FROM JUST-IN-TIME TO JUST-IN-CASE: TRANSITION DYNAMICS, DIGITALIZATION AND FINANCIAL IMPLICATIONS FOR EUROPEAN COMPANIES

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Abstract
For decades, the just-in-time (JIT) paradigm has defined operational efficiency by minimizing inventories and reducing working capital requirements. However, recent global disruptions have exposed its structural vulnerabilities, prompting renewed interest in just-in-case (JIC) strategies that prioritize resilience through redundancy, inventory buffering, and supplier diversification. At the same time, rapid advances in digital technologies are reshaping how firms manage this transition. This paper examines the interplay between transition dynamics, digitalization, and financial implications as European companies move from JIT to JIC. Building on a structured review of the literature, we develop a conceptual framework that positions digitalization not merely as an enabler but as a mediating force that redefines the efficiency-resilience trade-off. Digital tools such as real-time data analytics, platform integration, and predictive systems alter inventory strategies, risk management practices, and capital allocation decisions. Drawing on illustrative case evidence, we show that digitalization can both mitigate and amplify the financial burdens of JIC adoption, depending on firms' capabilities and resource endowments. The paper contributes by integrating fragmented insights across supply chain management, digital transformation, and corporate finance, offering a coherent perspective on strategic adaptation under uncertainty. It also provides actionable implications for firms and policymakers navigating an increasingly volatile and digitalized economic landscape.

Keywords*: Just-in-Time (JIT), Just-in-Case (JIC), Supply Chain Resilience, Digitalization, Financial Impact*
JEL classification: L23, G31, O33, F23, L25

INTRODUCTION

Over the last four decades, the logic of global production has been fundamentally shaped by the just-in-time (JIT) system. Rooted in the pursuit of lean efficiency, JIT transformed supply chain management by minimizing inventories, compressing lead times, and reducing working capital requirements (Choi et al., 2023). The model became synonymous with operational excellence and international competitiveness, particularly in manufacturing-intensive sectors where cost optimization and process synchronization were treated as central determinants of firm performance. Yet the conditions that sustained this paradigm have become progressively unstable. A succession of systemic disruptions (including the COVID-19 pandemic, geopolitical fragmentation, energy market volatility, semiconductor shortages, logistical bottlenecks, and inflationary pressures) has exposed the fragility embedded within hyper-optimized supply networks.

Firms operating with minimal buffers discovered that efficiency achieved through extreme synchronization often came at the expense of adaptability and resilience. Supply chain interruptions rapidly translated into production stoppages, revenue losses, liquidity pressures, and heightened financial uncertainty. The pandemic further revealed the limited adaptive capacity of many SMEs, as workforce reductions, stricter health and safety requirements, and disruptions in procurement and distribution networks significantly weakened operational continuity and strategic flexibility (Ahmić & Skopljak, 2021). As a consequence, the longstanding assumption that lean systems necessarily maximize firm value has come under renewed scrutiny.

Against this backdrop, the resurgence of just-in-case (JIC) strategies represents a significant reconfiguration of corporate thinking about risk, resilience, and strategic preparedness. Unlike JIT systems, JIC approaches emphasize redundancy, inventory buffering, supplier diversification, regionalization, and strategic slack as mechanisms for absorbing external shocks (Qamar et al., 2025).

This transition signals more than a technical adjustment in inventory policy; it reflects a broader transformation in how firms conceptualize efficiency under conditions of persistent uncertainty. Increasingly, resilience is no longer perceived as a costly deviation from optimization, but as a strategic capability with direct implications for competitiveness, continuity, and long-term value creation (Wang & Xi, 2026). At the same time, this transition is unfolding in parallel with an unprecedented wave of digital transformation. Advances in artificial intelligence, cloud computing, industrial Internet of Things (IIoT), blockchain architectures, predictive analytics, and integrated enterprise platforms are fundamentally altering the informational foundations of supply chain governance (Ceptureanu et al., 2025).

However, the relationship between digitalization and the transition from JIT to JIC remains theoretically underdeveloped and empirically fragmented (Domingues et al., 2026).

Existing literature often examines supply chain resilience, digital transformation, and corporate finance as separate domains, despite their increasing interdependence in practice. Research on JIT systems has traditionally focused on operational efficiency and cost reduction, whereas resilience-oriented studies emphasize robustness and continuity under disruption.

Meanwhile, digitalization research frequently concentrates on technological adoption without sufficiently examining its financial consequences or its mediating role in strategic inventory decisions.

This paper investigates the transformation of European supply chains from traditional Just-in-Time (JIT) systems toward hybrid resilience-oriented models that integrate selected Just-in-Case (JIC) principles, emphasizing the strategic importance of digitalization and the resulting financial consequences for firms operating under conditions of persistent uncertainty.

Building on a structured analysis of the literature and the conceptual findings presented in the study, the paper develops the Resilience-Optimized Supply Chain (ROSC) framework, arguing that European companies increasingly combine lean operational efficiency with strategic redundancy, flexible production capabilities, diversified sourcing structures, and resilience-adjusted capital allocation in order to balance competitiveness with continuity and disruption preparedness. Finally, the study demonstrates that digital technologies function not merely as operational support mechanisms, but as the core integrative infrastructure through which firms enhance predictive capabilities, strengthen adaptive decision-making, optimize risk-sensitive inventory management, and redefine the economic foundations of supply-chain management in the emerging post-pandemic European business environment.

The contribution of this study is threefold. First, it integrates fragmented insights from supply chain management, digital transformation, and corporate finance into a unified analytical perspective. Second, it advances the emerging debate on post-pandemic supply chain restructuring by conceptualizing the JIT-to-JIC transition as a dynamic and digitally mediated process rather than a binary strategic shift. Third, it offers practical implications for managers and policymakers seeking to balance resilience, competitiveness, and financial sustainability in an increasingly volatile global economy.

1. JUST-IN-TIME MEANING AND ITS SUCCESS STORY

The just-in-time (JIT) concept emerged as one of the most influential operational philosophies of modern industrial capitalism. Originally developed within the Japanese manufacturing system - most notably through the Toyota Production System during the post-war period (Gil-Vilda et al., 2021), JIT was designed to eliminate inefficiencies by synchronizing production processes with actual market demand. At its core, the model rested on a simple principle: materials, components, and products should arrive “just in time” for their immediate use in production or distribution, thereby minimizing excess inventory and reducing waste throughout the value chain. The intellectual foundation of JIT was closely linked to the broader philosophy of lean management (Milewski, 2022). Rather than viewing inventories as safeguards against uncertainty, JIT conceptualized them as symptoms of inefficiency that concealed deeper organizational problems such as production imbalances, forecasting inaccuracies, defective quality control, and poor supplier coordination. Consequently, the reduction of inventories became both an operational objective and a diagnostic mechanism for continuous process improvement. The elimination of “non-value-adding activities” (including idle storage, overproduction, waiting times, and unnecessary transportation) was expected to enhance productivity, reduce costs, and improve responsiveness to customer demand.

Several interrelated principles enabled the success and global diffusion of JIT systems. First, production processes were organized around demand-driven “pull systems” rather than forecast-driven “push systems” (Reyes et al., 2024). Instead of producing goods for stock accumulation, firms produced according to real-time consumption signals, thereby reducing overproduction and inventory obsolescence. Second, supplier relationships became increasingly integrated and synchronized. Long-term partnerships, stable delivery schedules, and geographic proximity allowed firms to coordinate production with remarkable temporal precision. Third, standardization and quality management played a critical role. Since minimal inventories left little room for operational error, JIT systems depended on highly reliable production processes, continuous improvement practices (*kaizen*), and rigorous quality control mechanisms. The success of JIT was also inseparable from broader transformations in the global economic environment during the late twentieth century. Trade liberalization, declining transportation costs, containerization, and advances in information and communication technologies facilitated the emergence of globally fragmented production networks.

Firms could increasingly source components from geographically dispersed suppliers while maintaining synchronized production flows across continents. Simultaneously, relative geopolitical stability and predictable international trade regimes reduced the perceived need for strategic redundancy and inventory buffering. Under these conditions, lean supply chains appeared economically rational, technologically feasible, and strategically superior. Financial considerations further accelerated the global adoption of JIT practices. By minimizing inventory holdings, firms significantly reduced working capital requirements and improved cash flow efficiency. Inventory reduction enhanced key financial performance indicators such as return on assets, inventory turnover ratios, and operating margins, all of which were closely monitored by investors and financial markets. In increasingly financialized economies, JIT became more than a production model; it evolved into a mechanism for maximizing shareholder value through capital efficiency. Lean inventories allowed corporations to free capital for expansion, innovation, acquisitions, and short-term profitability enhancement. As a result, JIT gradually transcended its origins in manufacturing and became a dominant managerial ideology shaping global business strategy. Automotive, electronics, retail, pharmaceutical, and logistics sectors adopted lean operating models centered on speed, synchronization, and cost minimization. The model's apparent success reinforced the belief that competitiveness depended on eliminating redundancy and optimizing every stage of production and distribution. Efficiency was elevated from an operational objective to a normative principle of corporate governance.

2. JUST-IN-CASE AS A STRATEGIC ARCHITECTURE OF RESILIENCE

The renewed prominence of just-in-case (JIC) strategies reflects a fundamental transformation in the logic of contemporary production systems. Once regarded as economically inefficient and operationally excessive, JIC has re-emerged as a critical framework for navigating an increasingly volatile global environment characterized by geopolitical fragmentation, recurrent supply disruptions, technological dependency, and systemic uncertainty. Far from representing a temporary reaction to recent crises, the contemporary rise of JIC signals a broader redefinition of how firms understand resilience, continuity, and strategic preparedness in the twenty-first-century economy.

At its core, the JIC paradigm is built upon the principle that organizational survival and operational continuity require the deliberate preservation of adaptive capacity (Yu et al., 2024). Unlike highly optimized systems designed around uninterrupted flows and minimal redundancy, JIC recognizes that disruptions are not anomalous deviations from normality but structurally embedded features of modern global markets.Consequently, firms must maintain sufficient buffers, flexibility, and alternative capabilities to absorb shocks without experiencing severe operational paralysis. The foundational logic of JIC rests on several interrelated principles that collectively distinguish it as a resilience-oriented model of supply chain organization.

The first principle is strategic redundancy since JIC systems intentionally maintain reserve capacities capable of stabilizing operations during periods of disruption (Dzreke & Dzreke, 2025). These reserves may include safety inventories, backup suppliers, additional warehousing capacity, alternative transportation routes, or flexible manufacturing arrangements. Importantly, redundancy within modern JIC systems is not synonymous with inefficiency or uncontrolled accumulation. Rather, it is strategically calibrated according to the criticality of specific components, suppliers, or logistical nodes. Firms increasingly recognize that the absence of redundancy may generate far greater financial and operational costs during crises than the maintenance of carefully designed buffers under normal conditions. The second principle is supplier diversification.

Contemporary supply chains often rely upon highly specialized and geographically concentrated production ecosystems, particularly in sectors such as semiconductors, pharmaceuticals, advanced manufacturing, and energy-intensive industries. While concentration may generate cost efficiencies and scale advantages, it also creates systemic dependency risks. JIC therefore prioritizes the distribution of sourcing structures across multiple suppliers, regions, and geopolitical environments in order to reduce exposure to single points of failure (Kelka, 2024). Diversification enhances organizational resilience by ensuring that disruptions affecting one supplier or region do not immediately incapacitate the entire production system.

The third principle is operational flexibility. JIC systems emphasize the ability to rapidly adapt production, sourcing, and logistics arrangements in response to changing external conditions (Hosseini Shekarabi et al., 2025). Flexible manufacturing systems, modular production architectures, scalable logistics networks, and adaptive procurement strategies allow firms to reconfigure operations when disruptions occur. In highly volatile markets, agility increasingly depends on rapid operational reconfiguration, decentralized coordination, and the continuous refinement of organizational capabilities (Ahmić et al., 2025). In this sense, resilience is not derived solely from stock accumulation, but from the organizational capacity to respond dynamically to uncertainty. A fourth principle is continuity-oriented risk management. Traditional efficiency-centered models frequently approached risk as a calculable and manageable variable that could be minimized through optimization techniques. JIC adopts a broader understanding of risk, acknowledging that many contemporary disruptions are systemic, interconnected, and difficult to predict probabilistically. Consequently, the objective of JIC is not necessarily to eliminate risk altogether, but to ensure continuity under conditions where disruption cannot be fully prevented. This shift represents a profound transformation in managerial thinking: from optimizing stability to managing instability. Closely related to this is the principle of resilience as strategic value creation. Historically, resilience was often interpreted as a defensive or reactive capability associated with additional costs and reduced profitability. Today, however, resilience increasingly functions as a competitive advantage. Firms capable of sustaining production, maintaining supply reliability, and preserving customer relationships during crises strengthen market credibility and long-term strategic positioning. Under conditions of systemic volatility, resilience itself becomes economically productive.

3. JIT AND JIC COMPARISON - TRANSITION DYNAMICS, DIGITALIZATION AND FINANCIAL IMPLICATIONS

The contemporary transformation of global supply chains does not imply the complete abandonment of just-in-time principles nor the unconditional adoption of just-in-case structures. Rather, firms are increasingly moving toward hybrid organizational models that seek to reconcile operational efficiency with strategic resilience. Within this evolving strategic landscape, the objective is no longer the maximization of efficiency under stable conditions alone, but the construction of adaptive systems capable of preserving continuity amid persistent uncertainty. Emerging additive manufacturing technologies slightly modified JIT logic by enabling highly precise, demand-responsive production with reduced material waste, localized fabrication, and shorter distribution networks that minimized both inventory dependence and logistical complexity (Ahmić, 2025). Consequently, the future of supply chain management is increasingly shaped by the selective integration of lean synchronization, strategic redundancy, digital intelligence, and resilience-oriented governance.

As illustrated in Table 1, this evolving model may be conceptualized as a resilience-optimized supply chain architecture in which efficiency and adaptability cease to function as opposing logics and instead become mutually reinforcing dimensions of long-term competitiveness.

Table 1. Resilience-Optimized Supply Chains (ROSC): Integrating JIT Efficiency with JIC Adaptive Capacity (Source: Author's work)

Strategic Dimension	**What Should Be Retained from JIT**	**What Should Be Integrated from JIC**	**Emerging Hybrid Model: Resilience-Optimized Supply Chains (ROSC)**
Core Operating Philosophy	Lean process discipline and elimination of non-value-adding activities	Organizational resilience and continuity-oriented safeguards	Efficiency maintained within resilience boundaries rather than through extreme optimization
Inventory Management	Dynamic inventory turnover and demand synchronization	Strategic safety stocks for critical inputs and high-risk components	Intelligent buffering based on risk exposure, supply criticality, and predictive analytics
Production Systems	Standardization, process efficiency, and lean workflows	Flexible production capacity and contingency manufacturing arrangements	Modular and reconfigurable production systems capable of rapid adaptation
Supplier Strategy	Long-term collaborative supplier relationships and process integration	Multi-sourcing and geographically diversified supplier networks	Tiered supplier ecosystems balancing efficiency with strategic redundancy
Geographic Configuration	Global sourcing where efficiency advantages remain significant	Nearshoring, friend-shoring, and regional backup production capacity	Selective regionalization combined with globally diversified sourcing
Procurement Logic	Cost-efficient procurement and synchronized replenishment	Strategic sourcing focused on resilience and continuity	Risk-adjusted procurement balancing cost efficiency with supply security
Transportation & Logistics	Streamlined logistics networks minimizing delays and excess handling	Alternative logistics corridors and reserve transportation options	Adaptive logistics systems with built-in rerouting capacity
Risk Management	Operational risk minimization through process optimization	Systemic risk preparedness and disruption absorption mechanisms	Predictive resilience management integrating operational and geopolitical risks
Digital Infrastructure	ERP integration and real-time operational coordination	AI-driven forecasting, digital twins, predictive resilience systems	End-to-end digital visibility and adaptive decision-making systems
Data Utilization	Real-time synchronization and inventory optimization	Early-warning systems and disruption scenario modeling	Continuous resilience analytics combining operational and strategic intelligence
Decision-Making Model	Centralized coordination for operational consistency	Decentralized adaptive responsiveness during disruptions	Hybrid governance combining centralized visibility with local flexibility
Financial Orientation	Working capital efficiency and liquidity optimization	Strategic resilience investment and continuity financing	Resilience-adjusted capital allocation models
Working Capital Strategy	Minimized inventory-related capital lock-in	Selective capital allocation for critical reserve inventories	Differentiated inventory financing based on strategic importance
Performance Metrics	Cost reduction, inventory turnover, and operational speed	Recovery time, continuity capacity, and disruption resilience	Dual performance systems measuring both efficiency and resilience

Organizational Structure	Lean hierarchical coordination and operational discipline	Cross-functional crisis management and adaptive governance	Agile organizational systems capable of rapid strategic reconfiguration
Human Capital Requirements	Process specialization and operational precision	Strategic adaptability and crisis-response competencies	Workforce combining efficiency expertise with resilience-oriented capabilities
Technology Investment Priorities	Automation for cost efficiency and productivity gains	Technologies supporting predictive resilience and operational continuity	Smart supply-chain ecosystems integrating automation with resilience intelligence
Competitive Advantage Logic	Price competitiveness and speed-to-market	Reliability, continuity, and adaptive robustness	"Reliable efficiency" as the new competitive standard
Sustainability Integration	Waste minimization and lean resource utilization	Long-term continuity of sustainable supply networks	Sustainable resilience balancing ESG goals with operational security

4. TRANSITION FROM JIT TO JIC – EXAMPLES OF EUROPEAN COMPANIES

Recent disruptions have accelerated a visible transition from hyper-optimized just-in-time systems toward resilience-oriented just-in-case strategies across several major European industries. One of the clearest examples emerged within the European automotive sector following the semiconductor shortages that severely disrupted production between during Covid-19 lockdown period (Ramani et al., 2022). Manufacturers such as BMW and Volkswagen Group increasingly diversified suppliers, expanded strategic inventories of critical components, and strengthened regional sourcing arrangements in order to reduce dependency on highly concentrated Asian semiconductor ecosystems. The crisis demonstrated that lean synchronization without strategic buffers could rapidly evolve into operational paralysis under geopolitical and logistical disruption.

A similar transformation has become evident in the European pharmaceutical industry. Following persistent medicine shortages and disruptions in active pharmaceutical ingredient (API) supply chains, companies such as Sanofi accelerated investments in regional manufacturing capacity, inventory stockpiling, and strategic sourcing diversification (Fischer et al., 2023). These initiatives align with broader European Union efforts to strengthen pharmaceutical sovereignty and reduce dependence on externally concentrated production systems. The emerging model combines resilience-oriented inventories with digitally integrated production planning and supply-chain monitoring systems.

More broadly, European industrial strategy itself increasingly reflects a systemic shift toward resilience-oriented supply chain management. Recent evidence indicates growing investments in reshoring, nearshoring, and friend-shoring initiatives across sectors such as semiconductors, batteries, pharmaceuticals, and advanced manufacturing (Szczepański, 2021). According to recent European industry analyses, firms are progressively redesigning supply chains around regional diversification, strategic autonomy, and adaptive continuity rather than pure cost minimization. This transition demonstrates that the movement from JIT to JIC is not simply an operational adjustment, but part of a broader restructuring of European industrial competitiveness under conditions of permanent uncertainty.

CONCLUSION

The era in which efficiency alone defined corporate excellence is rapidly coming to an end. For decades, just-in-time systems symbolized the triumph of precision, synchronization, and cost minimization within an increasingly globalized economy. Yet the successive shocks of recent years have revealed a critical paradox of hyper-optimization: systems designed to eliminate inefficiencies often eliminated resilience as well. In this new landscape of permanent uncertainty, adaptability has become as valuable as efficiency itself.

This paper has shown that the transition from JIT toward hybrid resilience-oriented models represents far more than a technical adjustment in inventory management. It reflects a profound transformation in how firms understand risk, continuity, and strategic competitiveness. Through the comparative analysis of JIT and JIC approaches and the proposed Resilience-Optimized Supply Chain (ROSC) framework, the study demonstrates that European companies are increasingly seeking equilibrium between operational leaness and strategic redundancy rather than choosing one at the expense of the other.

At the center of this transformation stands digitalization. Digital technologies no longer function merely as operational tools, but as the intelligence infrastructure through which firms anticipate disruptions, strengthen flexibility, and redefine the financial logic of supply-chain management. Ultimately, the future will not belong to the most efficient supply chains, but to those capable of remaining efficient while enduring uncertainty, absorbing shocks, and continuously adapting to an increasingly volatile global economy.

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