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Moderating Effects of Production Efficiency and Sales Growth on the Working Capital–Profitability Nexus

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ABSTRACT

Effective working capital management shapes liquidity, operational stability and profitability, highlighting its role in financial strategy. This paper explores the effect of working capital management on profitability, considering the interaction of production efficiency and sales growth. Using a balanced panel of 60 firms in the Nifty India Manufacturing Index over 2011–2024, this study employs return on assets (ROA) as the measure of profitability. The cash conversion cycle (CCC) and its components inventory days, receivable days and payable days serve as a proxy for WCM. Ordinary Least Squares (OLS) and Fixed Effects (FE) estimators are used to ensure robust results.CCC is negatively associated with ROA in OLS and FE models. The moderating term PE × SG is positive and significant in the FE model. The Study indicates that WCM outcomes not only shaped by financial policies and also depend on a firm's production efficiency and sales growth.

Keywords: Working capital management, Profitability, Cash conversion cycle, Production efficiency, Sales growth

Introduction

Financial performance is a cornerstone of business stability and long-term sustainability. The global financial crisis of 2008 and the COVID-19 pandemic revealed how quickly liquidity shortages can disrupt operations and erode profitability, underscoring the importance of effective financial strategies (Murphy et al., 1996; Ahmad et al., 2022). Among these, working capital management (WCM) is particularly critical because it directly influences liquidity, operational continuity, and profitability. Poor WCM practices have often been linked to financial distress and even bankruptcy (Smith, 1980; Eljelly, 2004; Gill et al., 2010).

Working capital management is the efficient management of short-term assets and liabilities receivables, payables, and inventory to balance solvency with long-term value creation

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(Deloof, 2003). This balance is especially crucial in emerging economies such as India, where financing constraints are acute, current assets and liabilities dominate balance sheets, and firms often rely on internal liquidity rather than external financing (Padachi, 2006; Abuzayed, 2012; Bhatia & Srivastava, 2016).

From a theoretical perspective, this study extends the liquidity–profitability trade-off by showing that outcomes depend on firm-specific conditions, consistent with contingency theory. It also aligns with pecking order theory, as Indian firms tend to prioritize internal liquidity over costly external funds, and with the resource-based view, which frames operational efficiency and sales growth as complementary capabilities that enhance financial performance. From a practical perspective, managers should align WCM with operational and market strategies rather than treating it as a stand-alone financial function.

Despite extensive research, evidence on the WCM–profitability relationship remains inconclusive. While some studies associate shorter working-capital cycles with higher profitability, others highlight the benefits of trade credit, liquidity buffers, and inventory holdings. Recent work also suggests that WCM can act as a buffer during crises such as COVID-19 (Pant et al., 2023; Garg & Singh, 2024; Kayani et al., 2023). However, prior research has largely ignored how operational factors, such as production efficiency and sales growth, interact with WCM in shaping profitability.

This study examines whether production efficiency and sales growth jointly influence relationship between the WCM–profitability in Indian manufacturing firms. Using panel data for 60 listed firms from 2011 to 2024, we apply OLS and Fixed Effects estimators to test the hypothesis. The findings highlight the importance of considering the operational drivers in WCM research and yield insights that managers and policy makers can use in capital intensive sectors.

Literature Review

Working Capital Management and Measurement

The role played by working capital management (WCM) in helping firms to achieve an adequate level of liquidity for meeting their day-to-day obligations and at the same time earn a reasonable level of profitability is very significant. It concerns control of receivables, inventory and payables to match liquidity with profitability (Eljelly, 2004; Sharma & Kumar, 2011). The most commonly used metric of WCM efficiency is the CCC which represents the length of time starting from cash outlay for raw materials through to cash inflow from customer sales. Effective WCM can help decrease the financing cost and increases in assets use (Shin &Soenen, 1998) whereas excessive investment has funds stuck at low-returns assets lowers shareholder return (Kieschnick et al., 2013). So, the liquidity–profitability trade-off (Ricci & Viti, 2000) remains at the heart of corporate finance debate.

CCC and Profitability

The linkage between CCC and profitability remains challenged. Some authors suggest that having a longer CCC can improve relationships with suppliers and customers improve sales, reduce point-of-sale disruptions (Blinder &Maccini, 1991; Gill et al., 2010; Deloof&Jegers,

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1996; Ng et al., 1999; Wilner, 2000). Some empirical literature supporting this line of argument are Bhunia and Das (2015), Sharma & Kumar (2011), Raheman et al. (2010), and Martínez-Sola et al. (2013), who discovered a positive relationship between prolonged CCCs and firm performance.

Others maintain that shorter CCCs enhance profitability by generating internal cash, reducing reliance on external borrowing, lowering financial costs, and improving asset efficiency (Deloof, 2003; Nobanee, 2009; Autukaite&Molay, 2011). This perspective is supported by Bhatia & Srivastava (2016), Lyngstadaas& Berg (2016), Enqvist et al. (2014), Raheman & Nasr (2007) and Lazaridis &Tryfonidis (2006), who observed that firms with shorter cycles generally outperform those with longer ones.

In emerging markets, findings remain mixed. For India, Bhatia & Srivastava (2016) showed that longer CCCs reduce profitability, while Garg & Singh (2024) found receivables beneficial but inventory and payables detrimental. Pant et al. (2023) reported that liquidity buffers improved resilience during COVID-19 disruptions. Similar context-specific results are seen elsewhere: shorter CCCs boosted returns in Nigeria (Nwude et al., 2020), but extended payables enhanced profitability in South Africa and Egypt (Kayani et al., 2023). Simon et al. (2019) further highlighted that inflation moderated the CCC–profitability link in Nigeria. Together, these studies suggest that CCC outcomes are not universal but shaped by institutional and macroeconomic environments.

Accounts Receivable Period (ARP)

Receivables management show how quickly payments are collected. Shorter collection period makes liquidity greater and decreases default risk (Nazir &Afza, 2009), while extending credit terms will lead to customer loyalty and sales increase (Bastos &Pindado, 2007). The evidence is mixed in India: Sharma & Kumar (2011) and Bhatia & Srivastava (2016) found faster collections lead to higher returns, whereas Garg & Singh (2024), and Altaf & Shah, 2016 find long credit periods improve client relationships and performance. That discrepancy highlights the liquidity and growth trade-off.

Inventory Conversion Period (ICP)

Inventory policies always have to weigh holding costs against sales continuity. The JIT advocates lean inventory to keep costs down (Bhattacharya, 2008), as also supported by Padachi (2006) and Filippini& Forza (2016). Similarly, high levels of inventories can also serve as a cushion during demand or supply shocks (Modigliani, 1957; Tingbani, 2015). Empirical applications reveal a mixed empirical pattern: while Seth et al. (2020) stated a positive relationship between inventory efficiency and performance of Indian exporters, however, in the study Pant et al. (2023), firms with enough stock were able to survive the COVID-19 crisis.

Accounts Payable Period (APP)

Payables management determines how long companies delay to pay their suppliers. Extended payables relieve liquidity constraints and lower the requirement for financing (Mathuva, 2010; Boissay & Gropp, 2007); however, too long an extension might damage supplier relations or forfeit discounts (Ng et al., 1999). In India (Bhatia & Srivastava, 2016; Garg &

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Singh, 2024) the data indicates that there is a negative effect of extended payables on profitability, whereas Kahya et al. (2023) observed similar positive outcomes in African markets, especially during financial distress. These results indicate a critical role of payables, which is however contingent on organizational designs and crisis situations.

Prior research establishes that WCM influences profitability through CCC and its components, but the direction and magnitude of effects vary significantly across contexts. Indian studies highlight both efficiency gains from shorter cycles (Bhatia & Srivastava, 2016) and the importance of receivables, trade credit, and liquidity buffers (Pant et al., 2023; Garg & Singh, 2024; Altaf & Shah, 2016). International findings further emphasize the moderating role of macroeconomic shocks (Simon et al., 2019) and institutional environments (Kayani et al., 2023). Despite these insights, two gaps persist. First, most studies analyse WCM in isolation, without integrating operational or growth dynamics. Second, while production efficiency and sales growth have been examined separately, their joint moderating role in the WCM–profitability nexus has received little attention.

Data and Methodology

Data

A balanced panel of 60 manufacturing firms listed in the Nifty India Manufacturing Index is employed for the analysis, covering the period 2011–2024 and resulting 840 firm-year observations. A systematic deletion approach was employed to finalize the sample. Initially, firms with missing values were excluded, followed by those that did not adhere to a uniform financial year. After careful filtering, 60 companies remained in the final sample.

The manufacturing sector was selected as it is capital-intensive and highly dependent on working capital for daily operations. Firm-level financial data were obtained from the CMIE ProwessIQ database, which is widely used in Indian corporate finance research (Bhatia & Srivastava, 2016; Seth et al., 2020). Annual GDP growth data were sourced from the World development indicators to incorporate macroeconomic conditions into the analysis. To ensure reliability, firms with missing or inconsistent records were excluded, and the dataset was winsorized at the 3% tails to moderate the effect of outliers (Kayani et al., 2023; Pant et al., 2023).

Firms Profitability is measured by return on assets (ROA) which serves as dependent variable. Theindependent variables comprise CCC, AAI and AAP. To mitigate omitted variable bias production efficiency, sales growth, size, working capital financing and GDP growth are incorporated as control variables.

Table 1: Variables Description

Label	Name	Description	References
ROA	Return on Asset	Net Income / Total Asset	Kayani U. N et al. (2023) Soda, M. Z., et al. (2022)
CCC	Cash Conversion Cycle	AAI+AAR - AAP	Ren T et al. (2019) Sawarni et al. (2022)

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AAI	Average Age of Inventory	(Average Inventory/COGS) * 365	Garg M. C et al. (2024) Shukla et al. (2022)
AAR	Average Age of Receivables	(Average Receivables/Sales) * 365	Kayani U. N et al. (2023) Shukla et al. (2022)
AAP	Average Age of Payables	(Average Payables/COGS) * 365	Kayani U. N et al. (2023) Ng et al. (2017)
SG	Sales Growth	(Current Year Sales – Past Year Sales)/Past Year Sales	Garg M. C et al. (2024)
Size	Firm Size	Natural Logarithm of Total Asset	Garg M. C et al. (2024)
PE	Production Efficiency	Sales/ (Value of Plant, Property & Equipment)	Modi and Mishra (2011), Lu and Shang (2017), Pant et al. (2023)
PE*SG	Interaction term	Product of PE and SG	-
WCF	Working Capital Financing	Short Term Debt / Working Capital	Altaf, N. (2020)
GDP	Gross Domestic Product	Annual GDP growth rate	Bhatia S et al. (2016)

Source: Compiled by the authors.

Methodology

To test the hypotheses, the study adopts a multi-step empirical approach. First correlation analysis is employed to provide preliminary insights into the association between WCM variables and firm profitability. While useful, correlation analysis has important limitations, as it does not capture casual relationships. The Pearson correlation coefficient only measures the degree and directions of association but cannot establish whether changes in WCM affects profitability.

To overcome these limitations and to test the hypothesis, the study adopts panel regression models. The analysis is structured around eight econometric specifications: Model (1-4) examine the direct effect of WCM (proxied by CCC and its components) on profitability, while Models (5-8) extend the framework by introducing the interaction term between production efficiency (PE) and sales growth (SG).

Econometric specifications

The first set of regression models assess the impact of WCM variables on the profitability of firm *i* at time *t*, while incorporating controls for firm-specific and macroeconomic factors. To support this analysis, the following hypothesis is formulated and tested using four distinct model specifications:

H1: *Working capital components are significantly associated with firm profitability.*

$$ROA_{it}=\beta0+\beta1CCC_{it}+\beta2PE_{it}+\beta3Size_{it}+\beta4SG_{it}+\beta5WCF_{it}+\beta6GDP_{t}+\varepsilon_{it} \quad (1)$$

$$ROA_{it}=\beta0+\beta1AAI_{it}+\beta2PE_{it}+\beta3Size_{it}+\beta4SG_{it}+\beta5WCF_{it}+\beta6GDP_{t}+\varepsilon_{it} \quad (2)$$

$$ROA_{it}=\beta0+\beta1AAR_{it}+\beta2PE_{it}+\beta3Size_{it}+\beta4SG_{it}+\beta5WCF_{it}+\beta6GDP_{t}+\varepsilon_{it} \quad (3)$$

$$ROA_{it}=\beta0+\beta1AAP_{it}+\beta2PE_{it}+\beta3Size_{it}+\beta4SG_{it}+\beta5WCF_{it}+\beta6GDP_{t}+\varepsilon_{it} \quad (4)$$

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The second set of regression models extends the framework by incorporating the interaction term between production efficiency (PE) and sales growth (SG) to examine their moderating effect on the WCM–profitability relationship. To capture this effect, the following hypothesis is formulated and tested using four additional model specifications

H2: *Production efficiency (PE) and sales growth (SG) jointly strengthen the association between WCM and firm profitability.*

The following four models are used for testing the above-mentioned hypothesis:

$$ROA_{it}=\beta0+\beta1CCC_{it}+\beta2PE_{it}+\beta3Size_{it}+\beta4SG_{it}+\beta5WCF_{it}+\beta6GDP_{t}+\beta7(PE\times SG)_{it}+\varepsilon_{it} \quad (5)$$

$$ROA_{it}=\beta0+\beta1AAI_{it}+\beta2PE_{it}+\beta3Size_{it}+\beta4SG_{it}+\beta5WCF_{it}+\beta6GDP_{t}+\beta7(PE\times SG)_{it}+\varepsilon_{it} \quad (6)$$

$$ROA_{it}=\beta0+\beta1AAR_{it}+\beta2PE_{it}+\beta3Size_{it}+\beta4SG_{it}+\beta5WCF_{it}+\beta6GDP_{t}+\beta7(PE\times SG)_{it}+\varepsilon_{it} \quad (7)$$

$$ROA_{it}=\beta0+\beta1AAP_{it}+\beta2PE_{it}+\beta3Size_{it}+\beta4SG_{it}+\beta5WCF_{it}+\beta6GDP_{t}+\beta7(PE\times SG)_{it}+\varepsilon_{it} \quad (8)$$

Regression models are estimated using two techniques. Ordinary Least Square (OLS) provides baseline result but as OLS may be biased due to unobserved firm heterogeneity, the study also uses Fixed Effects (FE)/Random effects (RE) estimators, which control for time-invariant firm-specific characteristics. The Hausman test is conducted to decide the more appropriate specification between FE and RE. To strengthen the reliability of results. Heteroskadacity and autocorrelation are controlled by clustering standard errors at the firm level, and variance inflation factors (VIF) are used as a diagnostic for multicollinearity.

Result and Discussion

Descriptive Statistics and Correlation Analysis

Table 2 depicts the descriptive statistics of the study variables. ROA averages 8.2%, but with considerable variation across firms, ranging from losses of –15.9% to profits above 26%, indicating notable differences in financial performance. The mean CCC is 85 days, with wide dispersion, suggesting that while some firms collect cash quickly, others tie up capital for extended periods. Among the components, inventory (AAI) and receivables (AAR) exhibit higher averages (100 and 64 days, respectively) than payables (79 days), highlighting the greater financing burden of working capital in Indian manufacturing. Production efficiency (PE) shows high variability, reflecting differences in asset utilization across firms. Sales growth (SG) is modest on average (11.7%) but highly volatile, consistent with cyclical demand patterns in manufacturing. Firm size also varies substantially, and working capital financing (WCF) averages 0.48, suggesting moderate reliance on short-term debt. At the macro level, GDP growth averages 6.1% over the period, reflecting India's emerging market dynamics. These statistics point to wide heterogeneity in firm operations and justify the use of panel methods to account for cross-sectional differences.

Table 3 presents the Pearson correlation matrix. ROA is negatively correlated with CCC (r = -0.124) and with its components AAI (r = -0.216) and AAP (r = -0.427), consistent with the expectation that longer inventory holding and delayed payments hurt profitability. AAR is also negatively correlated with ROA (r = -0.287). In contrast, PE (r = -0.046) is negatively correlated and SG (r = 0.101) positively correlated with ROA, indicating that higher efficiency and stronger sales expansion improve firm performance. Among the controls, firm size is negatively correlated with ROA (r = -0.202), while GDP growth also shows a positive association (r = 0.004).

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All pairwise correlations are below 0.60, suggesting no serious multicollinearity. This is further confirmed by VIF values, which do not exceed the conventional threshold of 10. Together, the descriptive and correlation results provide preliminary support for the hypothesized relationships and justify the subsequent regression analysis ordinary Least Square Model.

Table 4 reports the OLS estimates for Models (1)–(8).

CCC is negative and significant (Model 1: $\beta = -0.000148$, $p < 0.01$), implying that longer working-capital cycles reduce profitability. Economically, a 30-day reduction in CCC raises ROA by about 0.45 percentage points (≈5.4% of mean ROA), supporting H1. At the component level, inventory days (AAI) are positive and significant, suggesting that higher stick levels may help firms sustain operations and sales. Receivables (AAR) show mixed effects: negative and significant when considered directly (Model 3), but positive and significant once the moderating term introduced (Model 7), indicating that the role of trade credit may depend on the operational and market conditions. Payables (AAP) remain negative and significant, suggesting that delayed supplier payments reduce profitability. Among the controls, sales growth is generally positive, production efficiency is significant in some specifications, and the firm size is consistently negative. The moderating effect between production efficiency and sales growth (PE × SG) is positive and not significant, providing limited OLS support for H2. Adjusted R^2 values of 0.34–0.39 indicates the explanatory power. Overall, the OLS results establish baseline evidence that efficient WCM enhances profitability, while moderation effects require further testing with FE estimators to address heterogeneity and endogeneity concerns.

Fixed Effects (FE) Model

Table 5 reports the FE estimates for Models (1)–(8).

CCC remains negative and significant (Model 1: $\beta \approx -0.000121$, $p < 0.01$), confirming H1 that longer working-capital cycles reduce profitability. Economically, a 30-day reduction in CCC is associated with an ROA increase of about 0.43 percentage points, consistent with the OLS results. At the component level, inventory days (AAI) and payables (AAP) both exhibit strong negative and significant coefficients, indicating that higher inventory holdings and longer supplier payments erode firm profitability. Receivables (AAR) are also negative and significant in the FE model, suggesting that extended credit periods reduce profitability when firm-specific heterogeneity is controlled. Production efficiency (PE) is positive and consistently significant across specifications, indicating that firms with higher asset utilization achieve stronger profitability. Sales growth (SG) also shows a positive and highly significant association with ROA, reinforcing its importance as a profitability driver. By contrast, firm size is consistently negative and significant, while working-capital financing (WCF) and GDP growth remain insignificant. The interaction term (PE × SG) is positive and significant across Models (5)–(8), providing robust support for H2. This implies that firms combining high production efficiency with strong sales growth are better able to translate efficient WCM into profitability improvements. Overall, the FE results strengthen the baseline conclusion that efficient WCM improves profitability (H1) and provide consistent evidence that production efficiency and sales growth jointly amplify this relationship (H2).

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Comparison of OLS and FE findings

While both OLS and FE models consistently confirm H1 that longer cash conversion cycles reduce profitability their results diverge with respect to the moderating effect of production efficiency and sales growth (PE × SG). In the OLS estimation, the interaction term is positive but lacks statistical significance, whereas in FE estimation it turns positive and strongly significant across model specifications. This difference suggests that the moderating influence of PE × SG is more evident once unobserved firm-specific characteristics are controlled for. In other words, the enhancement of WCM–profitability linkages through efficiency and growth appears to be a *within-firm effect*, driven by internal operational and strategic capabilities, rather than a cross-sectional difference across firms. These findings highlight the importance of model choice: OLS provides a useful baseline, but FE offers more reliable insights for panel data by capturing heterogeneity.

Conclusion and Managerial Implications

Focusing on Indian manufacturing firms, this study examines how working capital management influences profitability, using panel data for 60 listed firms over 2011–2024 and applying OLS and FE models. The results show that in OLS and FE, longer cash conversion cycles (CCC), inventory days, and payables reduce profitability, highlighting the importance of efficient WCM in Indian manufacturing firms. Component-level results indicate that excessive receivables and payables reduce performance. Evidence for the second hypothesis (H2) is mixed: the interaction between production efficiency (PE) and sales growth (SG) is positive and significant under FE but not robust across OLS, suggesting that its effect depends on firm context.

From a managerial perspective, the findings emphasize that efficient WCM – particularly inventory and payables is essential for profitability. Moreover, firms that combine production efficiency and sales expansion are better positioned to translate liquidity management into financial gains. To maximize benefits, managers should align working capital practices with production efficiency and sales growth strategies, ensuring that liquidity management directly supports both asset utilization and revenue expansion. For policy makers, the results highlight the importance of strengthening trade credit access and support liquidity practices that enhance resilience in capital intensive manufacturing sectors.

Future research could extent this analysis to non-manufacturing companies, explore nonlinear effects in the WCM–profitability relationships and incorporate macroeconomic shocks such as inflation and COVID-19. Such extensions would provide deeper insights into how working capital strategies interact with firm efficiency, growth, and external environments.

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