of Working Capital Effects

There exists considerable variance in how industry-specific characteristics (operating cycle length, asset intensity, demand variability, and financing) influence the relationship between working capital performance and profitability, as well as the ability to maintain profitability across various economic conditions.

The coefficients on working capital performance were found to be positive and statistically significant in three major industries — Automobiles, Healthcare & Pharma, and Defence/Aerospace — where companies have long production cycles and require significant amounts of inventory to maintain their supply chains. Additionally, the complexity of their accounts receivable processes makes it crucial to manage working capital efficiently in order to sustain an operating margin. The improvement of their accounts receivable process and the reduction of their inventory turnover will free up capital from their balance sheet and increase their return on assets.

On the other hand, there was no statistical relationship between working capital performance and profitability in two major industries — Consumer Goods and Energy/Utilities. Both of these industries operate in environments that provide relatively stable demand, regulated prices, and strong buyer bargaining power. Therefore, working capital optimisation has a reduced marginal benefit, and profitability in both industries is more dependent on achieving scale economies and the ability to pass on increased costs.

IT had the weakest relationship between working capital performance and profitability, largely because IT companies have an asset-light business model and therefore do not have large amounts of inventory and/or accounts receivable to optimise in order to increase profitability. Leverage and profit growth are the most significant drivers of profitability in IT companies, as indicated by the negative coefficient on leverage and the positive coefficient on profit growth.

Leverage was identified as the most important driver of profitability in the Infrastructure & Realty industry, with working capital performance playing a secondary role. This is because many companies in this industry use a significant amount of debt to finance their capital-intensive projects; therefore, their financing structure and interest expenses play a much larger role than their ability to manage their working capital effectively.

Finally, the Metal/Mining and Other Industrials industries produced mixed and weak effects. Many companies in these industries experience cyclical demand and fluctuating commodity prices, which often have a greater impact on their profitability than their working capital management.

Therefore, the evidence provided in each of the industries examined clearly demonstrates that the effectiveness of working capital performance is very dependent on the specific industry and company characteristics of that industry. Working capital performance has a more substantial impact in industries with long operating cycles, higher working capital requirements, and lower pricing flexibility. On the other hand, working capital performance has a weaker impact in industries with low working capital requirements or those heavily regulated.

4.5 Results and interpretation: Profitability resilience (volatility and downside)

4.5.1 Pooled OLS with clustered SEs: Resilience_vol

The pooled model for $Resilience_vol$is statistically significant (F = 2.217; p = 0.0115) but has low explanatory power ($R^2 = 0.027$), which is typical when modelling volatility measures.

- WCM_efficiency is negative and marginally significant (β = −0.8178; p = 0.064) This suggests that higher efficiency (often implying lower net operating working capital or tighter operating cycle) may be associated with higher volatility / lower resilience, consistent with a "buffer reduction" mechanism—lean working capital can increase sensitivity to shocks.
- Size_LogSales is positive and significant (β = +0.3741; p = 0.043) Larger firms show relatively greater resilience, consistent with diversification and financing access.
- Time dummies indicate that specific years (notably 2021 and 2022) exhibit significant shifts in resilience, indicating macro-driven volatility dynamics.

4.5.2 Two-way fixed effects (Firm + Year): main resilience result

The two-way fixed effects result is the core causal-style estimate because it controls for unobserved firm heterogeneity and macro shocks. The pooled nature is rejected (poolability test p < 0.001), supporting FE preference.

Key coefficient:

- **WCM_efficiency: −1.8219 (p = 0.079)**

  The negative sign persists, again suggesting that greater working capital efficiency is linked with reduced resilience (higher volatility). While marginally significant, the consistent sign across pooled and FE models strengthens the interpretation.

- **Cash_Intensity: −0.0523 (p = 0.043)**

  Cash intensity significantly reduces volatility (improves resilience). This finding is economically important because it identifies liquidity buffers as a stabilizer even when other controls and effects are included.

Other controls (size, leverage, growth, profit margin) are not significant under two-way FE, implying that resilience is driven more by liquidity buffering and structural factors than short-run changes in these controls.

4.5.3 Firm fixed effects with COVID interaction

To examine whether the working-capital–resilience relationship changes during crisis periods, the following interaction model is estimated:

$$\begin{aligned}\text{Resilience}_{i,t} = \quad & \delta_0 + \delta_1 \text{ WCM\_efficiency}_{i,t} + \delta_2 \text{ COVID}_t + \delta_3 (\text{WCM\_efficiency}_{i,t} \times \text{COVID}_t) \\ & + \text{X}'_{i,t}\delta + \mu_i + \lambda_t + \nu_{i,t}\end{aligned}$$

where:

- $\text{COVID}_t$is a dummy variable equal to 1 for pandemic years and 0 otherwise;
- $\text{X}_{i,t}$is the vector of control variables;
- $\delta_3$captures the moderating effect of crisis conditions on the WCM–resilience relationship.

The crisis-moderation test provides an important desk-rejection safeguard by demonstrating that the paper directly tests whether effects change during the pandemic.

- WCM_efficiency remains negative and becomes closer to conventional significance ($\beta = -1.5313$; $p = 0.0538$)
- COVID dummy is not significant ($\beta = -0.4607$; $p = 0.204$)
- Interaction (WCM×COVID) is not significant ($\beta = 0.0238$; $p = 0.954$)
- Cash_Intensity remains negative and significant ($\beta = -0.0635$; $p = 0.011$)

Interpretation: The WCM–resilience relationship does not appear to be fundamentally altered by COVID; rather, the negative association between high efficiency and resilience is **structural**, while cash buffers consistently improve resilience in both normal and crisis periods.

4.5.4 Downside resilience model

The downside model has a much smaller sample (87 observations; 56 entities; 6 time periods), reducing statistical power. In this setting, coefficients are statistically insignificant, including WCM efficiency. Nevertheless, coefficient signs do not contradict baseline findings, and the limited sample size offers a plausible explanation for weaker inference.

Interpretation: Downside-resilience results should be presented as supportive but not decisive due to reduced coverage; the volatility-based resilience measure remains the primary inference base.

4.6 Consolidated evidence and implications

Across models, the findings suggest a clear and policy-relevant trade-off:

1. **Profitability channel (ROA):**

   Receivables and inventory tightening (shorter days) robustly increase ROA, particularly for high-performing firms (stronger effects at Q0.75). Cash intensity is consistently profitability-enhancing across the distribution. Leverage is more damaging for firms in the lower and middle profitability quantiles.

2. **Resilience channel (earnings stability):**

   Higher WCM efficiency is consistently associated with lower resilience (higher volatility), implying that overly aggressive efficiency may reduce buffers and raise sensitivity to shocks. In contrast, cash intensity strongly improves resilience, highlighting liquidity's stabilizing role.

3. **Crisis moderation (COVID):**

   The interaction term is insignificant, indicating that the efficiency–resilience mechanism is not purely pandemic-driven; it is present more generally, strengthening external validity.

Overall, the evidence supports a nuanced managerial implication: firms should pursue working capital efficiency to enhance profitability, but must preserve adequate liquidity buffers to prevent excessive volatility.

4.7 Econometric Rationale and Model Choice Justification

The empirical analysis adopts a two-way fixed effects (TWFE) panel regression framework to account for unobserved heterogeneity across firms and over time. Firm-specific fixed effects control for time-invariant characteristics such as managerial quality, operational efficiency, governance structure, and industry positioning, which may simultaneously influence working capital decisions and profitability outcomes. Year fixed effects absorb macroeconomic shocks, regulatory changes, business cycle fluctuations, and economy-wide disruptions—including the post-COVID recovery phase—that affect all firms contemporaneously.

The use of fixed effects is econometrically justified over pooled ordinary least squares, as diagnostic tests and substantial improvements in within-R^2 indicate the presence of correlated unobserved heterogeneity. To address potential heteroskedasticity and within-firm serial correlation, standard errors are clustered at the firm level, ensuring consistent statistical inference. Sector-wise regressions are estimated only for sectors meeting minimum data sufficiency thresholds in terms of firm count and time coverage, thereby avoiding weak identification and over-parameterization. Finally, micro-sectors are aggregated into economically meaningful broad sector groups to enhance statistical power, comparability, and interpretability of sectoral heterogeneity in working capital–profitability dynamics.

4.8 Tables for manuscript

Table 5.1. Summary of estimated models and key results

Dependent variable	Estimator	Key WCM variables	Main inference
ROA	Pooled OLS (HC3)	Receivables_Days (−), ***Inventory_Days* (−)**, Cash_Intensity (+**), *Leverage (−)*	WCM tightening improves profitability; cash buffers support ROA
ROA	Two-way FE (firm+year, HC3)	Receivables_Days (−), **Size (+)**, Sales growth (+*)	Collection efficiency is the strongest within-firm profitability driver
ROA	Quantile regression (0.25/0.50/0.75)	Effects strengthen toward upper quantiles; cash positive throughout; size negative at 0.50/0.75	WCM effects are heterogeneous and strongest for high-profit firms
Resilience_vol	Pooled OLS (clustered)	WCM_efficiency (−*), Size (+**), year effects	Higher efficiency may reduce resilience
Resilience_vol	Two-way FE (entity+time, clustered)	WCM_efficiency (−*), Cash_Intensity (−**)	Liquidity buffers improve resilience; efficiency reduces resilience
Resilience_vol	Firm FE + COVID interaction	WCM_efficiency (−*), WCM×COVID (ns), Cash_Intensity (−**)	Relationship is structural; COVID does not materially moderate
Resilience_downside	Two-way FE	WCM_efficiency (ns)	Limited power due to small N; treat as supplementary

Notes: ***, **, * denote significance at 1%, 5%, 10%; ns = not significant.

4.9 Sector-wise Fixed-Effects Model Specification

To formally examine heterogeneity in the working capital–profitability relationship across industries, sector-wise fixed-effects regressions are estimated by re-estimating the baseline two-way fixed-effects model separately for each broad sector s.

The sector-specific model is specified as:

$$\mathrm{ROA}_{i,t}^{(s)} = \alpha^{(s)} + \beta_1^{(s)}\mathrm{WCM\_efficiency}_{i,t} + \beta_2^{(s)}\mathrm{Cash\_Intensity}_{i,t} + \beta_3^{(s)}\mathrm{Leverage}_{i,t} + \beta_4^{(s)}\mathrm{Size}_{i,t} + \beta_5^{(s)}\mathrm{SalesGrowth}_{i,t} + \beta_6^{(s)}\mathrm{ProfitGrowth}_{i,t} + \mu_i^{(s)} + \lambda_t^{(s)} + \varepsilon_{i,t}^{(s)}$$

where:

- $i$indexes firms and $t$indexes years,

- $s$denotes the broad sector group,
- $\mu_i^{(s)}$captures sector-specific firm fixed effects,
- $\lambda_t^{(s)}$captures common time effects within sector s, and
- $\varepsilon_{i,t}^{(s)}$is the idiosyncratic error term.

All coefficients are allowed to vary across sectors, enabling identification of structural differences in how working capital efficiency affects profitability across industries. Sector-wise estimation is restricted to sectors satisfying minimum data sufficiency thresholds in terms of firm count and time coverage to ensure reliable inference.

4.9.1 Sector-wise fixed-effects results (Dependent: ROA)

Sector-specific estimations are conducted by estimating Equation (1) separately for each broad sector s:

$$\mathrm{ROA}_{i,t}^{(s)} = \beta_0^{(s)} + \sum_{k=1}^{K} \beta_k^{(s)} Z_{k,i,t} + \mu_i^{(s)} + \lambda_t + \varepsilon_{i,t}^{(s)}$$

where $Z_{k,i,t}$represents the set of working-capital and control variables, and coefficients are allowed to vary across sectors to capture structural heterogeneity.

The sector-wise fixed-effects estimates indicate that the relationship between working-capital efficiency and profitability is heterogeneous across broad sectors, with Automobiles, Defence & Aerospace, Healthcare & Pharma, and Infrastructure & Realty showing the most consistent and statistically meaningful patterns. In contrast, Energy & Utilities and Metals & Mining show profitability drivers dominated by scale and growth rather than working-capital mechanisms, while Consumer Goods presents a leverage-led profitability pattern.

Automobiles (N=127; firms=15; years=9; R^2within=0.364)

Automobiles show a positive and significant effect of WCM_efficiency on ROA (β=0.096; p=0.017), implying that improvements in working-capital efficiency are associated with higher operating profitability after controlling for firm and year heterogeneity. Cash_Intensity is significantly negative (β=−0.230; p<0.001), indicating that tying funds in cash/near-cash (as captured in your proxy) is associated with lower ROA in this sector, consistent with opportunity-cost logic. Leverage_DE is also negative and significant (β=−1.331; p=0.027), suggesting that debt burden may compress profitability in auto supply chains where margins are sensitive to financing costs. Other controls are not significant, implying that WCM and financial structure effects dominate sector profitability differences.

Construction Materials (N=35; firms=4; years=9; R^2within=0.438)

Construction Materials provides weak-to-moderate evidence (marginal significance) that WCM_efficiency improves ROA (β=0.061; p=0.058) and that Profit_Growth_pct supports profitability (β=0.0149; p=0.060). Given the very small panel (4 firms), these results should be interpreted cautiously and positioned as indicative rather than conclusive. Still, the direction aligns with the sector's reliance on tight working-capital cycles and demand-linked profit expansion.

Consumer Goods (N=121; firms=15; years=9; R^2within=0.307)

For Consumer Goods, Leverage_DE is positive and significant (β=3.790; p=0.013), suggesting that leverage—possibly reflecting expansion financing and scale-linked distribution advantages—correlates with ROA within firms over time. However, WCM_efficiency is not significant (p=0.447), implying that profitability in this bucket is less sensitive to working-capital improvements compared to sectors like Automobiles or Healthcare. Profit_Growth_pct is marginal (p≈0.095), hinting that growth in profitability contributes to ROA but not strongly.

Defence & Aerospace (N=40; firms=5; years=9; R^2within=0.586)

This sector shows very strong internal explanatory power and clear working-capital relevance. WCM_efficiency is strongly positive and significant (β=0.0106; p<0.001), indicating that improvements in efficiency translate into profitability gains. Cash_Intensity is significantly negative (β=−0.095; p=0.0019), consistent with the view that liquidity hoarding or capital lock-in reduces ROA. Leverage_DE is significantly negative (β=−2.301; p=0.034), indicating financing structure constraints. Profit_Growth_pct is significantly positive (β=0.0227; p=0.023), suggesting that profitability improvements reinforce ROA in this sector. Overall, the evidence supports a WCM–profitability channel that is particularly relevant in defence-related firms.

Energy & Utilities (N=56; firms=9; years=9; R^2within=0.182)

None of the key variables are statistically significant, including **WCM_efficiency** (p=0.242). This indicates that ROA dynamics in this sector may be more regulated, asset-heavy, and rate-of-return constrained, where short-run working-capital movements have limited explanatory power relative to structural factors not captured here.

Healthcare & Pharma (N=154; firms=18; years=9; R^2within=0.196)

Healthcare & Pharma exhibits a strong and coherent pattern. WCM_efficiency is positive and significant (β=0.064; p=0.0014), implying that tighter working-capital management enhances ROA. Cash_Intensity is negative and significant (β=−0.163; p=0.0011), suggesting efficiency losses from higher cash locking or liquidity build-up. Size_LogSales is positive and significant (β=6.265; p=0.0025), indicating scale advantages in profitability (e.g., better bargaining, distribution, and operating leverage). Profit_Growth_pct is also positive and significant (β=0.00258; p=0.031). Collectively, this sector provides one of the best "clean" narratives for your paper: WCM efficiency + scale + profitability momentum jointly drives ROA.

Information Technology (N=151; firms=19; years=9; R^2within=0.438)

WCM_efficiency is not significant (p=0.208), suggesting the WCM mechanism is weaker in IT because the operating cycle is not inventory-heavy. However, cash_Intensity is strongly positive (β=0.136; p=0.0018), which is plausible for IT firms where cash buffers may support capability investments, resilience, acquisitions, or pricing flexibility. A striking result is Leverage_DE being strongly negative (β=−0.196; p≈0), consistent with IT firms being disadvantaged by leverage due to volatility of intangible-driven earnings. Profit_Growth_pct is positive and significant (β=0.00625; p=0.0048), reinforcing that profitability improvements translate into higher ROA.

Infrastructure & Realty (N=89; firms=11; years=9; R^2within=0.194)

Infrastructure & Realty exhibits highly significant leverage sensitivity and a meaningful WCM signal. WCM_efficiency is positive and significant (β=0.00361; p<0.001), indicating that even small improvements in working-capital efficiency matter for ROA. Leverage_DE is extremely significant and positive (β=0.0609; p≈0), which likely reflects project-finance structures where leverage enables asset creation and revenue generation. Because the leverage effect is unusually strong, your paper should acknowledge that capital structure may dominate profitability in this bucket relative to operating-cycle improvements.

Metals & Mining (N=111; firms=13; years=9; R^2within=0.202)

WCM_efficiency is not significant (p=0.183). Instead, Size_LogSales is strongly positive (β=7.858; p<0.001), implying large scale profitability advantages in metals. Sales_Growth_pct is significantly negative (β=−0.059; p=0.008), which may reflect growth phases associated with margin pressure or cyclicality (volume expansion during downturns). Profit_Growth_pct is strongly positive (β=0.000131; p<0.001), supporting the idea that profitability improvements—not working capital—drive ROA in this cyclical sector.

Other Industrials (N=261; firms=33; years=9; R^2within=0.084)

This bucket shows limited within explanatory power. Leverage_DE is negative and significant (β=−0.0325; p=0.002), suggesting debt hurts profitability across a mixed industrial set. WCM_efficiency is marginal (p=0.108) and thus should be treated as weak evidence only. This supports the idea that sector aggregation may dilute clear operating-cycle patterns, and motivates your use of more focused sector buckets (which you already did).

5.0 Discussion of Results

The research outcomes reveal significant variability in the correlation between WCM efficiency and firm profitability across sectors and operational conditions. Although overall results from two-way fixed-effects models show that the correlation between WCM efficiency improvements and increased profitability under uncertainty exists positively, the existence of such correlations will be affected by the characteristics of sectors involved, as well as the presence or absence of a number of other control variables.

Additionally, the negative coefficients for cash intensity in many capital-intensive sectors indicate that excessive cash accumulation can lead to resource waste through operational inefficiency or a precautionary motive. In addition, the degree of negativity and statistical significance of the negative association between cash intensity and profitability were most significant in sectors characterized by a manufacturing orientation (for example, automobiles; healthcare), where the potential to achieve cost savings and profit margin enhancement through greater efficiency in operational processes and in the areas of inventory turnover and accounts receivable management is relatively high.

Similarly, leverage also has sector-specific effects. Specifically, leverage had a negative and statistically significant association with profitability in capital-intensive and cyclically-sensitive sectors, but was non-significant in technology-oriented sectors. These results reflect varying degrees of risk tolerance and differing financial structures within the sectors studied.

Lastly, the positive association between profitability and firm size (measured by log sales) indicates that larger firms have the advantage of being able to weather operational disruptions and shocks associated with working capital in sectors exhibiting economies of scale (for example, healthcare, IT, metals).

However, the fixed effects estimate also show that WCM is statistically and economically important in three sectors: Defence & Aerospace; Healthcare & Pharmaceuticals; and Infrastructure. Overall, therefore, the results provide evidence for the theoretical proposition that efficient WCM enhances a firm's ability to deal with operational stresses in environments characterized by demand uncertainty and capital intensity.

6.0 Conclusions and Implications

This research utilises a large dataset of firms over time to examine whether effective working capital management enhances the resilience of profit levels among listed Indian firms. Four different types of statistical models were employed (pooled OLS, two-way fixed effects, interaction models, and firm-specific models) to determine that the ability to manage working capital is a significant factor in determining a company's profit.

Moreover, this study finds that each industrial sector will also benefit from effective working capital management, although to different degrees. Industrial sectors with extended supply chains, requiring substantial capital investments, and operating within long-term business cycles, will derive the most significant benefits from effective working capital management. On the other hand, companies operating in fast-cash-cycle industries will be harmed by excessive liquidity.

Additionally, these results support the notion that managers should develop working capital management strategies tailored to the needs of their respective industries, rather than relying on general rules. For instance, managers of companies in industries requiring large amounts of funds will initially target improving accounts receivable, optimising inventory, and establishing formal methods of using excess profits generated through better working capital management.

In addition, the results support the notion that policymakers should expand access to short-term financing options for companies that are highly dependent on liquidity.

In conclusion, this study represents an original combination of three distinct fields: profit resilience, sectoral heterogeneity, and working capital efficiency, which form a new understanding of how working capital affects profitability. Future studies will build upon this research by developing dynamic panel data models, measuring firm-wide resilience in a variety of ways, and comparing working capital practices in various countries to understand international variations in working capital management in various sectors.

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