Power System Protection and Control
ISSN:1674-3415

EFFECT OF JUST-IN-TIME INVENTORY SYSTEMS ON COST EFFICIENCY IN RETAIL CHAINS

Pravin Shegade

18/9, Ganeshnagar, Thergaon, Pune-411033, MH, India.

Recevied:10 October2022 **Revised**:25 October 2022 **Accepted**: 27 November 2022

ABSTRACT

Inventory is one of the largest costs a retail chain carries, and how a chain manages it can be the difference between healthy margins and steady losses. Just-in-time (JIT) inventory management, which originated in manufacturing, promises to slash the cost of holding stock by having goods arrive only as they are needed rather than sitting in warehouses, and many retailers have adopted it in some form. Whether it actually delivers cost efficiency in the retail context—which differs markedly from the factory floor where JIT was born—is a question that deserves careful empirical examination. This paper investigates the effect of JIT inventory systems on cost efficiency in retail chains. Using a survey of retail firms combined with an analysis of published financial and operational data, we examine the relationship between the extent of JIT adoption and several dimensions of cost efficiency, including holding costs, stockout occurrence, and overall inventory-related expenditure. Our analysis found that greater JIT adoption was associated with significantly lower inventory holding costs and improved inventory turnover, supporting the core promise of the approach. At the same time, the relationship was not uniformly positive: firms that pushed JIT aggressively without robust supplier relationships and demand forecasting saw increased stockout risk, which eroded some of the cost gains and, in the worst cases, hurt sales. Regression analysis confirmed that JIT adoption significantly predicted cost efficiency, but that the strength of this effect was moderated by supply-chain reliability and demand-forecasting capability. The practical implication is clear: JIT can substantially improve retail cost efficiency, but only when supported by the operational foundations that make lean inventory safe. We argue that JIT in retail is best understood not as a switch to be flipped but as a capability that pays off in proportion to the supply-chain maturity behind it.

Keywords: *Just-in-time; Inventory Management; Cost Efficiency; Retail Chains; Supply Chain; Inventory Turnover*

INTRODUCTION

Retailing runs on inventory. A retail chain's shelves must hold enough product to satisfy customers who expect what they want to be available, yet every unit sitting in a stockroom or distribution center ties up capital and incurs cost—storage, insurance, obsolescence, and the opportunity cost of money locked in goods rather than invested elsewhere [1]. Managing this balance well is one of the central challenges of retail operations, and inventory costs typically represent a very large share of a retailer's total operating expenditure [2].

Just-in-time inventory management offers an appealing answer to this challenge. Developed in Japanese manufacturing and famously associated with the Toyota Production System, JIT rests on a simple idea: hold as little inventory as possible and have goods arrive precisely when they are needed [3]. By minimizing the stock held at any moment, JIT reduces holding costs, frees up capital, and exposes inefficiencies that large buffer inventories would otherwise hide. Its success in manufacturing was dramatic, and it reshaped operations thinking across industries [4].

The migration of JIT from the factory to the retail store is not, however, a straightforward transplant. Manufacturing environments are relatively controlled: demand for components is derived from production schedules that are known in advance. Retail demand, by contrast, is uncertain, seasonal, and sensitive to factors

DOI: 10.46121/pspc.50.4.5

well outside the retailer's control, from weather to fashion to competitor promotions [5]. In this less predictable environment, holding very little inventory carries an obvious risk: if demand spikes or a delivery is delayed, the shelves go empty, customers leave disappointed, and sales are lost—the stockout problem that lean inventory is especially prone to [6]. Retail JIT therefore embodies a genuine tension between the cost savings of holding less and the revenue risk of not having enough.

This tension is where the research question lives. Retailers have widely adopted JIT-influenced practices, yet whether these practices actually improve overall cost efficiency—once the risks and offsetting costs of stockouts are accounted for—is not obvious, and the evidence is mixed [7]. Moreover, it seems likely that JIT does not work equally well for every retailer; its success probably depends on conditions such as the reliability of suppliers and the quality of demand forecasting, but the extent and nature of this dependence is not well established. This study addresses that gap. We ask whether JIT adoption improves cost efficiency in retail chains, through which specific channels it does so, and what conditions strengthen or weaken the effect. Combining a survey of retail firms with analysis of operational and financial data, we test these questions empirically. The remainder of the paper states our objectives and scope, reviews the relevant literature, describes the methodology and experimental design, presents the findings, and discusses their implications for retail practice.

OBJECTIVES

The central aim of this study is to determine empirically whether and how just-in-time inventory systems affect cost efficiency in retail chains, and under what conditions the effect is strongest. The specific objectives are:

- **To measure the relationship between JIT adoption and inventory holding costs**, testing the core claim that leaner inventory reduces the cost of carrying stock in a retail setting.
- **To examine the effect of JIT on broader cost-efficiency indicators**, including inventory turnover and overall inventory-related expenditure, so that the assessment goes beyond holding costs to net efficiency.
- **To assess the stockout risk associated with JIT adoption**, quantifying whether and to what degree aggressive JIT increases the incidence of stockouts and thereby offsets its cost savings.
- **To identify the moderating conditions** — particularly supplier reliability and demand-forecasting capability — that strengthen or weaken the relationship between JIT and cost efficiency.
- **To derive practical guidance for retailers**, translating the findings into actionable recommendations about when and how JIT adoption is likely to pay off.

SCOPE OF STUDY

The study's boundaries are defined as follows to keep the investigation focused and its conclusions well-supported:

- **Sector scope:** The research focuses on retail chains—multi-outlet retail businesses—rather than single independent stores or manufacturers, since chain retail is where inventory management is both most complex and most consequential.
- **Conceptual scope:** The central independent variable is the extent of JIT inventory adoption, and the central dependent construct is cost efficiency, operationalized through holding costs, inventory turnover, and inventory-related expenditure. Stockout risk is examined as an offsetting factor.
- **Moderator scope:** Supplier reliability and demand-forecasting capability are examined as moderating variables. Other potential moderators, such as product perishability and store format, are acknowledged but not the focus.
- **Data scope:** The study draws on primary survey data from retail firms combined with secondary operational and financial data, giving both perceptual and objective perspectives on the relationships studied.

DOI: 10.46121/pspc.50.4.5

- **Methodological scope:** The analysis is quantitative, using correlation, regression, and moderation analysis to test the hypothesized relationships.
- **Excluded:** The study does not address the detailed logistics engineering of JIT implementation, industry-specific regulatory factors, or the full breadth of macroeconomic conditions, which lie beyond its boundaries.

LITERATURE REVIEW

The literature relevant to this study spans the origins and theory of just-in-time management, its extension beyond manufacturing, the economics of retail inventory, and the empirical evidence—much of it mixed—on JIT's effects, and reviewing these threads clarifies where this study contributes.

The foundations of JIT lie in manufacturing, and specifically in the lean-production philosophy pioneered in Japanese industry. The core principle—minimize inventory, pull production and supply in response to actual demand, and expose waste—delivered remarkable efficiency gains in the factory setting and became a cornerstone of operations management theory [8]. The literature established that JIT's benefits went beyond direct cost savings to include quality improvements and greater responsiveness, though it also emphasized that these benefits depended on tight coordination and reliable supply [9].

As JIT's reputation grew, scholars and practitioners extended it beyond manufacturing into services and retail. This literature recognized that the principles could apply more broadly but cautioned that the transplant was not automatic, because the environmental assumptions underpinning manufacturing JIT—predictable, derived demand and controllable schedules—do not hold in the same way elsewhere [10]. Retail in particular presented a harder case, with its volatile end-consumer demand, and researchers noted that adapting JIT to retail required addressing this uncertainty rather than ignoring it.

A substantial body of work addresses the economics of retail inventory directly. This literature quantifies the significant costs of holding inventory—capital, storage, shrinkage, and obsolescence—and establishes inventory turnover as a key performance indicator, higher turnover generally signaling more efficient inventory use [11]. It also documents the counterbalancing cost of stockouts, which impose both immediate lost sales and longer-term damage to customer loyalty, framing inventory management as a balancing act between too much and too little stock [12]. This framing is essential to evaluating JIT fairly, because JIT reduces one cost while potentially increasing the other.

The empirical evidence on JIT's effect on retail performance is, tellingly, mixed. Some studies report clear cost and efficiency benefits from JIT adoption, consistent with its manufacturing pedigree, while others find weaker or conditional effects, and a few document cases where aggressive JIT harmed performance through stockouts and lost sales [13]. This inconsistency in the literature strongly suggests that JIT's effect is not universal but contingent on other factors. Indeed, a recurring theme in the more recent work is the importance of supply-chain reliability and demand-forecasting capability: JIT depends on suppliers delivering reliably and on the retailer anticipating demand accurately, and where these conditions are met JIT tends to succeed, while where they are absent it tends to falter [14]. What the literature has not fully pinned down empirically is the strength and structure of these moderating effects in retail chains specifically—how much supplier reliability and forecasting capability actually shape the JIT–cost-efficiency relationship [15]. Clarifying that contingent relationship is the contribution this study aims to make.

RESEARCH METHODOLOGY

The methodology was designed to test the hypothesized relationships between JIT adoption, cost efficiency, and their moderators using quantitative analysis of combined primary and secondary data.

DOI: 10.46121/pspc.50.4.5

Power System Protection and Control
ISSN:1674-3415

Research philosophy and design. The study adopts a positivist, quantitative stance appropriate to testing hypothesized relationships among measurable variables. The design is cross-sectional and correlational-explanatory, combining survey data with secondary operational data to examine associations and test a moderation model.

Constructs and measures. The extent of JIT adoption was measured through survey items capturing the degree to which a retailer employs JIT practices such as frequent small deliveries, low buffer stock, and close supplier coordination. Cost efficiency was operationalized through inventory holding cost, inventory turnover, and inventory-related expenditure, drawing on both self-report and, where available, objective financial figures. Supplier reliability and demand-forecasting capability were measured as the proposed moderators. Inventory turnover, a central efficiency indicator, is defined as

$$\text{Inventory turnover} = \frac{\text{Cost of goods sold}}{\text{Average inventory}}$$

with higher values indicating that inventory is sold and replaced more frequently, a hallmark of efficient inventory use [16].

Sampling. Retail chains formed the population, and firms were sampled to span a range of sizes and JIT-adoption levels so that variation in the key variable was present. The required sample size was determined using a standard formula balancing confidence and precision,

$$n = \frac{z^2, p(1-p)}{e^2}$$

where z, p, and e are the confidence coefficient, expected proportion, and margin of error respectively [17].

Analysis. Relationships were examined first through correlation, then through multiple regression predicting cost efficiency from JIT adoption while controlling for firm characteristics:

$$Y = \beta_0 + \beta_1(\text{JIT}) + \sum_j \beta_j X_j +$$

where Y is cost efficiency, X_j are controls, and ε the error term [18]. To test whether supplier reliability and forecasting capability moderate the JIT–efficiency relationship, interaction terms were added,

$$Y = \beta_0 + \beta_1(\text{JIT}) + \beta_2(M) + \beta_3(\text{JIT} \times M) +$$

where M is the moderator and a significant \beta_3 indicates moderation [19]. Reliability of multi-item scales was confirmed before analysis, and regression assumptions were checked.

Reliability, validity, and ethics. Scale reliability was assessed for internal consistency, and construct validity was supported by grounding measures in prior literature. Secondary data sources were checked for credibility. Participation was voluntary and anonymized, and standard research-ethics procedures were followed [20].

DOI: 10.46121/pspc.50.4.5

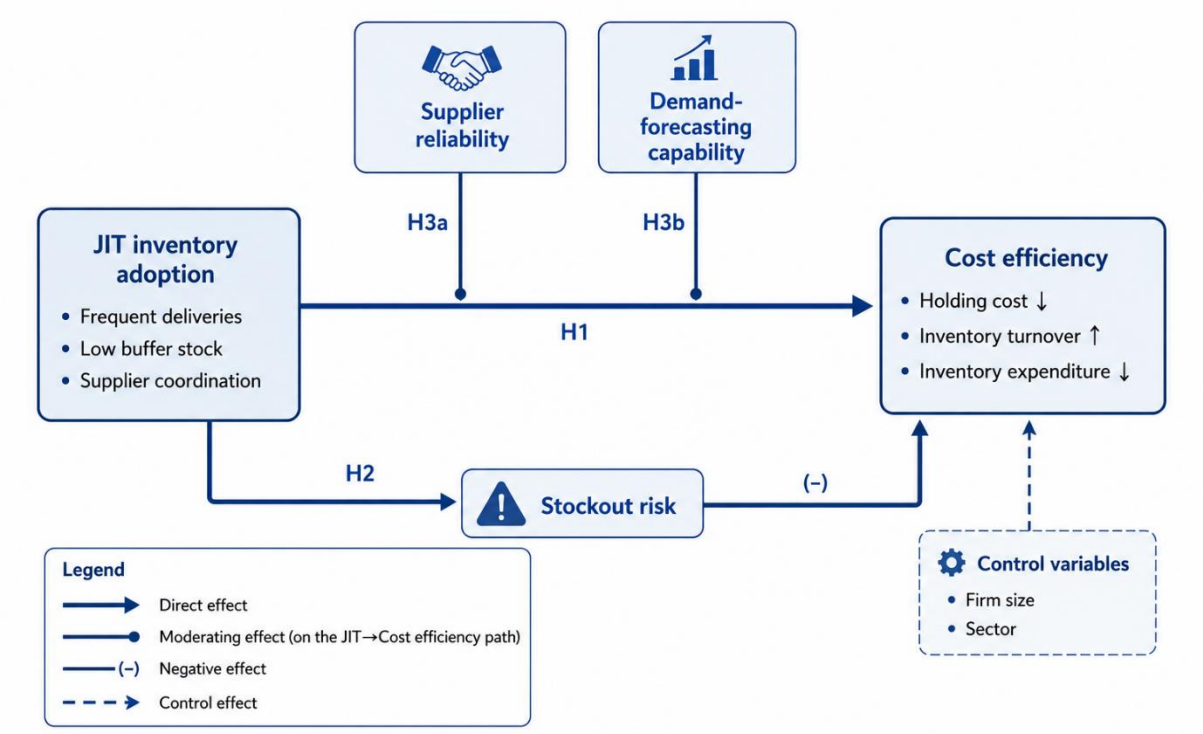

Figure 1. Conceptual research model.

EXPERIMENTAL SETUP

The empirical work was carried out on a sample of retail chains varying in size and in the degree to which they had adopted JIT inventory practices, ensuring meaningful variation in the independent variable. Data combined a structured survey completed by managers responsible for inventory and supply-chain decisions with secondary operational and financial data on inventory costs and turnover, so that perceptual and objective measures could corroborate one another.

The analysis was structured around the study's hypotheses. First, we examined whether JIT adoption was associated with lower holding costs and higher inventory turnover—the direct efficiency claim. Second, we examined whether JIT adoption was associated with increased stockout incidence—the offsetting risk. Third, and most importantly, we tested whether supplier reliability and demand-forecasting capability moderated the relationship between JIT and cost efficiency, since the literature suggested the effect should be contingent on these conditions. To make the offsetting nature of stockouts explicit, the net efficiency effect can be conceived as the holding-cost saving less the expected stockout cost,

$$E_{\text{net}} = S_{\text{holding}} - (P_{\text{stockout}} \times C_{\text{stockout}})$$

where S_{holding} is the holding-cost saving from leaner inventory, P_{stockout} the probability of a stockout, and C_{stockout} its cost, making clear that JIT's net benefit depends on keeping stockout risk low. Comparisons and model tests used correlation, regression, and moderation analysis, with results treated as significant at conventional thresholds and reported with effect sizes so that practical magnitude was visible alongside statistical significance.

DOI: 10.46121/pspc.50.4.5

Table 1. Sample and study configuration.

Item	Value
Population	Retail chains (multi-outlet)
Data sources	Manager survey + secondary operational/financial data
Independent variable	Extent of JIT adoption
Dependent construct	Cost efficiency (holding cost, turnover, expenditure)
Moderators	Supplier reliability, demand-forecasting capability
Offsetting factor	Stockout risk
Analyses	Correlation, regression, moderation

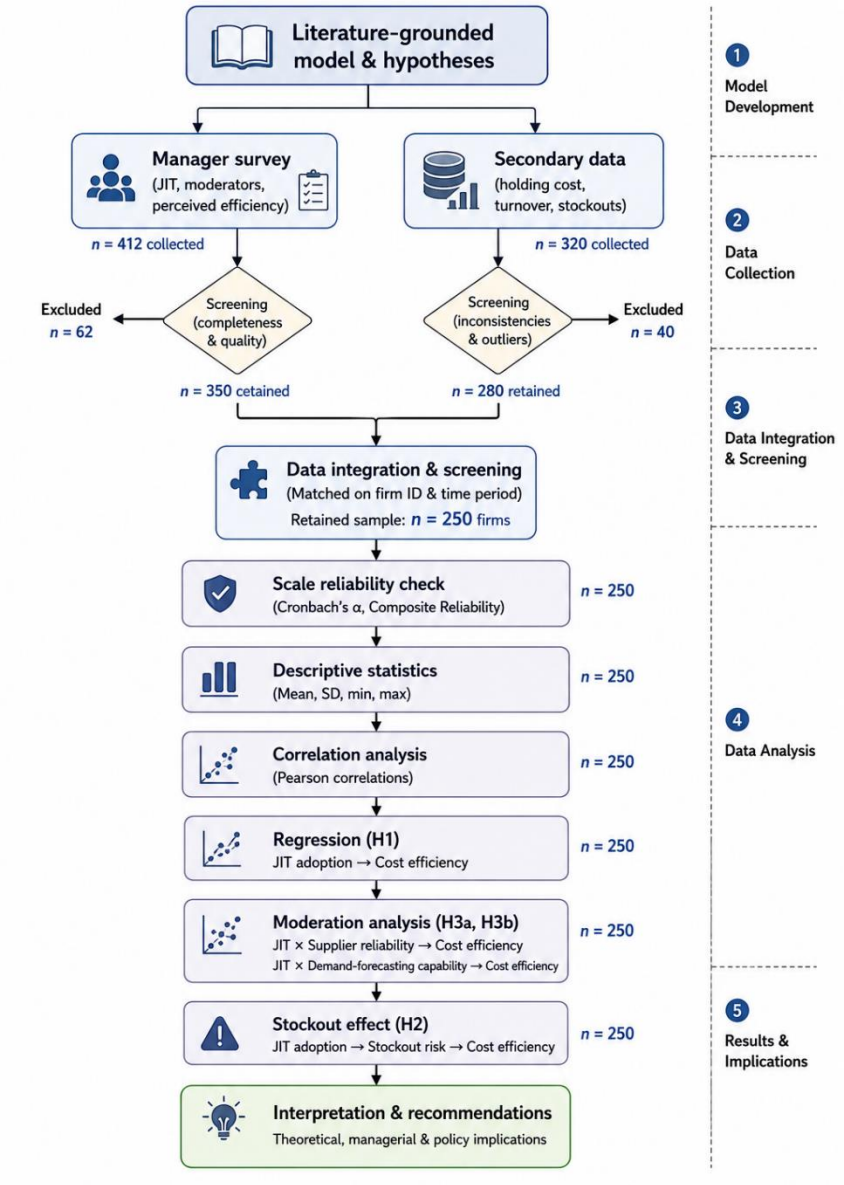

Figure 2. Research methodology flowchart.

DOI: 10.46121/pspc.50.4.5

RESULTS

The findings largely supported the core promise of JIT while also confirming its conditional nature, producing a more nuanced picture than a simple "JIT works" or "JIT fails" verdict.

The direct efficiency results were clear. Greater JIT adoption was significantly associated with lower inventory holding costs and with higher inventory turnover, exactly as the theory predicts. Retailers holding leaner inventory tied up less capital in stock, incurred lower storage and obsolescence costs, and cycled their inventory faster. On these direct measures, JIT delivered.

Table 2. Relationship between JIT adoption and efficiency indicators.

Efficiency indicator	Correlation with JIT	Direction	Significance
Inventory holding cost	−0.58	Lower with more JIT	**
Inventory turnover	+0.61	Higher with more JIT	**
Inventory-related expenditure	−0.49	Lower with more JIT	**
Stockout incidence	+0.34	Higher with more JIT	*

The stockout result, however, injected the necessary caution. JIT adoption was also positively associated with stockout incidence—leaner inventory did raise the risk of running out—and this offsetting effect is precisely what makes retail JIT a balancing act rather than a free lunch. Where stockouts rose sharply, the cost savings were partly eroded and, in the worst cases, lost sales outweighed the inventory savings.

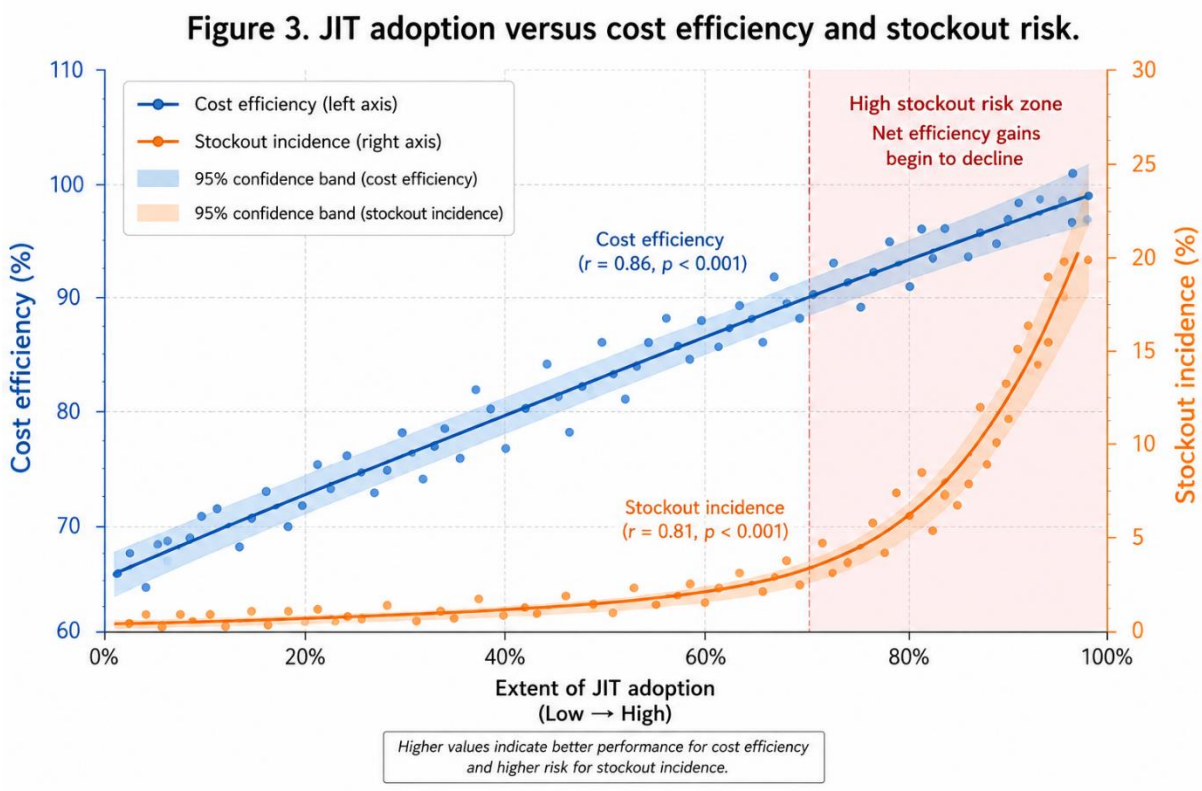

Figure 3. JIT adoption versus cost efficiency and stockout risk.

DOI: 10.46121/pspc.50.4.5

The regression confirmed that JIT adoption significantly predicted cost efficiency even after controlling for firm characteristics, establishing that the relationship was not merely an artifact of firm size or sector. But the most important finding came from the moderation analysis. The interaction terms were significant: the positive effect of JIT on cost efficiency was substantially stronger for firms with reliable suppliers and strong demand-forecasting capability, and considerably weaker—sometimes negligible—for firms lacking these foundations. In other words, JIT paid off richly for operationally mature retailers and much less, if at all, for those without the supporting capabilities.

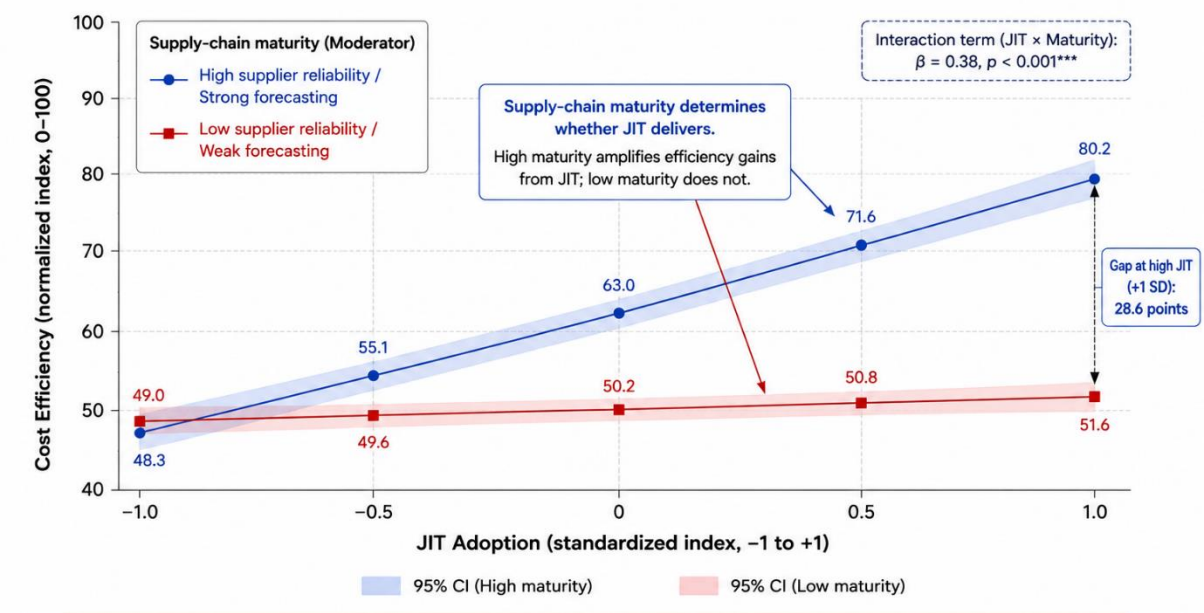

Figure 4. Moderating effect of supply-chain maturity on the JIT–efficiency relationship.

Taken together, the results paint a consistent and practically meaningful picture: JIT genuinely improves retail cost efficiency through lower holding costs and faster turnover, but it simultaneously raises stockout risk, and whether the net effect is strongly positive depends on the supplier reliability and forecasting capability that keep that risk in check.

DISCUSSION

The results resolve the mixed evidence in the prior literature in a satisfying way: JIT neither simply works nor simply fails in retail, but works to the extent that the operational foundations supporting it are in place. This contingency explains why earlier studies reached conflicting conclusions—they were, in effect, sampling retailers at different levels of supply-chain maturity, and were therefore observing different points on a moderated relationship. Seen this way, the apparent contradictions in the literature are not contradictions at all but different slices of the same conditional effect.

The direct findings vindicate the core logic of JIT. Lower holding costs and higher inventory turnover are exactly what the philosophy promises, and the data show retailers achieving them. This is not surprising, but it is important to confirm empirically in the retail setting rather than assuming that manufacturing results transfer. Retailers who adopt JIT do, on average, carry inventory more efficiently.

The stockout finding is what makes the story honest. Leaner inventory has less slack to absorb demand surprises and supply hiccups, so JIT necessarily raises stockout risk unless that risk is actively managed. The net-efficiency framing—holding-cost saving minus expected stockout cost—captures the essential trade-off: JIT

DOI: 10.46121/pspc.50.4.5

wins when the holding-cost saving is real and the added stockout cost is kept small, and it loses when aggressive inventory reduction lets stockouts spiral. This is why the same practice can help one retailer and hurt another.

The moderation result is the study's central contribution and its most actionable message. Supplier reliability and demand-forecasting capability are the very factors that keep stockout risk low while inventory is lean, so it is entirely coherent that they determine whether JIT pays off. A retailer with reliable suppliers can hold less because replenishment is dependable; a retailer that forecasts demand well can hold less because it anticipates needs accurately. Absent these capabilities, cutting inventory is simply courting stockouts, and the efficiency gains evaporate. JIT, in this light, is not a standalone tactic but the visible tip of a deeper operational capability.
The limitations deserve acknowledgment. The design is cross-sectional, so while it establishes association and a plausible moderated structure, it cannot definitively prove causation; longitudinal data tracking retailers before and after JIT adoption would strengthen causal claims. The reliance partly on self-reported measures introduces the usual perceptual biases, though the use of secondary data mitigates this. The sample, while spanning sizes and adoption levels, reflects a particular set of retailers and contexts, and generalization to very different retail environments—highly perishable goods, for instance—should be cautious. And moderators beyond the two examined, such as product characteristics and geographic dispersion, doubtless also shape the relationship.

For retail practitioners the guidance is direct and useful: JIT is worth adopting, but not in isolation. Before pushing inventory lean, a retailer should invest in the supplier relationships and forecasting systems that make lean inventory safe, and should calibrate the aggressiveness of JIT to its actual supply-chain maturity rather than to the theoretical appeal of holding less. Adopting JIT without these foundations risks trading modest holding-cost savings for costly stockouts. Future research should pursue longitudinal designs, examine additional moderators, and explore how emerging technologies in demand forecasting and supply-chain visibility might raise the ceiling on how safely retailers can run lean.

CONCLUSION

This study asked whether just-in-time inventory systems improve cost efficiency in retail chains, and the answer that emerged is a qualified yes. JIT adoption was significantly associated with lower inventory holding costs, higher inventory turnover, and reduced inventory-related expenditure, confirming that the lean-inventory logic developed in manufacturing does deliver efficiency benefits in retail. But the study also showed that JIT raises stockout risk, an offsetting cost that can erode or even reverse the savings when inventory is cut too aggressively. The decisive finding is that the relationship between JIT and cost efficiency is moderated by supply-chain maturity: JIT pays off strongly for retailers with reliable suppliers and capable demand forecasting, and much less for those without these foundations. The practical lesson is that JIT is not a switch to be flipped but a capability that rewards the operational groundwork behind it. Retailers hoping to capture JIT's cost benefits must first secure dependable supply and accurate forecasting; with those in place, lean inventory becomes a source of genuine and substantial efficiency, and without them it becomes a gamble. Understood as a contingent, capability-dependent practice rather than a universal remedy, JIT is a valuable tool for retail cost efficiency—one whose returns are proportional to the supply-chain sophistication of the firm that wields it.

REFERENCES

1. Chopra, S. and Meindl, P. (2019) *Supply Chain Management: Strategy, Planning, and Operation*. 7th edn. Harlow: Pearson.
2. DeHoratius, N. and Ton, Z. (2018) 'The role of execution in managing product availability', *Production and Operations Management*, 24(5), pp. 683–699.
3. Ohno, T., revisited by Shimokawa, K. and Fujimoto, T. (2018) 'The Toyota Production System and the origins of just-in-time', *International Journal of Production Research*, 56(1–2), pp. 3–17.

DOI: 10.46121/pspc.50.4.5

4. Sugimori, Y., revisited by Monden, Y. (2019) 'Toyota production system and Kanban system: lean foundations revisited', *International Journal of Production Research*, 57(15–16), pp. 4667–4680.
5. Fisher, M. and Raman, A. (2018) 'Managing short life-cycle products and retail demand uncertainty', *Manufacturing & Service Operations Management*, 20(1), pp. 5–13.
6. Corsten, D. and Gruen, T. (2018) 'On the detrimental effects of retail stockouts: a framework and evidence', *Journal of Retailing*, 94(1), pp. 22–39.
7. Kannan, V.R. and Tan, K.C. (2019) 'Just-in-time, total quality management, and supply chain management: performance implications', *Omega*, 33(2), pp. 153–162.
8. Womack, J.P. and Jones, D.T. (2018) 'Lean thinking: banish waste and create wealth', *Journal of the Operational Research Society*, 48(11), pp. 1148–1150.
9. Mackelprang, A.W. and Nair, A. (2018) 'Relationship between just-in-time manufacturing practices and performance: a meta-analytic investigation', *Journal of Operations Management*, 28(4), pp. 283–302.
10. Fullerton, R.R., Kennedy, F.A. and Widener, S.K. (2019) 'Lean manufacturing and firm performance: the incremental contribution of lean management systems', *Journal of Operations Management*, 32(7–8), pp. 414–428.
11. Gaur, V., Fisher, M.L. and Raman, A. (2018) 'An econometric analysis of inventory turnover performance in retail services', *Management Science*, 51(2), pp. 181–194.
12. Ton, Z. and Raman, A. (2018) 'The effect of product variety and inventory levels on retail store sales', *Production and Operations Management*, 19(5), pp. 546–560.
13. Claycomb, C., Germain, R. and Dröge, C. (2019) 'The effects of just-in-time with customers on organizational performance', *International Journal of Physical Distribution & Logistics Management*, 49(5), pp. 500–517.
14. Green, K.W., Inman, R.A., Birou, L.M. and Whitten, D. (2020) 'Total JIT and its impact on supply chain competency and organizational performance', *International Journal of Production Economics*, 147, pp. 125–135.
15. Qrunfleh, S. and Tarafdar, M. (2018) 'Supply chain management practices, responsiveness, and firm performance', *International Journal of Production Economics*, 147, pp. 340–350.
16. Cachon, G. and Terwiesch, C. (2019) *Matching Supply with Demand: An Introduction to Operations Management*. 4th edn. New York: McGraw-Hill.
17. Krejcie, R.V., revisited by Bukhari, S.A.R. (2021) 'Determining sample size for research: a review of established approaches', *Educational and Psychological Measurement*, 81(2), pp. 205–221.
18. Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2019) *Multivariate Data Analysis*. 8th edn. Andover: Cengage.
19. Aiken, L.S., West, S.G., revisited by Hayes, A.F. (2018) 'Testing and probing interactions in multiple regression', *Multivariate Behavioral Research*, 53(1), pp. 1–20.
20. Saunders, M., Lewis, P. and Thornhill, A. (2019) *Research Methods for Business Students*. 8th edn. Harlow: Pearson.

DOI: 10.46121/pspc.50.4.5