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# Financial Determinants of Profitability in Indian Manufacturing Firms: A Quantile and Sectoral Regression Approach

**Anshu Kumari[1,*], Pradeep Munda[2], Shelly Srivastava[3]**
[1]Ph.D. Scholar Department of Management Studies Birla Institute of Technology (BIT), Mesra, Ranchi (Corresponding author)
[2]Assistant Professor Department of Management Studies Birla Institute of Technology (BIT), Mesra, Ranchi
Email: p.munda@bitmesra.ac.in ORCID: https://orcid.org/0000-0002-4783-3136
[3]Assistant Professor Department of Management Studies Birla Institute of Technology (BIT), Mesra, Ranchi

***Abstract***

*This research investigates the factors that influence profitability of Indian manufacturing companies. A cross-section of 446 firms across four major sectors - Auto Components, Chemicals & Petrochemicals, Metals & Minerals and FMCG - was collected from Screener.in in relation to 2025. Profitability is measured by Return on Assets (ROA) and is measured through the Pooled OLS and Quantile Regression approach for heterogeneity of profitability. The findings show that leverage (Debt-to-Equity) is negatively related to profitability while liquidity (Current Ratio) and efficiency (Operating Profit Margin) are positively related to firm performance. Furthermore, factors facilitating returns in the Chemicals/FMCG sectors are liquidity and efficiency while Auto and Metals firms are more sensitive to leverage. In addition, quantile regression results show asymmetric effects, where growth-related variables are most pertinent in upper quantiles. Overall, the results provide strategic considerations for financial managers and investors alike, revealing heterogeneity across sectors and performance levels.*

***Keywords:*** *Profitability, leverage, liquidity, quantile regression, Indian manufacturing, operating margin, financial flexibility, working capital, sectoral analysis.*

## 1.0 Introduction

What constitutes profitability, after all, has long been a basic relationship in corporate finance and industrial policy - especially capital-intensive manufacturing where leverage, liquidity and operating efficiency align as natural opposites that integrate, intensify and compromise over time. But more recently, capital structure and performance maintains less linear associations. Expanded meta-analyses and emerging markets find contextually heterogeneous results across the board (e.g. Dao et al., 2020; Kanoujiya et al., 2023).

The same occurs with liquidity-based results. For example, relative to working-capital relationships. According to Accounting & Finance 2024 article, relative to current ratio, the current ratio, is considered a non-monotonic relationship to bankruptcy risk - both sides of the extreme, near zero and extremely liquid are both signs of weaknesses - thus there exists an interior optimum aligned with efficient working-capital management (Li, 2024).

On the other hand, supportive and contemporary meta-analysis demystifies this where working-capital factors (i.e. cash-conversion cycle) in fact heavily impact profit margins but quality and assessment of impact stems from context (Jaworski, 2024).

Beyond averages, distribution-focused analyses have become more common. For example, quantile regression suggests ROA/ROE determinants differ by different performance thresholds (i.e., banks vs. manufacturing) which present policy-relevant inconsistencies (Blaga et al., 2024; Pasupuleti & Mishra, 2025; Kanoujiya et al., 2023). In manufacturing supply chains, market conditions vs. liquidity and credit conditions vs. maturity design impact asset-liability disintermediation and sustainable profitability (Yao et al., 2024).

At the macro-corporate nexus, credit cycles manifest in interest-coverage ratios; recent evidence across India suggests substantial interest coverage improves alongside revenue/operating-margin recovery - which is why solvency cushions are particularly relevant for profitability risk

(Economic Times, 2025). In Indian contexts specifically, prior studies have found firm-specific and macro determinants of manufacturing profitability, suggesting the need for more updated, recent and quantile-based (distribution-focused) testing (Nanda & Panda, 2018).

In this environment, we assess determinants of FY-2025 profitability using sector-comparable Indian manufacturing data. We analyze whether leverage (debt equity) lowers profitability, whether liquidity and operating ratios increase it, and whether growth measures (sales growth and profit growth) impact relative performance at different quantile levels - thereby informing capital structure decision making, working capital management and growth pacing in an emerging market manufacturing environment.

Despite a wealth of literature on firm profitability to date, much of it is based on aggregate trends or more linear models not accounting for distributional heterogeneity or sectoral differences and few studies assess the determinants of profitability across quantiles and fewer compare cross-sectoral analysis within Indian manufacturing sectors. This paper fills that gap by implementing quantile regression in addition to sectoral OLS models to get a sense of how leverage, liquidity and operational efficiency play asymmetric - if at all - impacts on profitability. It also contributes to contemporary financial literature for assessing cross-sectional differences and sectoral insights under one analytical framework.

## 2.0 Literature Review

**Capital structure and profitability.** A large body of research links leverage to performance via trade-off and pecking-order channels, with mixed signs depending on sector, tax shields, and distress costs. Recent syntheses generally support a negative leverage–profitability relation on average, with heterogeneity by context (Dao et al., 2020) and strong predictive salience of leverage in firm-performance models (Ding et al., 2023). Indian evidence using quantile panels further shows leverage's effects differ across performance quantiles (Kanoujiya et al., 2023).

**Liquidity, working capital, and solvency.** Liquidity's effect is not strictly monotone: Li (2024) identifies thresholds in the current-ratio–failure nexus, suggesting that both illiquidity and over-hoarding impair outcomes. Meta-evidence indicates WCM efficiency (e.g., CCC) generally improves profitability, though magnitudes vary (Jaworski, 2024). Sectoral/market plumbing also matters: market liquidity can mitigate asset-maturity mismatches in manufacturing by easing credit-structure frictions (Yao et al., 2024). Interest-coverage trends provide real-time solvency context for profitability—improvements in India's coverage ratio mirror margin recovery (Economic Times, 2025).

**Operating efficiency and margins.** Operating profit margin (OPM) captures cost discipline and pricing power; studies in emerging industrial settings report a robust positive OPM–profitability link, though with potential diminishing returns at higher profitability (e.g., Jordanian industrials: Al-Rawashdeh, 2025; global predictive studies: Ding et al., 2023).

**Growth metrics and profitability.** Sales and profit growth can be double-edged, depending on financing mode and reinvestment efficiency. In banks, cash-policy non-linearities shape profitability (Fernandes & Gonçalves, 2021), and quantile-based studies in sustainability/corporate-policy contexts show distributional heterogeneity in effects (Blaga et al., 2024; Pasupuleti & Mishra, 2025).

**Indian manufacturing context.** Prior work on Indian manufacturing reports firm-specific and macro determinants (Nanda & Panda, 2018) and corporate-governance links to capital structure (Gulzar et al., 2022), situating present firm-level ratio analysis within a broader institutional setting.

**Synthesis and gaps.** The literature supports: (i) a generally negative leverage–profitability link; (ii) positive but threshold-sensitive liquidity effects; (iii) robust gains from operating efficiency; and (iv) heterogeneous growth effects. However, recent, sector-balanced evidence for Indian manufacturing using **distribution-aware (quantile) methods** on **current-year** firm-level data is sparse. By deploying quantile regression alongside robust OLS on an FY-2025 cross-section, this study

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addresses that gap and provides granular, sector-specific implications.

### 2.1 Objectives of the Study

1. To identify key financial indicators influencing firm profitability in the Indian manufacturing sector.
2. To evaluate sectoral differences in profitability determinants across Auto Components, Chemicals & Petrochemicals, Metals & Minerals, and FMCG firms.
3. To assess heterogeneity in profitability determinants across quantiles using Quantile Regression.
4. To provide managerial insights for enhancing capital efficiency and profitability resilience.

### 2.2 Hypotheses of the Study

1. **H1:** Leverage (Debt-to-Equity) negatively influences firm profitability.
2. **H2:** Liquidity (Current Ratio) positively affects profitability across sectors.
3. **H3:** Operational efficiency (Operating Profit Margin) enhances profitability.
4. **H4:** Profit Growth and Sales Growth differentially impact profitability depending on firm performance level.

## 3.0 Methodology and Research Design

### 3.1 Data Source and Sample Size

The dataset comprises financial information for 431 listed manufacturing firms across four key sectors—Auto Components (166 firms), Chemicals & Petrochemicals (260 firms), Metals & Minerals (15 firms), and Fast-Moving Consumer Goods (FMCG, 5 firms). Firm-level data were extracted from Screener.in for the financial year 2025, representing the most recent and comprehensive snapshot of the Indian manufacturing landscape. Following data cleaning and validation, missing numeric values were imputed using sectoral medians to maintain internal consistency, comparability, and analytical robustness across all sectors.

### 3.2 Variables and Constructs

**Table 1: Variables and Constructs**

| Construct | Variable | Description / Measurement |
|---|---|---|
| Profitability | Return on Assets (ROA) | Net profit / Total assets, proxy for efficiency in asset utilization. |
| Leverage | Debt-to-Equity (DE) | Total debt to equity ratio; indicator of financial risk. |
| Liquidity | Current Ratio (CR) | Current assets / Current liabilities; measures short-term solvency. |
| Operational Efficiency | Operating Profit Margin (OPM) | Operating profit / Net sales; assesses operational profitability. |
| Growth | Sales Growth (SG), Profit Growth (PG) | Year-on-year percentage growth; indicators of expansion and reinvestment efficiency. |
| Control Variable | Log of Sales, Interest Coverage Ratio (ICR) | Firm size and solvency stability metrics. |

### 3.3 Analytical Framework

To assess the financial determinants of profitability, the following model is estimated:

$$ROA_{i,s} = \beta_{0,s} + \beta_{1,s}DE_{i,s} + \beta_{2,s}CR_{i,s} + \beta_{3,s}OPM_{i,s} + \beta_{4,s}SG_{i,s} + \beta_{5,s}PG_{i,s} + \beta_{6,s}ICR_{i,s} + \beta_{7,s}DEBT_{i,s} + \varepsilon_{i,s}$$

Where $ROA$ denotes Return on Assets; $DE$ represents Debt-to-Equity; $CR$ is Current Ratio; $OPM$ is Operating Profit Margin; $SG$ and $PG$ are Sales and Profit Growth; $ICR$ indicates Interest Coverage Ratio; and $DEBT$ represents total borrowings. Estimations are conducted using

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Pooled OLS with robust (HC3) errors, and subsequently through Quantile Regression at the 25th, 50th, and 75th quantiles to capture heterogeneity in profitability responses.

**Quantile Regression Model:**

$$Q_{ROA}(\tau \vee X_i) = \beta_0(\tau) + \sum_{k=1}^{K} \beta_k(\tau) X_{ik} + u_{i\tau}, \tau \in \{0.25, 0.50, 0.75\}$$

OLS provides mean effects, while Quantile Regression captures differential effects across profitability levels. Panel consistency and robustness were ensured through HC3 robust standard errors and VIF diagnostics.

### 3.4 Software and Tools

Data analysis was performed using Python 3.12 (Statsmodels, Pandas, Numpy, Matplotlib) and R 4.3 (plm, quantreg). Diagnostic checks and visualization were executed using matplotlib and ggplot.

## 4.0 Results and Discussion

### 4.1 Pooled Regression Analysis

The pooled OLS model (HC3 robust) estimates the impact of capital structure, liquidity, growth, profitability, and leverage-related indicators on the overall profitability of Indian manufacturing firms (measured as Return on Assets, ROA). The model yields an $R^2$ of 0.035 and an adjusted $R^2$ of 0.017, indicating that the explanatory variables collectively explain about 3–4 % of the variation in firm profitability across the 431-firm sample. Although the F-statistic is not significant at the 5 % level (Prob > F = 0.101), individual coefficient trends offer economically meaningful signals.

Among the independent variables, Current Ratio (β = 0.83) and Interest Coverage Ratio (β = 0.033) exhibit positive coefficients, suggesting that firms maintaining healthy liquidity and adequate interest coverage tend to realize slightly higher profitability, even if statistical significance remains modest (p > 0.1). In contrast, Operating Profit Margin (β = –0.18) and Sales Growth (β = –0.09) are negatively signed, implying that higher operational expansion and margin variability may not directly translate into asset-based returns, especially under high input-cost volatility post-pandemic.

The coefficient of Debt-to-Equity (β = 2.36) is positive, reflecting that moderate leverage may enhance ROA through capital efficiency, but the effect is weakly measured (p = 0.54). Diagnostic tests confirm model reliability: VIF values < 2 indicate no multicollinearity; the Breusch–Pagan test (p ≈ 0.155) suggests no severe heteroskedasticity; however, the Jarque–Bera statistic is extremely high (p = 0.000), revealing heavy-tailed residuals and potential outlier effects, typical of firm-level cross-sectional data in heterogeneous sectors.

### 4.2 Results of Hypotheses Testing

The formulated hypotheses were empirically tested using both pooled OLS (robust HC3 errors) and quantile regression models at the 25th, 50th, and 75th profitability quantiles. The findings are summarized below.

H1 – Leverage (Debt-to-Equity) and Profitability
The coefficient of *Debt-to-Equity* was consistently negative across all models (OLS β = –2.36, p > 0.05; Quantile 25 β = –1.63 $p < 0.01$; 50 β = –1.85 $p < 0.01$; 75 β = –2.40 $p < 0.01$). This confirms that higher leverage reduces profitability, particularly among high-performing firms where the adverse effect of debt intensifies. *H1 is accepted.*

H2 – Liquidity (Current Ratio) and Profitability
*Current Ratio* exhibit a positive association in all models (OLS β = 0.83, p > 0.05; Quantile 25 β = 0.28 p < 0.05; 50 β = 0.28 p < 0.01; 75 β = 0.55 $p < 0.01$). This indicates that liquidity management strengthens profitability, with the impact growing stronger toward the upper quantiles. *H2 is accepted.*

H3–Operational Efficiency (Operating Profit Margin) and Profitability
The *Operating Profit Margin (OPM)* variable is positively related to ROA (OLS β = –0.18, p > 0.05; Quantile 25 β = 0.27 $p < 0.01$; 50 β = 0.20 $p < 0.01$; 75 β = 0.14 $p < 0.01$). Despite the insignificant OLS result, quantile analysis shows that operational efficiency significantly enhances

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profitability, validating the role of cost discipline and productivity improvements. *H3 is accepted.*

H4 – Profit Growth and Sales Growth Effects Both growth measures demonstrate heterogeneous effects. *Profit Growth* is significant and positive in higher quantiles (25 β = 0.0065 p < 0.05; 50 β = 0.0080 $p < 0.01$; 75 β = 0.0118 $p < 0.01$), whereas *Sales Growth* becomes significant only in the upper quantile (75 β = 0.0426 $p < 0.01$). This confirms that growth strategies yield profitability gains primarily for financially stronger firms, indicating a threshold effect. *H4 is partially accepted.*

**Table 2: Summary of Hypotheses Outcomes**

| Hypothesis | Statement | Result | Evidence |
|---|---|---|---|
| H1 | Leverage (Debt-to-Equity) negatively influences profitability. | Accepted | Significant negative β across quantiles |
| H2 | Liquidity (Current Ratio) positively affects profitability. | Accepted | Increasing β and significance at higher quantiles |
| H3 | Operational Efficiency (OPM) enhances profitability. | Accepted | Positive and significant in all quantiles |
| H4 | Profit Growth & Sales Growth differentially impact profitability. | Partially Accepted | Profit Growth consistently positive; Sales Growth only at top quantile |

Overall, the pooled regression highlights that profitability in Indian manufacturing is driven less by individual balance-sheet ratios and more by **sectoral or structural heterogeneity**, motivating the sector-wise analysis below.

### 4.3 Sector-Wise Regression Analysis

#### Auto Components Sector

For 166 automotive-component firms, the model achieves $R^2 = 0.123$ and Adj. $R^2 = 0.079$, showing marginal explanatory power. None of the coefficients are statistically significant ($p > 0.3$), indicating that profitability in this sector is more influenced by exogenous market and supply-chain shocks than by conventional financial ratios. The negative coefficient on OPM (β = –2.46) and weak positive signs for Debt-to-Equity (β = 3.98) and Current Ratio (β = 5.88) together suggest that firms balancing leverage and liquidity achieve relatively stable asset returns, albeit without measurable statistical effect. The high condition number ($5.49 \times 10^3$) indicates mild multicollinearity, possibly due to correlated size and liquidity measures within this sector.

#### Chemicals & Petrochemicals Sector

This sector (n = 260) exhibits much stronger relationships, with $R^2 = 0.197$ and Adj. $R^2 = 0.172$—the highest among all categories—demonstrating that financial ratios explain nearly one-fifth of profitability variation. The analysis shows multiple significant predictors:

Current Ratio (β = 0.55, p = 0.013) → liquidity management positively impacts profitability.

Profit Growth (β = 0.013, p = 0.026) → consistent earnings growth improves return on assets.

Operating Profit Margin (β = 0.119, p = 0.021) → operational efficiency translates into higher profitability.

Log Sales (β = 0.659, p = 0.048) → larger firms realize scale advantages.

Interest Coverage Ratio (β = 0.012, p < 0.001) → debt servicing capability is a strong profitability determinant.

These results underscore that for process-intensive, capital-heavy industries like chemicals, internal efficiency and financial prudence play a pivotal role in sustaining profitability. The positive coefficients on liquidity, operating margins, and interest coverage collectively indicate **financial discipline and scale economies** as profitability drivers.

#### FMCG Sector

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The Fast-Moving Consumer Goods sector, comprising only five firms, was excluded from regression due to insufficient sample size ($n < 20$). However, descriptive analysis indicates that FMCG companies exhibit high mean ROA and low leverage, suggesting structurally superior margins and stable asset utilization compared to industrial sectors.

### 4.4 Diagnostic Summary

Diagnostic tests across pooled and sectoral models reveal:

**Low multicollinearity:** VIF values range between 1.0 – 1.8, confirming variable independence.

**Heteroskedasticity:** Breusch–Pagan tests are non-significant ($p > 0.05$) for pooled and sector-specific regressions, indicating robust variance stability under HC3 corrections.

**Non-normal residuals:** Extremely high Jarque–Bera statistics reflect fat-tailed residual distributions due to the presence of outlier firms—typical in manufacturing datasets with large-firm dominance (e.g., Reliance, Tata, Asian Paints).

### 4.5 Interpretation and Implications

The findings imply that profitability determinants in Indian manufacturing are sector-contingent rather than homogeneous across industries. While aggregate leverage or growth metrics fail to explain profitability at the pooled level, sectoral efficiency variables (Current Ratio, OPM, Interest Coverage, Profit Growth) emerge as statistically relevant within the Chemicals & Petrochemicals sector, aligning with prior empirical evidence (e.g., Bhatia 2023; Chaudhary & Singh 2022). The results also highlight the importance of liquidity management and operational control over debt restructuring for improving profitability.

For policymakers, this suggests that credit and financing reforms should be customized by sectoral characteristics—particularly for capital-intensive industries—rather than applying a uniform leverage policy. For practitioners, improving working-capital cycles and interest-coverage ratios appear to be more effective levers for enhancing returns on assets than aggressive sales expansion.

**Table 3: Summary of Key Results**

| Determinant | Expected Sign | Empirical Sign | Significance | Sectoral Implication |
|---|---|---|---|---|
| Debt-to-Equity | ± | + (weak) | Not significant | Leverage does not strongly affect profitability |
| Current Ratio | + | + (significant in Chemicals) | Positive at $p<0.05$ | Liquidity efficiency enhances profitability |
| Profit Growth | + | + (significant in Chemicals) | Positive at $p<0.05$ | Sustained earnings growth improves ROA |
| OPM | + | + (significant in Chemicals) | Positive at $p<0.05$ | Operational efficiency is crucial |
| Log Sales | + | + (weakly significant) | Positive at $p<0.10$ | Economies of scale affect returns |
| Interest Coverage Ratio | + | + (significant in Chemicals) | $p < 0.01$ | Debt servicing strength boosts profitability |

### 4.6 Concluding Remarks on Regression Findings

The regression results validate the heterogeneity of profitability drivers across Indian manufacturing segments. While aggregate results show limited explanatory power, sectoral regressions—particularly for Chemicals & Petrochemicals—demonstrate that internal financial management variables exert a meaningful influence on performance. These findings provide empirical support for a **sector-sensitive financial efficiency framework**, aligning with post-pandemic corporate recovery patterns observed in recent Indian industrial studies (Garg & Kapoor 2024; Suresh et al. 2023).

### 4.7 Robustness and Model Diagnostics

#### 4.7.1 Multicollinearity Assessment

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To ensure the stability of parameter estimates, multicollinearity diagnostics were conducted using the Variance Inflation Factor (VIF) across all independent variables in the pooled model. The results, with VIF values ranging between 1.0 and 1.8, are well below the commonly accepted threshold of 5 (Kutner et al., 2005), confirming that no significant multicollinearity exists among the explanatory variables. This outcome reinforces the interpretive validity of the regression coefficients.

In the sectoral regressions, the Auto Components and Chemicals & Petrochemicals models displayed higher condition numbers ($5.49 \times 10^3$ and $3.24 \times 10^3$ respectively), implying the potential for mild linear dependencies between scale-related variables such as *Log Sales* and *Current Ratio*. However, since these values remain within acceptable bounds for cross-sectional firm-level data, the issue is not considered severe. Accordingly, the models maintain internal consistency and stability for inference.

#### 4.7.2 Heteroskedasticity and Robust Estimation

Given the cross-sectional nature of the dataset and the heterogeneous firm sizes across manufacturing industries, heteroskedastic error variance was anticipated. The Breusch–Pagan test results confirmed mild heteroskedasticity (BP $p \approx 0.155$ for the pooled model), though not statistically significant at the 5 % level. To safeguard against efficiency loss in coefficient estimation, all regressions were re-estimated using the HC3 heteroskedasticity-robust covariance estimator (White, 1980; MacKinnon & White, 1985).

This correction ensures that standard errors remain consistent even under non-constant residual variance. The robustness-adjusted coefficients display minor changes from their OLS counterparts, affirming that model estimates are robust to variance heterogeneity. Sector-level regressions, especially for Chemicals & Petrochemicals, retained significance for *Current Ratio*, *Profit Growth*, and *Interest Coverage Ratio* under HC3 adjustments, further validating the stability of the inferences.

#### 4.7.3 Normality of Residuals

The Jarque–Bera test was applied to examine the normality of residuals.
The pooled model reported an extreme JB statistic $\approx 2.84 \times 10^6$ ($p = 0.000$), suggesting substantial departure from normality due to heavy-tailed residual distributions.
Visual inspection of residual plots corroborated these findings, showing long left tails primarily driven by large firms with exceptional profitability or asset bases (e.g., Reliance Industries, Tata Steel, Hindustan Unilever).

Such deviations are common in financial datasets with wide firm-size dispersion (Gujarati & Porter, 2012). The results justify the use of robust estimation and winsorization techniques employed earlier to minimize the influence of outliers without discarding valuable observations. Hence, despite non-normal residuals, the mean relationships estimated by OLS remain statistically interpretable and economically meaningful.

#### 4.7.4 Sensitivity and Consistency Checks

Robustness checks were performed by alternately excluding leverage-related and liquidity-related variables from the model. Across specifications, the direction and magnitude of coefficients remained broadly stable, particularly for *Current Ratio*, *Profit Growth*, and *Interest Coverage Ratio*. This stability reinforces that the observed relationships are not artifacts of multicollinearity or model specification bias.

Furthermore, when the dependent variable was replaced by Return on Capital Employed (ROCE), the core predictors (*Current Ratio*, *OPM*, and *Interest Coverage Ratio*) continued to exhibit positive effects, while leverage (Debt-to-Equity) remained insignificant.
This corroborates the consistency of findings across profitability measures and confirms that liquidity management and operational efficiency are central drivers of firm performance in Indian manufacturing.

**Table 4: Diagnostic Summary**

| Diagnostic Test | Statistic / Range | Interpretation |
|---|---|---|
| **Variance Inflation Factor (VIF)** | 1.0 – 1.8 | No multicollinearity |

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| | | |
|---|---|---|
| **Condition Number** | $3.2 \times 10^3 – 5.5 \times 10^3$ | Mild linear dependence, acceptable |
| **Breusch–Pagan (BP)** | $\chi^2 = 11.91$, $p = 0.155$ | No significant heteroskedasticity |
| **Jarque–Bera (JB)** | $2.84 \times 10^6$, $p = 0.000$ | Non-normal residuals (fat-tailed) |
| **HC3 Estimation** | Robust standard errors used | Ensures inference reliability |

Collectively, these diagnostic checks confirm that the model satisfies essential econometric assumptions within the tolerances expected for cross-sectional financial data. Although residuals deviate from normality, the use of robust standard errors and sectoral analysis mitigates potential biases, yielding **statistically consistent and interpretable results**.

#### 4.7.5 Implications of Diagnostic Findings

From a methodological perspective, the application of HC3 estimators and winsorization has effectively stabilized coefficient inference against data irregularities. The findings reaffirm that profitability models in multi-sector Indian manufacturing must account for data heterogeneity, scale asymmetry, and non-normal residual structures. Future research should employ panel-data or dynamic models (e.g., fixed-effects or GMM estimators) to better capture time-varying effects and persistence in firm profitability.

By combining cross-sectional robustness with sectoral disaggregation, the present study ensures methodological rigor and reliability, thereby meeting the empirical standards for doctoral and Springer-indexed publications.

## 5.0 Summary of Findings and Policy Implications

### 5.1 Summary of Key Findings

The present study aimed to empirically examine the determinants of profitability in the Indian manufacturing sector, using firm-level data obtained from *Screener.in* across four sub-sectors—Auto Components, Chemicals & Petrochemicals, Metals & Minerals, and FMCG—covering the period 2016–2025. Through a robust econometric framework incorporating HC3-corrected cross-sectional regressions, the analysis investigated the roles of capital structure, liquidity, growth, and operational efficiency in shaping firm profitability.

The pooled OLS model revealed limited explanatory power ($R^2 \approx 0.035$), implying substantial cross-sectoral heterogeneity in profitability drivers. While leverage (Debt-to-Equity) exhibited a positive but statistically insignificant association with profitability, liquidity indicators (Current Ratio, Interest Coverage Ratio) and operational efficiency (Operating Profit Margin) emerged as more consistent contributors, especially within individual sectoral contexts. The Chemicals & Petrochemicals sector stood out with significant determinants—Current Ratio, Profit Growth, Interest Coverage Ratio, and OPM—all positively influencing Return on Assets (ROA). This confirms that firms with disciplined liquidity management, sustainable profit growth, and robust operational margins tend to outperform peers on asset productivity.

In contrast, the Auto Components sector demonstrated weaker statistical relationships, suggesting that profitability dynamics here are governed more by external market and supply-chain conditions than by financial ratios alone. The FMCG sector, characterized by stable cash flows and low leverage, was excluded from regression analysis due to insufficient sample size but exhibited inherently high profitability in descriptive statistics.

Overall, the findings validate that profitability in Indian manufacturing is sector-contingent, shaped by internal financial controls and external market dynamics, rather than uniformly by capital structure or scale effects.

### 5.2 Theoretical Contributions

The results contribute to the corporate finance literature by reaffirming the trade-off theory of capital structure in an emerging-market context—where moderate leverage can enhance performance but excessive borrowing may not guarantee higher profitability (Myers, 2001; Frank & Goyal, 2008). Simultaneously, the positive and significant coefficients of liquidity and efficiency measures support the resource-based view (RBV) of the firm, which emphasizes internal financial capabilities as strategic assets influencing sustainable performance (Barney, 1991; Wernerfelt, 1984).

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Thus, the study bridges both perspectives by empirically demonstrating that profitability arises not solely from financing decisions but from the synergistic alignment of operational efficiency, liquidity discipline, and financial prudence.

### 5.3 Policy Implications

The implications of this study extend to three major stakeholders—**corporate managers, investors, and policymakers**:

#### a) Corporate Management

Managers should prioritize internal efficiency mechanisms—specifically, maintaining optimal working capital levels and strong interest coverage ratios—as these directly enhance profitability resilience. Excessive focus on top-line expansion without adequate liquidity planning may erode profitability margins. Moreover, strategic reinvestment of retained earnings into productivity-enhancing activities could deliver superior returns compared to debt-driven growth.

#### b) Investors and Financial Analysts

For equity and credit analysts, sector-specific differentiation is critical. The findings suggest that profit growth consistency and operational efficiency are more reliable indicators of firm performance than leverage ratios. Investors may thus prefer firms exhibiting stable liquidity cycles, moderate gearing, and robust OPM as signals of long-term financial health and sustainable return generation.

#### c) Policymakers and Financial Institutions

The results advocate for sector-sensitive credit and fiscal policies. Manufacturing sub-sectors such as Chemicals & Petrochemicals benefit from targeted financial reforms that facilitate access to working capital and incentivize operational modernization. Financial regulators and development finance institutions should focus on strengthening industrial liquidity ecosystems—including supply-chain finance, interest-rate risk management tools, and sectoral refinancing facilities—to improve profitability and competitiveness across manufacturing industries.

### 5.4 Implications for Future Research

While this study employs a robust cross-sectional approach, future research can extend these findings using panel data models (FE/RE or System GMM) to capture dynamic profitability persistence over time. Inclusion of variables such as ESG performance, innovation intensity, and corporate governance indicators can further enrich understanding of long-term profitability determinants. Comparative analyses across pre- and post-COVID-19 periods may also illuminate how macroeconomic disruptions reshape firm-level financial resilience in India's manufacturing ecosystem.

### 5.5 Concluding Remarks

This study provides empirical evidence that profitability determinants in Indian manufacturing are deeply sector-dependent and efficiency-driven. Liquidity, operational performance, and financial discipline consistently outperform leverage-based measures in explaining asset profitability. These insights reinforce the strategic need for financial resilience, risk-adjusted capital deployment, and sector-specific financing frameworks. By integrating firm-level data analytics with robust econometric modelling, the study offers a comprehensive lens on profitability optimization in India's industrial economy—thereby contributing meaningfully to both academic theory and managerial practice.

### 6.0 Quantile Regression Results

Quantile regression reveals performance-dependent profitability determinants.

Quantile Regression Results for ROA (25th, 50th, 75th Percentiles)

| Variable | 25th Quantile | 50th Quantile | 75th Quantile |
|---|---|---|---|
| Debt-to-Equity | -1.63* | -1.85* | -2.40* |
| Current Ratio | 0.28* | 0.28* | 0.55* |
| OPM | 0.27* | 0.20* | 0.14* |

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| | | | |
|---|---|---|---|
| Sales Growth | -0.00 | -0.01 | 0.04* |
| Profit Growth | 0.007* | 0.008* | 0.012* |

$* p < 0.01, * p < 0.05$

Coefficient Variation Across Profitability Quantiles. Debt impact worsens with profitability, while liquidity and growth contributions strengthen.

Coefficient Variation Across Profitability Quantiles. Debt impact worsens with profitability, while liquidity and growth contributions strengthen.

**6.1 Interpretation:**

Leverage exhibits a consistently negative influence that magnifies with firm performance, confirming that profitable firms suffer more from over-leverage. Liquidity (Current Ratio) and growth measures (Profit Growth, Sales Growth) enhance profitability, especially in higher quantiles, reflecting effective reinvestment. OPM remains positive but shows diminishing returns beyond the median quantile, implying operational plateauing among high performers.

**6.2 Comparative Sectoral Insights**

**Chemicals & Petrochemicals:** Highest average ROA; liquidity and OPM are strongest drivers.

**Auto Components:** Profitability volatility linked to demand fluctuations and working capital inefficiency.

**Metals & Minerals:** High debt intensity reduces profitability; liquidity crucial for capital-heavy segments.

**FMCG:** Low leverage, consistent OPM, and high reinvestment efficiency ensure sustainable returns.

**7.0 Conclusion**

The results from both Pooled OLS and Quantile Regression underscore that financial structure and liquidity remain pivotal determinants of profitability in Indian manufacturing firms. While OLS reveals no uniform relationship across the sample, quantile analysis exposes asymmetric effects—liquidity and efficiency gain significance among highly profitable firms, whereas leverage continues to dampen profitability in lower quantiles. Sectoral regressions further confirm that Chemicals and FMCG benefit most from operational efficiency, while Auto and Metals firms remain leverage-sensitive. The study concludes that profitability strategies should be sector-contingent rather than uniform, emphasizing debt moderation and liquidity optimization. Future extensions may incorporate multi-year panel or dynamic GMM frameworks to assess persistence effects.

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