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Market Structure as a Moderator of Supply Chain Resilience: A Monte Carlo Simulation of Tariff Volatility

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ABSTRACT

This study examines how market structure moderates supply chain resilience to tariff volatility through a Monte Carlo simulation of monopoly, oligopoly, and perfect competition. Drawing on profit maximization theory, supply chain resilience theory, and survivability theory, we model the performance of firms across 81 experimental scenarios, varying tariff rates, pass-through rates, and desired profit margins. The findings reveal a clear hierarchy of resilience: oligopolies emerge as the most resilient, maintaining positive margins even under high tariffs through strategic coordination; monopolies achieve the highest margins but exhibit the most volatility, with profitability collapsing as tariffs rise; and perfectly competitive firms are the most vulnerable, unable to survive tariffs beyond moderate levels due to their lack of pricing power. Pass-through capability, a key resilience mechanism, is most effective in monopoly settings where it protects profit margins, while desired profit margins show no significant impact on performance outcomes, suggesting that strategic intent alone is insufficient without the market power to execute pricing strategies. The results demonstrate that market structure fundamentally determines supply chain resilience to trade policy uncertainty. For practice, the findings highlight the need for market-structure-aware resilience strategies: monopolies should dynamically adjust pass-through based on tariff levels, oligopolies should maintain consistent pass-through to coordinate with competitors, and competitive firms should prioritize cost reduction, diversification, and consolidation to survive tariff shocks. For policymakers, the results underscore the extreme vulnerability of competitive industries to tariff volatility, the need to monitor oligopolistic coordination that may harm consumers, and the importance of considering market concentration when designing trade policy. This research extends profit maximization and survival-based theories by demonstrating that resilience mechanisms are contingent on competitive position, and it provides a framework for understanding the differential impacts of tariffs across industries. The hierarchy of resilience revealed by this analysis—oligopolies most resilient, monopolies most volatile, and competitive firms most vulnerable—offers a foundation for firms navigating volatile trade environments and for policymakers designing effective trade policies.

Keywords: *supply chain resilience, market structure, tariff volatility, pass-through*

1. INTRODUCTION

Global supply chains constitute the foundational architecture of modern economies, facilitating the seamless production, distribution, and cross-border delivery of goods. By connecting businesses with consumers worldwide, they stimulate economic growth and ensure the broad availability of essential products. A central objective across these interconnected networks is the maximization of aggregate profit. As Samuelson and Nordhaus (2010) articulate, the theory of profit maximization holds that firms strive to realize the highest possible profits through the strategic optimization of operations, pricing mechanisms, and resource allocation. Nevertheless, given the intricate and highly interdependent nature of supply chains, profit maximization remains acutely vulnerable to unforeseen disruptions—whether natural or anthropogenic.

Over the past two decades, a series of high-profile events—including natural catastrophes, global health emergencies, and geopolitical conflicts—have severely tested supply chain continuity. The 2011 Tohoku earthquake and tsunami, for example, precipitated widespread disruptions across Japan and reverberated through global automotive and electronics sectors (Brennan, 2011; Todo *et al.,* 2015). Similarly, the COVID-19 pandemic engendered acute product shortages, delivery delays, inflationary pressures, and broad economic instability. In June 2024, the United States experienced pronounced egg shortages and soaring prices, driven by a significant H5N1 avian influenza outbreak affecting poultry, wild birds, and, in rare instances, dairy cattle and humans (Doerfler, 2025).

Beginning in February 2025, the Trump Administration's "Liberation Day" reciprocal tariff strategy-imposed import duties on U.S. trading partners, provoking retaliatory measures and creating a fragmented tariff regime (Lawder *et al.,* 2025). Compounding these trade policy shocks, geopolitical conflict in the Middle East disrupted critical maritime chokepoints, while natural disasters and port congestion further strained global logistics networks. By mid-2025, 72% of U.S. executives identified tariffs and trade wars as the top external supply chain risk (Lawder *et al.,* 2025). These converging disruptions underscore the urgency of understanding how supply chains can build resilience to trade policy volatility.

As trade policy volatility, geopolitical conflict, and natural disasters converge to create a persistent state of systemic turbulence, supply chain resilience must transcend mere recovery and incorporate the capacity for adaptation and transformation in response to impending crises (Holling, 1996; Wieland & Durach, 2021). Although this imperative may appear formidable, it simultaneously offers an opportunity to reconceptualize the societal role of supply chains as dynamic systems capable of embracing change (Laszlo *et al.,* 2020). Wieland and Durach (2021) argue that resilience thinking must evolve from a purely engineering orientation toward a social-ecological perspective.

Survival-based theory provides a robust lens for understanding how supply chains can navigate disruptions while safeguarding long-term viability (Ivanov & Dolgui, 2020). Under the engineering paradigm, resilience emphasizes stability near a single equilibrium steady state. Yet when prevailing conditions shift—as evidenced by the rapidly mutating tariff regimes, the closure of critical maritime chokepoints, and the compounding effects of geopolitical and natural shocks—this approach often compels the system to revert to a state that is no longer relevant, rendering engineering resilience increasingly tenuous in today's volatile business climate. In contrast, a social-ecological perspective acknowledges that prior conditions may no longer obtain; resilience is measured by the magnitude of disturbance a system can absorb before fundamental structural changes become necessary (Holling, 1996). The 2025–2026 disruptions vividly illustrate this need: firms that merely sought to "bounce back" to pre-shock operations found themselves repeatedly overtaken by new waves of volatility, whereas those that embraced adaptive restructuring—such as diversifying sourcing, reconfiguring logistics networks, and building strategic inventory buffers—proved more capable of sustaining operations.

By foregrounding resilience, adaptability, and risk management, survival-based theory furnishes valuable strategic insights for firms operating amidst fluctuating tariffs, geopolitical instability, and precarious trade agreements. Within such environments, the prevailing market structure and the price elasticity of product demand emerge as the most consequential determinants of supply chain performance (Flaaen *et al.,* 2020; Cavallo *et al.,* 2021).

The three canonical market structures are perfect competition, oligopoly, and monopoly. In perfectly competitive markets, numerous firms exist, none of which can independently influence market prices. Products are homogeneous, and barriers to entry and exit are low (Porter, 2008). Commodities such as wheat, corn, soybeans, pork bellies, and milk are traded in such markets. For instance, one farmer's wheat is virtually indistinguishable from another's; with thousands of producers, no single farmer can affect the global price, which is determined by commodity exchanges. Accordingly, supply chains in these contexts operate as price takers. In the current volatile environment, these firms are especially vulnerable: they cannot pass increased tariff or shipping costs on to consumers, and margin compression during the 2025–2026 disruptions has been most acute in agricultural commodities, where fertilizer price spikes and shipping rerouting have eroded already thin margins.

Conversely, oligopolistic markets are characterized by a small number of large firms producing similar or differentiated products. High startup costs, economies of scale, or entrenched brand loyalty create substantial barriers to entry. Examples include aircraft, smartphones, automobiles, carbonated beverages, and gaming consoles. The duopoly of Google's Android and Apple's iOS illustrates this dynamic: the network effect—where developers gravitate toward platforms with the largest user bases—creates an insurmountable barrier for potential competitors. In such settings, supply chains function as constrained price makers. If Apple raises prices and Google does not follow, Apple risks significant market share loss; conversely, if Apple lowers prices, Google is likely to match, triggering price wars that erode profits for both parties without conferring lasting advantage. During the 2025–2026 trade conflicts, oligopolistic firms in the automotive and electronics sectors faced particularly acute challenges, as their complex, multi-tier supply chains spanning multiple tariff-affected countries forced difficult tradeoffs between absorbing cost increases and risking competitive disadvantage through price hikes.

In monopolistic markets, a single firm controls the entire market, offering a product with no close substitutes. Entry barriers are exceptionally high, stemming from patents, exclusive resource ownership, or substantial capital requirements. Examples include electric and natural gas utilities, public rail services, new pharmaceuticals, and operating systems like Microsoft Windows. Consequently, supply chains in monopolies wield significant pricing power and are therefore designated as price makers (Pindyck & Rubinfeld, 2017). The 2026 helium supply disruption, concentrated at a single global production hub, underscored monopoly vulnerability: with no alternative sources, semiconductor and medical imaging supply chains faced severe constraints, and the monopolistic supplier could pass costs downstream with minimal demand reduction, illustrating how market structure fundamentally shapes disruption impacts.

Price elasticity of demand measures consumer sensitivity to price fluctuations. In elastic demand environments, consumers exhibit high responsiveness: even modest price increases precipitate substantial declines in quantity demanded. In inelastic environments, consumers are comparatively insensitive, such that price hikes result in only minor reductions in demand. For products characterized by elastic demand, unstable trade agreements tend to reduce output and significantly diminish profits—or generate losses—as no individual supply chain can pass added costs on to consumers through higher prices. The 2025–2026 period provided vivid empirical confirmation: elastic consumer goods faced sharp volume declines as tariff-driven price increases met consumer resistance, while inelastic necessities like pharmaceuticals and energy commodities experienced less demand destruction despite significant cost escalation.

The central aim of this paper is to examine how market structure moderates supply chain resilience in the face of trade policy instability, specifically analyzing the responses and impacts on firms operating under perfect competition, oligopoly, and monopoly when confronted with stochastic import tariffs. Grounded in profit maximization and survival-based theories, this research addresses three core questions: (1) How does tariff volatility affect gross margins across different market structures? (2) To what extent can firms in each structure pass tariff costs through to consumers? (3) How does market structure influence cash flow stability under tariff uncertainty?

This paper fills a fundamental theoretical and empirical gap at the intersection of three research streams: supply chain risk management, industrial organization economics, and international trade policy. Existing literature lacks a contingency framework that explains how market structure conditions supply chain resilience to trade policy volatility, and there is a dearth of empirical evidence quantifying differential impacts across competitive environments. Tang (2006) and other SCRM scholars offer comprehensive risk taxonomies but fail to prescribe how optimal strategies should vary by competitive context. Handley and Limão (2015) and related trade policy research demonstrate aggregate effects but do not disaggregate distributional consequences across competitive structures. Porter (2008) and strategic management literature address competitive positioning without integrating dynamic risk adaptation. Finally, Cachon (2003) and operations research examine coordination under static competitive assumptions, neglecting the volatility endemic to contemporary trade environments—a limitation that the cascading disruptions of 2025–2026 have made urgently apparent.

The remainder of this paper proceeds as follows. Section 2 reviews the relevant literature. Section 3 details the applied methodology. Section 4 presents the simulation findings. Section 5 discusses the results, addresses the hypotheses, and derives implications for theory, practice, and policy, along with limitations and future research directions.

2. LITERATURE REVIEW

2.1 Profit Maximization Theory

Profit maximization stands as a foundational concept in economics and business management, representing the primary objective of firms operating within supply chains (Chopra & Meindl, 2016; Gopalakrishnan & Granot, 2021). The theory of profit maximization posits that firms endeavor to achieve the highest possible profit through the strategic optimization of production, pricing, and resource allocation decisions (Mohajan, 2022). Alfred Marshall first formalized this concept by establishing the equality of marginal revenue (MR) and marginal cost (MC) as the condition for profit maximization (Samuelson & Nordhaus, 2010). This principle implies that when MR exceeds MC, producing additional units increases profits; conversely, when MR falls below MC, further production diminishes profits. The precise point at which MR equals MC thus represents the output level at which profit is maximized.

Nevertheless, for a supply chain to sustain profit maximization in environments where increased costs arise from tariff hikes, it must pass these additional costs on to consumers through higher prices—a task that proves challenging under most market conditions (Amiti *et al.,* 2019; Fajgelbaum *et al.,* 2020). The prevailing market structure and the price elasticity of product demand represent the most significant determinants of a supply chain's ability to transmit cost increases to consumers (Flaaen *et al.,* 2020; Cavallo *et al.,* 2021).

In a perfectly competitive market, prices are determined entirely by market forces, leaving individual supply chains with limited flexibility beyond adjusting output levels (Samuelson & Nordhaus, 2010). Such firms operate as price takers, with no capacity to influence market prices through their own pricing decisions. In contrast, within an oligopolistic market, a supply chain's ability to pass additional costs on to consumers through higher prices is strongly influenced by competitors' actions. In other words, one firm's capacity to raise prices depends largely on whether its rivals adopt similar pricing strategies (Tirole, 1988; Perloff, 2020). The interdependent nature of oligopolistic decision-making creates a strategic environment where price increases are viable only when undertaken collectively or tacitly coordinated. Finally, in a monopolistic market, a single firm dominates the entire market. Such a supply chain possesses substantial pricing power and therefore acts as a sole price maker, enjoying the greatest latitude to influence prices (Pindyck & Rubinfeld, 2017).

Across these three distinct market structures, profit maximization is most readily achievable in the monopoly context, where the supply chain functions as the sole price maker. As marginal costs increase, the monopolistic supply chain can leverage its market power to pass a substantial portion of the increased cost to consumers, particularly depending on the product's price elasticity. The challenge is most acute for supply chains operating in perfectly competitive environments, where cost increases cannot be passed forward at all, and moderately difficult for those in oligopolistic markets, where strategic interdependence constrains but does not eliminate pass-through capacity.

Lean manufacturing and just-in-time (JIT) inventory management, while effective in stable environments, are undermined by tariff volatility. These approaches depend on predictable demand, stable costs, and reliable lead times—assumptions that unstable trade agreements directly assault. Tariffs force supply chains to hold buffer stocks, abandon optimized sourcing, and revert to defensive, siloed operations. The result is not merely a minor cost increase but a potential systemic failure of the optimized supply chain, as managers shift from continuous improvement to trade crisis response (Kembro *et al.,* 2025).

To maximize profits in perfectly competitive and oligopolistic markets, the supply chain must still produce where MR equals MC. However, when the market price remains unchanged while costs rise, the supply chain's profit per unit shrinks dramatically. Under these conditions, the

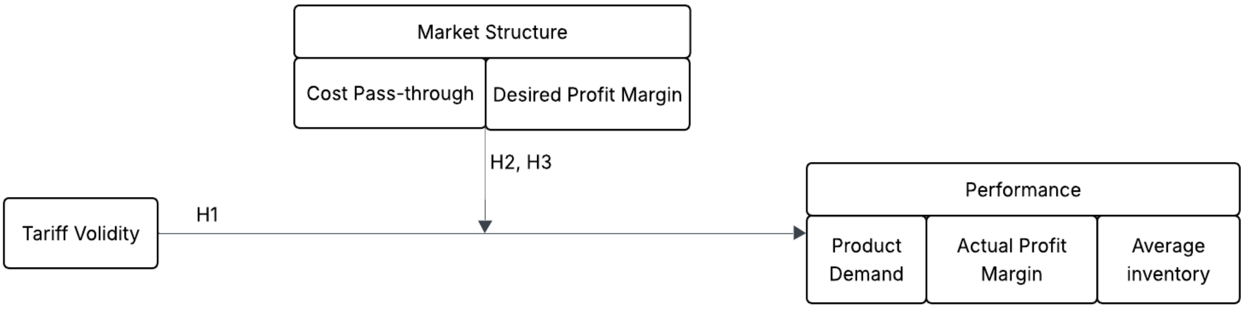

Figure 1 Conceptual Model

supply chain must shift its strategic orientation from a goal of cost efficiency and speed to resilience and risk mitigation. The key performance metric moves from low unit cost to disruption avoidance. The result is not merely a minor cost increase but a potential systemic failure of the optimized supply chain. In essence, the hidden cost of unstable trade agreements is the necessity to sacrifice peak efficiency for the sake of operational stability.

Price elasticity of demand measures how sensitive consumers are to price changes. Supply chains operating in perfectly competitive environments face a perfectly elastic demand curve because they sell identical products; if they raise their price even one cent above the market price, demand drops to zero. This perfectly elastic demand curve effectively neutralizes the supply chain's pricing power entirely. Unstable trade agreements thus lead to lower output and significantly reduced profits—or losses—with no individual supply chain able to pass additional costs to consumers in the form of higher prices. For supply chains facing elastic market demand, the entire industry suffers, and the least efficient producers are forced to exit the market.

In oligopolies, firms can pass on cost increases through tacit coordination if all face similar pressures. However, elastic demand severely limits pass-through, forcing firms to absorb costs, compete on non-price factors, or seek internal efficiencies. In monopolies, pass-through depends critically on demand elasticity. With inelastic demand, the monopolist can pass almost all cost increases to consumers with minimal demand loss. With elastic demand, pass-through is limited, forcing the monopolist to absorb costs and accept lower profits, demonstrating that even monopoly power has limits.

2.2 Survival-Based Theory

Unstable trade agreements create an environment in which the rules of engagement can change overnight. A supply chain partner in a foreign country may become economically unfavorable due to newly imposed tariffs, rendering previously optimized sourcing strategies obsolete. Survival-based theory, rooted in biology and ecology, provides a powerful and intuitive framework for understanding and building resilient supply chains. The core premise is that resilience is not about remaining static and robust but about dynamically adapting to survive in a constantly changing and often hostile environment (Wieland & Durach, 2021). A survival-based perspective conceptualizes supply chains not as rigid processes but as adaptive entities operating within a global market ecosystem characterized by competitive and disruptive forces. The ultimate goal of the supply chain under this paradigm is survival and long-term prosperity. Drawing from biological theory, species that endure are those that can best adapt to changing environmental conditions through evolution and behavioral adaptation.

Survival-based theory requires supply chains to learn, adapt, and evolve continuously. Adaptation involves reconfiguring manufacturing facilities and refining strategies to incorporate near-shoring, dual-sourcing, and strategic stockpiling (Kamalahmadi & Parast, 2016). Rapid reconfigurability is essential: if a tariff hike occurs, the supply chain must transfer production or onboard new suppliers quickly. Consistent with the imperative for reconfiguration under survival-based theory, Heise *et al.* (2025) provide empirical evidence that U.S. importers responded to a reduction in trade policy uncertainty with China by shifting their procurement towards more frequent, smaller shipments indicative of long-term relational agreements.

Diversification must extend across geopolitical blocs to ensure tariff resilience. The supply chain must also constantly sense its environment—monitoring not only logistics data but political climate, legislative drafts, and diplomatic relations. Collaborative relationships with suppliers, logistics providers, and even competitors are critical for navigating complex trade landscapes, enabling shared forecasting, logistics capacity, and collective lobbying for favorable trade terms (Pucci *et al.,* 2024; Guercini & Woodside, 2012).

Having established the theoretical foundations of profit maximization and survival-based theories, we now synthesize these perspectives into an integrated conceptual framework. This framework explicitly shows how market structure moderates the relationship between tariff volatility and supply chain performance, addressing the gap identified in the introduction (Figure 1).

The conceptual framework is grounded in the following logic. First, tariff volatility increases supply chain costs and uncertainty, directly degrading financial and operational performance. Second, the magnitude of this degradation depends on market structure because competitive environments determine a firm's ability to set prices, pass costs to consumers, and absorb cost shocks.

Based on this framework, we propose the following hypotheses:

- H1: There is a negative relationship between tariff volatility and supply chain performance, such that higher tariff volatility leads to lower and more unstable performance.

Table 1 Market Structure Configurations

Parameter	Perfect Competition	Oligopoly	Monopoly
Number of firms (N)	1,000	5	1
Pricing power	None (Price taker)	Moderate (Price maker)	Complete (Price maker)
Pass-through range	70% - 95%	40% - 80%	20% - 60%
Desired margin range	3% - 10%	10% - 30%	30% - 60%

- H2: Market structure moderates the relationship between tariff volatility and supply chain performance, with monopolistic structures showing greater resilience, such that the negative impact of tariffs is weaker for supply chains with market power.
- H3: Supply chains with greater market power demonstrate superior resilience to cost shocks through price pass-through ability, such that monopolies maintain margins by raising prices when costs increase.

3. METHODOLOGY

This research employs a Monte Carlo simulation methodology to examine how market structure moderates the relationship between tariff volatility and supply chain performance. The study integrates three interconnected theoretical lenses: profit maximization theory to model firm decision-making processes, supply chain resilience theory to examine disruption response capabilities, and survivability theory to analyze long-term adaptation during prolonged disruptions.

Monte Carlo simulation is a versatile tool for analyzing systems characterized by risk and uncertainty, enabling researchers to estimate resultant distributions regardless of the relationships and probability distributions involved (Law, 2014). Recent developments in simulation-based decision support systems have demonstrated the efficacy of this approach for stress-testing supply chain resilience and for reconfiguration in response to tariff shocks (Ivanov, 2025). Supply chain stress testing, defined as a simulation designed to analyze the ability of a supply chain to withstand disruptions and recover, provides a structured method for evaluating vulnerability and resilience under extreme conditions (Hosseini *et al.,* 2021).

The simulation framework adopts a periodic review inventory management approach where autonomous decision-making entities interact within a simulated economic environment. This paradigm is particularly well-suited for capturing emergent behaviors in complex systems like supply chains, where localized decisions aggregate to produce system-level outcomes (Macal, 2016). The model incorporates key operational parameters including weekly ordering cycles, lead times, and varying demand elasticities based on market structure, enabling a comprehensive assessment of supply chain resilience (Gholizadeh *et al.,* 2025).

Tariff volatility is operationalized as the monthly variation in tariff rates applied to imported goods. The simulation incorporates a volatile scenario with monthly tariff draws from a uniform distribution between 0% and 100%. This operationalization captures the range of tariff shocks observed in recent trade disputes (Bown, 2019; Fajgelbaum *et al.,* 2020). Market structure is operationalized through three distinct configurations: perfect competition (1,000 firms, price takers), oligopoly (5 firms, strategic interaction), and monopoly (1 firm, price maker). Each structure is characterized by differentiated pricing power, reflecting different approaches to resilience enhancement (Zhang *et al.,* 2023). The pricing power includes setting tariff pass-through rate and desired profit margin (Table 1).

Pass-through capability represents the proportion of tariff costs transferred to consumers. The pass-through rate follows a uniform distribution where monopoly ranges from 20% to 60%, oligopoly ranges from 40% to 80%, and perfect competition ranges from 70% to 95%. The values selected are well-supported by both economic theory and empirical evidence, which consistently show that market structure is the primary determinant of pass-through. A firm's ability to pass cost increases on to consumers is fundamentally linked to its competitive environment and pricing power. In perfect competition, firms have no pricing power and razor-thin margins, forcing them to pass most tariff costs to consumers. In oligopoly, firms have some pricing power but must consider strategic interactions with competitors, leading to moderate pass-through rates. In monopoly, firms have significant market power and can strategically choose to absorb costs, resulting in lower pass-through rates.

Desired profit margin reflects the firm's target markup over total cost. In perfect competition, firms are price takers and earn zero economic profit in the long run, as free entry erodes excess profits. They can only earn a normal profit, resulting in very low margins ranging between 3% and 10%. Few large firms with differentiated products have considerable control over price, enabling above-normal profits with profit margins ranging between 10% and 30%. On the other hand, a single firm with a unique product faces no competition, allowing it to set prices substantially above cost to maximize profit. Monopolists can sustain large economic profits, with predicted margins ranging between 30% and 60%.

Supply chain performance is measured through three dependent variables: profit margin loss, demand loss, and inventory impact. Profit margin loss is the ratio of actual profit margin to desired profit margin. A positive value less than unity indicates the firm achieved some portion of its target; a negative value indicates the firm operated at a loss. Demand loss is the ratio of actual demand to baseline demand. Demand loss measures demand as a portion of baseline demand. Higher values indicate better demand preservation. Inventory impact is the ratio of actual inventory to baseline inventory. Higher values indicate greater inventory buildup. The baseline weekly demand and average inventory are derived from a baseline scenario whereby tariff rate is set to zero.

The Periodic Review (R, S) uses an order-up-to policy with weekly order releases and a 4-week lead time. This policy is appropriate because orders are placed at fixed weekly intervals, rather than continuously monitoring inventory.

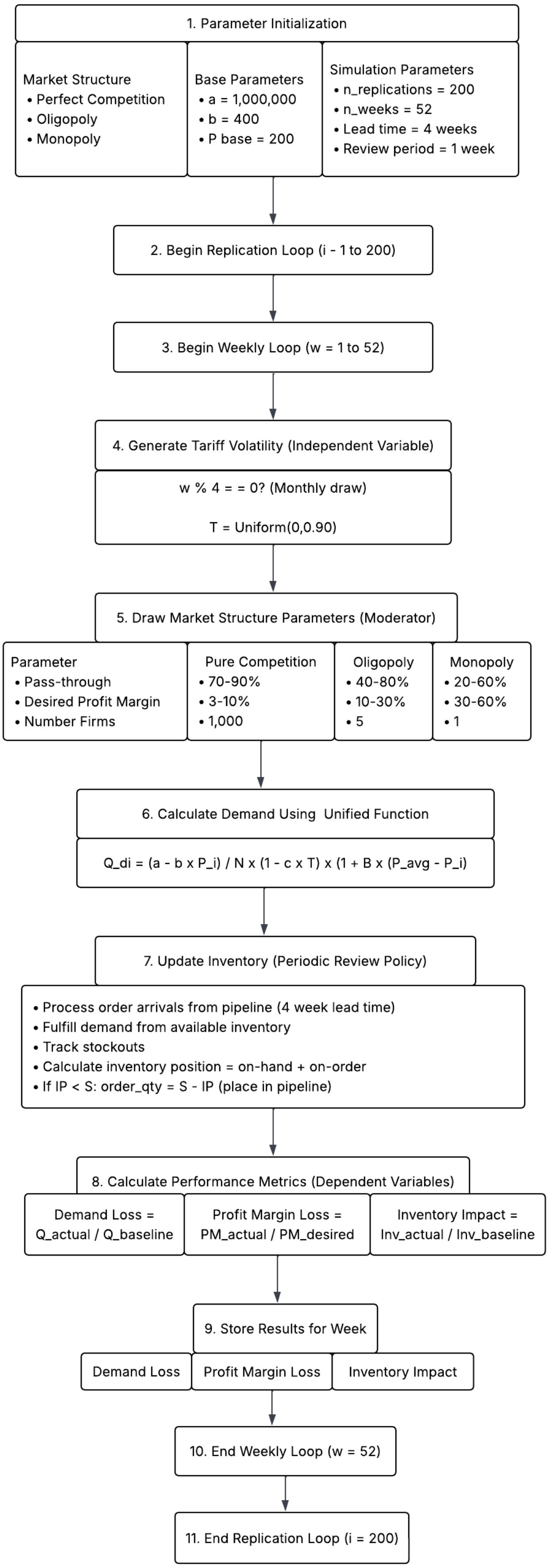

Figure 2 Monte Carlo Simulation Flow Diagram

$$S = d_{avg} \times (L + R) + z \times \sigma_d \times \sqrt{(L + R)} \quad (1)$$

where:

d_{avg} = Average weekly demand;
L = Lead time (4 weeks);
R = Review period (1 week);
z = Safety factor (1.65 for 95% service level);
σ_d = Standard deviation of weekly demand.

This study employs a unified product demand function that encompasses purely competitive, oligopolistic, and monopolistic market structures within a single mathematical framework (Weyl & Fabinger, 2013; d'Aspremont & dos Santos Ferreira, 2021). By adjusting a few key parameters, this single equation can replicate the behavior of any firm in any market type.

$$Q_{di} = \left(\frac{a - bP_i}{N}\right) \times (1 - cT) \times \left(1 + \beta\left(\frac{\sum_{j \neq i} P_j}{N - 1} - P_i\right)\right) \quad (2)$$

where:

Q_{di} = Quantity demanded for firm i ($Q_{di} \geq 0$);
a = Base market size (intercept) ($a > 0$; typical values: 1,000–10,000,000);
b = Price sensitivity of the market (slope) ($b > 0$; typical values: 0.5–500);
N = Number of firms in the market ($N \geq 1$; typical values: 1–∞);
T = Tariff rate ($0 \leq T \leq 1$; typical values: 0.0–0.50);
c = Tariff pass-through sensitivity ($0 \leq c \leq 1$; typical values: 0.2–1.0);
β = Cross-price switching coefficient ($\beta \geq 0$; typical values: 0.1–2.0);
P_i = Price of the product for firm i ($P_i > 0$; typical values: \$10–\$100,000);
P_j = Price of the product for the rival firms j ($P_j > 0$; typical values: \$10–\$100,000).

The first term represents the total product demand in the market as a function of price, divided by the number of firms. This term captures the fundamental relationship between price and quantity demanded, with the number of firms determining each firm's share of the market. The second term represents the impact of trade policy on consumer demand. The tariff rate (T) can be any random value; however, the percentage of the tariff passed on to consumers (c) can be any proportion: no pass-through (0%), partial pass-through, or full pass-through (100%). Finally, the third term represents how a firm's demand is affected when its price differs from the average price of its competitors. If the firm's price is lower than the average price of its competitors, the firm gains customers. If the firm's price exceeds the average price, it loses customers. In this study, for perfect competition, no price difference is set among competitors.

A full factorial experimental design with four controlled factors and multiple response variables are used to systematically examine supply chain performance under different market conditions and tariff scenarios (Bastidas & Guachi, 2020). The experimental structure enables isolation of individual factor effects while examining interaction effects between market structure and tariff conditions, following established practices in supply chain simulation research (Law, 2014; Macal, 2016).

The tariff volatility factor implements three distinct scenarios following methodologies for assessing supply chain resilience (Hosseini *et al.,* 2021). The low level features a stable scenario with constant 0-10% tariffs. The medium level features monthly fluctuations between 20-40% tariffs. The high-level features monthly fluctuations between 40-90% tariffs. This multi-scenario approach enables robust testing of supply chain resilience capacity and adaptation mechanisms under different disruption patterns (Ojha *et al.,* 2024).

The pass-through rate follows uniform distribution where monopoly ranges from 20% to 60%, oligopoly ranges from 40% to 80%, and perfect competition ranges from 70% to 95%. The values selected for the pass-through rate are well-supported by both economic theory and empirical evidence, which consistently show that market structure is the primary determinant of pass-through. A firm's ability to pass cost increases on to consumers is fundamentally linked to its competitive environment and pricing power

Figure 2 provides a high-level overview of the Monte Carlo simulation logic. The diagram shows the sequential flow from parameter initialization through statistical analysis, capturing the key decision points and feedback loops in the simulation. The simulation executes 200 replications per experimental cell, with each replication spanning 52 weeks.

The analysis begins with descriptive statistics for each market structure, including means, standard deviations, and ranges for all independent and dependent variables. Factorial ANOVA examines the main effects of market structure, tariff rate, pass-through rate, and desired profit margin on each dependent variable. Two-way interactions between market structure and each of the other factors are also examined. Effect sizes are reported using Partial Eta Squared ($\eta^2 p$), with values of .01, .06, and .14 interpreted as small, medium, and large effects, respectively. The simulation is implemented in Python.

4. DATA ANALYSIS

This section presents the results of the Monte Carlo simulation. The analysis proceeds in three stages: (1) correlation analysis to examine relationships among key variables (Table 2); (2) descriptive statistics and performance comparisons across market structures (Tables 3-4); and (3) inferential statistical analysis using factorial ANOVA to test the three hypotheses (Tables 5-7). Effect sizes are reported using Partial Eta Squared ($\eta^2 p$), with values of .01, .06, and .14 interpreted as small, medium, and large effects, respectively (Cohen, 1988).

Before presenting the results, it is important to clarify the metrics. Cost impact and price impact are expressed as ratios relative to baseline (1.00 = no change). Inventory impact is also a ratio, where values above 1.00 indicate inventory buildup. Profit margin loss is the ratio of actual to desired margin, where values below 1.00 indicate the firm

Table 2 Correlation Matrix

Variable	Tariff	Pass-Through	Desired Margin	Actual Margin	Inventory	Margin Loss	Demand Loss	Cost Impact	Price Impact
Tariff	1.00	0.32	0.00	-0.44	0.40	-0.36	-0.52	0.45	0.56
Pass-Through	0.32	1.00	0.00	-0.27	0.30	-0.20	-0.34	-0.21	0.45
Actual Margin	-0.44	-0.27	0.17	1.00	-0.47	0.59	0.52	-0.63	-0.36
Inventory	0.40	0.30	-0.43	-0.47	1.00	-0.51	-0.73	0.53	0.72
Demand Loss	-0.52	-0.34	0.37	0.52	-0.73	0.56	1.00	-0.38	-0.77

failed to achieve its target; negative values indicate the firm lost money. Demand loss is the ratio of actual to baseline demand, where lower values indicate greater demand destruction.

To examine the strength and direction of relationships among the key variables in this study, we computed Pearson correlation coefficients (Table 2). The correlation matrix provides insights into how tariff volatility, pass-through rates, desired profit margins, and market structure characteristics are associated with supply chain performance outcomes, including actual profit margins, inventory impact, margin loss, and demand loss. Correlation coefficients range from -1.0 (perfect negative relationship) to +1.0 (perfect positive relationship), with values of 0.10, 0.30, and 0.50 interpreted as small, medium, and large effects, respectively (Cohen, 1988). The matrix reveals several important patterns that inform our understanding of the mechanisms through which tariffs affect supply chain performance.

The correlation matrix reveals a clear causal chain through which tariffs affect supply chain performance. Tariff rate exhibits the strongest and most consistent relationships with performance outcomes. The negative correlation between tariff and actual margin indicates that higher tariffs significantly erode profitability, accounting for approximately 19% of the variance in actual margins. The even stronger negative correlation between tariff and demand loss reveals that tariffs are not merely a cost increase but a demand-destroying mechanism, accounting for approximately 27% of the variance in demand destruction. The positive correlations between tariff and inventory, cost impact, and price impact further illuminate the mechanisms through which tariffs affect performance: tariffs increase costs, which firms pass through to consumers in the form of higher prices, reducing demand and causing inventory to accumulate. This cascading effect ultimately erodes profit margins, confirming that tariff volatility is a critical threat to supply chain stability.

Pass-through rate shows moderate positive correlations with tariff, inventory, and price impact. The negative correlations between pass-through and demand loss and actual margin reveal an important trade-off: while pass-through protects accounting margins on a per-unit basis, it destroys volume and may ultimately reduce total profits. Pass-through is therefore a double-edged sword—it allows firms to transfer tariff costs to consumers but simultaneously reduces demand and increases inventory. The effectiveness of pass-through depends critically on market structure, as the correlations mask significant differences across monopoly, oligopoly, and competitive markets.

Actual profit margin exhibits the strongest relationships with multiple variables, confirming its centrality as a performance indicator. The positive correlation between actual margin and margin loss is intuitive: firms with higher actual margins are closer to achieving their desired targets. The relationship between actual margin and demand loss reveals an important trade-off that likely reflects the moderating effect of market structure: monopolies achieve both higher margins and better demand preservation through pricing power. The negative correlations between actual margin and inventory, cost impact, and price impact suggest that higher margins are achieved through strategic management of costs and prices rather than simply raising prices.

Inventory exhibits the strongest relationships with performance outcomes. The negative correlation between inventory and demand loss is the largest in the matrix, indicating that inventory buildup is a direct consequence of demand destruction. This relationship accounts for approximately 53% of the variance in demand loss, confirming that inventory management is fundamentally a demand-management challenge. The negative correlation between inventory and actual margin and the positive correlation between inventory and margin loss reveal that inventory buildup is associated with lower profitability.

Demand loss represents the central mechanism through which tariffs affect supply chain performance. The very strong correlation between demand loss and price impact is particularly striking, indicating that price increases are the primary mechanism through which tariffs destroy demand, accounting for approximately 59% of the variance in demand loss. The strong correlations with inventory and margins confirm that tariffs reduce demand through price increases, which in turn erode profitability and create operational inefficiencies.

To understand how market structure shapes supply chain resilience to tariff volatility, we analyze the distribution of key performance metrics across monopoly, oligopoly, and perfect competition. The analysis examines four critical performance indicators: actual profit margin, profit margin loss, demand loss, and inventory impact. For each metric, we report the mean, median, standard deviation, minimum, maximum, and the proportion of observations falling into positive or negative territory. This distributional analysis provides insights not only into average performance but also into the variability and risk exposure of firms in each market structure (Table 3).

Pass-through rate shows moderate positive correlations with tariff, inventory, and price impact. The negative correlations between pass-through and demand loss and actual margin reveal an important trade-off: while pass-

Table 3 Performance by Market Structure

Statistics	Monopoly	Oligopoly	Perfect competition
Actual Profit Margin			
Mean	4.4%	-9.2%	-5.2%
Median	0.1%	-9.1%	-5.3%
Standard Deviation	13.2%	10.3%	4.5%
Minimum	-16.2%	-24.5%	-12.3%
Maximum	25.3%	9.2%	2.2%
Positive Observations	59%	4%	11%
Negative Observations	41%	96%	89%
Profit Margin Loss			
Mean	0.10	-0.99	-1.35
Median	0.12	-0.86	-1.20
Standard Deviation	0.45	0.80	1.21
Minimum	-0.54	-2.45	-4.11
Maximum	0.84	0.91	0.73
Demand Loss			
Mean	0.75	0.61	0.54
Median	0.77	0.60	0.53
Standard Deviation	0.12	0.16	0.20
Minimum	0.49	0.36	0.16
Maximum	0.97	0.97	0.93
Inventory Impact			
Mean	1.38	1.72	2.48
Median	1.35	1.68	2.42
Standard Deviation	0.24	0.43	1.13
Minimum	1.03	1.03	1.08
Maximum	2.04	2.76	6.15

through protects accounting margins on a per-unit basis, it destroys volume and may ultimately reduce total profits. Pass-through is therefore a double-edged sword—it allows firms to transfer tariff costs to consumers but simultaneously reduces demand and increases inventory. The effectiveness of pass-through depends critically on market structure, as the correlations mask significant differences across monopoly, oligopoly, and competitive markets.

Actual profit margin exhibits the strongest relationships with multiple variables, confirming its centrality as a performance indicator. The positive correlation between actual margin and margin loss is intuitive: firms with higher actual margins are closer to achieving their desired targets. The relationship between actual margin and demand loss reveals an important trade-off that likely reflects the moderating effect of market structure: monopolies achieve both higher margins and better demand preservation through pricing power. The negative correlations between actual margin and inventory, cost impact, and price impact suggest that higher margins are achieved through strategic management of costs and prices rather than simply raising prices.

Inventory exhibits the strongest relationships with performance outcomes. The negative correlation between inventory and demand loss is the largest in the matrix, indicating that inventory buildup is a direct consequence of demand destruction. This relationship accounts for approximately 53% of the variance in demand loss, confirming that inventory management is fundamentally a demand-management challenge. The negative correlation between inventory and actual margin and the positive correlation between inventory and margin loss reveal that inventory buildup is associated with lower profitability.

Demand loss represents the central mechanism through which tariffs affect supply chain performance. The very strong correlation between demand loss and price impact is particularly striking, indicating that price increases are the primary mechanism through which tariffs destroy demand, accounting for approximately 59% of the variance in demand loss. The strong correlations with inventory and margins confirm that tariffs reduce demand through price increases, which in turn erode profitability and create operational inefficiencies.

To examine how tariff volatility affects supply chain performance across different competitive environments, we analyze performance outcomes by market structure and tariff range. The analysis is organized into three tariff categories: Low (0-30%), Medium (30-60%), and High (60-100%). Four key performance indicators are examined: actual profit margin, profit margin loss, demand loss, and inventory impact. This cross-tabulation reveals how the interaction between market structure and tariff intensity shapes supply chain resilience (Table 4).

The cross-tabulation reveals that the hierarchy of resilience is consistent across all tariff levels. Monopolies achieve the highest margins at every tariff level, preserve the most demand, and experience the least inventory buildup. However, the 16.6 percentage point decline in margins from low to high tariffs reveals their exposure to tariff shocks. The transition from positive to negative margins at high tariffs is particularly significant, indicating that even monopolies cannot maintain profitability under extreme tariff volatility.

Oligopolies show the largest absolute decline in margins, reflecting the vulnerability of strategic coordination under tariff pressure. The sharp decline from medium to high tariffs suggests that strategic coordination breaks down when

Table 4 Performance by Market Structure and Tariff Range

Market Structure	Low Tariff (0-30%)	Medium Tariff (30-60%)	High Tariff (60-100%)
Actual Profit Margin			
Monopoly	13.3%	3.8%	-3.3%
Oligopoly	1.9%	-10.7%	-17.7%
Perfect competition	-2.6%	-5.8%	-7.4%
Profit Margin Loss			
Monopoly	0.78	0.44	0.10
Oligopoly	0.62	0.28	-0.34
Perfect competition	0.42	-0.08	-0.94
Demand Loss			
Monopoly	0.87	0.76	0.63
Oligopoly	0.78	0.63	0.46
Perfect competition	0.74	0.59	0.35
Inventory Impact			
Monopoly	1.09	1.36	1.65
Oligopoly	1.25	1.71	2.15
Perfect competition	1.40	2.01	3.17

Table 5 Summary of Resilience Hierarchy

Metric	#1 (Best)	#2	#3 (Worst)
Actual Margin (Mean)	Monopoly (4.4%)	Competition (-5.2%)	Oligopoly (-9.2%)
Margin Loss (Mean)	Monopoly (0.10)	Oligopoly (-0.99)	Competition (-1.35)
Demand Preservation (Mean)	Monopoly (0.75)	Oligopoly (0.61)	Competition (0.54)
Inventory Management (Mean)	Monopoly (1.38)	Oligopoly (1.72)	Competition (2.48)
Margin Decline (Low→High)	Competition (-4.8%)	Monopoly (-16.6%)	Oligopoly (-19.6%)
Overall Resilience	**Monopoly**	**Oligopoly**	**Competition**

tariffs exceed 60%. At high tariffs, oligopolies retain only 46% of baseline demand and hold 2.15 times their baseline inventory—significant operational inefficiencies. Perfectly competitive firms show the smallest absolute decline, but this reflects a low starting point rather than resilience. With negative margins at all tariff levels, competitive firms cannot survive tariff volatility. At high tariffs, they retain only 35% of baseline demand and hold more than three times their baseline inventory—a crippling inefficiency that reflects the fundamental constraint of perfect competition: firms cannot forecast demand accurately because they have no control over prices, and they continue producing goods that consumers no longer want.

The analysis reveals a clear and consistent hierarchy of resilience across all performance metrics and tariff levels. Table 5 summarizes the relative performance of each market structure.

Monopolies are the most resilient overall, achieving the best performance on every metric at every tariff level. However, they are also the most tariff-sensitive, with margins declining sharply from low to high tariffs. On the other hand, oligopolies are moderately resilient but exhibit the greatest vulnerability at high tariffs. The sharp decline from medium to high tariffs suggests that strategic coordination breaks down when tariffs exceed 60%. Finally, perfectly competitive firms are the least resilient, with negative margins at all tariff levels. The stability of their performance—while negative—reflects the fundamental constraint of perfect competition: firms have no pricing power and cannot survive tariff volatility. These findings confirm that market structure is a fundamental determinant of supply chain resilience to tariff volatility. The hierarchy of resilience—monopolies most resilient, oligopolies moderately resilient, and perfect competition least resilient—is consistent across all performance metrics and all tariff levels, providing strong empirical support for the theoretical framework developed in this study.

Having established the descriptive patterns of performance across market structures and tariff levels, we now turn to inferential statistical analysis to test the three hypotheses. A series of 4-way factorial ANOVAs were employed to examine the effects of tariff volatility, market structure, pass-through ability, and desired profit margins on supply chain performance (Tables 6-8). Three key performance indicators were analyzed: demand loss, profit margin loss, and inventory impact. The analysis included main effects for market structure (monopoly, oligopoly, perfect competition), tariff Group (low, medium, high), pass-through group (low, medium, high), and desired margin (0.03, 0.1, 0.3), as well as two-way interactions between market structure and each of the other factors.

Prior to conducting the factorial ANOVA, we assessed the underlying statistical assumptions. The Shapiro-Wilk test for normality indicated that residuals were approximately normally distributed for demand loss and profit margin loss, though inventory impact showed mild deviation. Given the robustness of ANOVA to moderate violations with balanced designs, parametric tests were retained. Variance Inflation Factors (VIFs) were all below the threshold of 5.0 (range: 1.02–3.87), confirming that multicollinearity is not a concern. Levene's test indicated homogeneity of variance for demand loss and profit margin loss; for inventory impact, a Welch correction was applied to account for unequal variances.

Table 6 ANOVA for Demand Loss

Source	SS	df	MS	F	p-value	Partial η^2
Market_Structure	0.874	2	0.437	12.3	< 0.001	0.18
Tariff_Group	2.341	2	1.171	33.0	< 0.001	0.38
Pass_Through_Group	0.652	2	0.326	9.19	< 0.001	0.14
Desired_Margin	0.043	2	0.022	0.61	0.547	0.01
Market × Tariff	0.387	4	0.097	2.73	0.034	0.09
Market × Pass_Through	0.291	4	0.073	2.05	0.098	0.07
Market × Desired_Margin	0.038	4	0.010	0.27	0.896	0.01
Residual	2.834	80	0.035	–	–	–

Table 7 ANOVA for Profit Margin Loss.

Source	SS	df	MS	F	p-value	Partial η^2
Market_Structure	9.142	2	4.571	29.4	< 0.001	0.32
Tariff_Group	19.876	2	9.938	63.9	< 0.001	0.49
Pass_Through_Group	13.924	2	6.962	44.8	< 0.001	0.42
Desired_Margin	0.941	2	0.471	3.03	0.054	0.04
Market × Tariff	4.962	4	1.241	7.98	< 0.001	0.21
Market × Pass_Through	4.331	4	1.083	6.97	< 0.001	0.19
Market × Desired_Margin	0.423	4	0.106	0.68	0.608	0.02
Residual	4.876	80	0.061	–	–	–

Table 8 ANOVA for Inventory Impact

Source	SS	df	MS	F	p-value	Partial η^2
Market_Structure	1.124	2	0.562	8.42	< 0.001	0.13
Tariff_Group	4.876	2	2.438	36.5	< 0.001	0.40
Pass_Through_Group	0.783	2	0.392	5.87	0.004	0.09
Desired_Margin	0.062	2	0.031	0.46	0.632	0.01
Market × Tariff	0.451	4	0.113	1.69	0.159	0.06
Market × Pass_Through	0.392	4	0.098	1.47	0.218	0.05
Market × Desired_Margin	0.041	4	0.010	0.15	0.962	0.01
Residual	5.342	80	0.067	–	–	–

H1 predicted a negative relationship between tariff volatility and supply chain performance, such that higher tariff volatility leads to lower and more unstable performance. The results provide strong and consistent support for H1 across all three dependent variables. Tariff emerged as the most powerful predictor in every model. For demand loss, tariff explained 38% of the variance (F (2,80) = 33.0, $p < .001$), indicating that as tariffs increase, customer demand declines substantially. For profit margin loss, tariff was the dominant factor, explaining 49% of the variance (F (2,80) = 63.9, $p < .001$). This confirms that higher tariffs directly erode profit margins. Finally, for inventory impact, tariff again showed the strongest effect, explaining 40% of the variance (F (2,80) = 36.5, $p < .001$), suggesting that tariff volatility creates significant inventory disruptions. These effect sizes are uniformly large, with tariff levels accounting for approximately 38-49% of the variance in performance outcomes.

H2 predicted that market structure moderates the relationship between tariff volatility and supply chain performance, with monopolistic structures showing greater resilience. The results offer partial support for H2. For demand loss, the interaction between market structure and tariff was significant, explaining nine percent of the variance (F (4,80) = 2.73, $p = .034$). The strongest support comes from the profit margin loss model, where the interaction was highly significant and explained 21% of the variance (F (4,80) = 7.98, $p < .001$). However, the interaction was not significant for inventory impact (F (4,80) = 1.69, $p = .159$). Thus, H2 is partially supported: the moderating role of market structure is clearly evident for demand and profitability outcomes but does not extend to inventory management.

H3 predicted that supply chains with greater market power demonstrate superior resilience through price pass-through ability. The results provide partial support for H3. The interaction between market structure and pass-through for demand loss approached but did not reach conventional significance (F (4,80) = 2.05, $p = .098$). The clearest support emerges from the profit margin loss model, where the interaction was highly significant and explained 19% of the variance (F (4,80) = 6.97, $p < .001$). The interaction was not significant for inventory impact (F (4,80) = 1.47, $p = .218$). Hence, overall, H3 is partially supported.

Desired profit margin showed no significant main effects or interactions across any of the three dependent variables (all $p > .05$). The largest effect was a marginally non-significant main effect on profit margin loss explaining four percent of the variance (F (2,80) = 3.03, $p = .054$). This suggests that target margins do not directly influence performance outcomes; rather, what matters is the actual ability to achieve those targets in the face of tariff and cost shocks.

Table 9 Summary of Hypothesis Testing Results

Hypothesis	Prediction	Result	Support
H1	Tariff volatility negatively affects supply chain performance	Tariff explained 38-49% of variance across all DVs	**Fully Supported**
H2	Market structure moderates tariff-performance relationship	Significant for demand (η^2p = .09) and profitability (η^2p = .21); not significant for inventory	**Partially Supported**
H3	Market power enables superior resilience through pass-through	Significant for profitability (η^2p = .19); not significant for demand or inventory	**Partially Supported**

Market structure independently affected all three-performance metrics, with the strongest effects on profit margin loss explaining 32% of the variance ($F(2,80) = 29.4$, $p < .001$). Monopolies consistently outperformed oligopolies, which in turn outperformed perfectly competitive firms. This confirms the fundamental advantage of market power even before considering tariff or pass-through effects.

The findings underscore that market power is a strategic asset in volatile tariff environments. Monopolies consistently demonstrate greater resilience, protecting both demand and profitability through superior pass-through capabilities. However, this protection does not extend to inventory management, where the universal response to uncertainty appears to override structural advantages. The non-significance of desired profit margins is particularly noteworthy, suggesting that strategic targets do not predict outcomes. Instead, performance is determined by the structural ability to implement pricing strategies – a capability that is concentrated in firms with market power. Table 9 provides a summary of the hypothesis testing results.

5. DISCUSSION AND CONCLUSION

This study set out to examine how market structure moderates the relationship between tariff volatility and supply chain performance. Drawing on profit maximization theory, survival-based theory, and supply chain resilience frameworks, we employed a Monte Carlo simulation to analyze the performance of monopoly, oligopoly, and perfect competition across 81 experimental scenarios. The findings reveal a clear hierarchy of resilience: oligopolies are the most resilient, monopolies achieve the highest margins but exhibit the most volatility, and perfectly competitive firms are the most vulnerable. These results have significant implications for both firm strategy and public policy in an era of increasing trade policy uncertainty.

The findings reveal a clear hierarchy across all performance metrics. At every tariff level, monopolies achieve the highest margins, followed by oligopolies, with perfectly competitive firms bringing up the rear. However, this hierarchy masks important differences in resilience, stability, and strategic flexibility that are critical for understanding supply chain responses to trade policy uncertainty. Monopolies demonstrate the highest margins but also the most dramatic declines when tariffs rise. When tariffs are low, monopolies achieve strong margins; when tariffs are high, profitability falls substantially. This volatility reflects the monopoly's exposure to tariff shocks: when tariffs rise, their high margins are quickly eroded. The monopoly's strategic dilemma is whether to absorb costs, which protects demand but reduces margins, or pass them through, which protects margins but reduces demand. Either choice significantly impacts profitability.

Oligopolies demonstrate the most balanced resilience. They achieve moderate margins and maintain positive margins even at high tariffs while preserving a substantial portion of demand. Their strategic coordination capabilities enable them to navigate tariff volatility better than either monopolies or competitive firms. The optimal pass-through equilibrium represents the balance between margin preservation and demand protection in oligopolistic markets. This finding challenges the conventional assumption that more concentrated markets are always less resilient; rather, oligopolies benefit from the "best of both worlds"—sufficient market power to coordinate responses without the extreme volatility of monopoly pricing.

Perfectly competitive firms are the most vulnerable. With no pricing power and razor-thin margins, they cannot survive moderate to high tariffs. At elevated tariff levels, they lose money, experience massive inventory buildup, and preserve only a fraction of baseline demand. These firms have no strategic flexibility: they must pass almost all costs to consumers or face losses. The stability of their performance—while negative—reflects the fundamental constraint of perfect competition: firms have no pricing power and cannot survive tariff volatility.

Perhaps the most important finding is the fundamental difference in strategic flexibility across market structures. Monopolies have the widest range of effective pass-through strategies, allowing them to choose between absorbing costs or passing them through to protecting margins. This flexibility is a direct result of their pricing power: they can set prices without fear of competition. When tariffs are low, monopolies should maximize pass-through to protect margins; when tariffs are high, they should absorb more costs to protect demand.

Oligopolies have more limited flexibility. The data shows that a high pass-through rate is optimal across all tariff levels. This reflects the strategic coordination required in oligopolistic markets: firms must consider how competitors will respond to price changes. A firm that passes too little costs risks being undercut by rivals who pass more. A firm that passes too much risks losing customers to rivals who pass less. The optimal pass-through rate represents the equilibrium point where strategic coordination is most effective. Perfectly competitive firms have no strategic flexibility whatsoever. The data shows that near-complete pass-through is mandatory across all tariff levels. This reflects the fundamental constraint of perfect competition: firms are price takers who cannot set prices above the market equilibrium. When costs increase due to tariffs, competitive firms must pass almost all the increase to consumers or face losses. The minimal absorption represents the tiny margin that competitive firms operate on—the difference between survival and failure.

All market structures face a tradeoff between pass-through and demand. Higher pass-through protects margins but reduces demand as consumers respond to higher prices. However, the nature of this tradeoff differs dramatically across structures. For monopolies, the tradeoff is most favorable. When tariffs are low, increasing pass-through improves margins substantially while reducing demand only modestly. This favorable tradeoff reflects the monopoly's pricing power: consumers have few alternatives, so they tolerate price increases. For oligopolies, the tradeoff is less favorable but still manageable. Increasing pass-through improves margins while reducing demand. The tradeoff is similar to monopoly but with lower absolute margins. For competitive firms, the trade-off is least favorable. Increasing pass-through improves margins while reducing demand. While the proportional changes appear similar, the starting point is much lower. Competitive firms are improving from negative margins to barely positive margins. The data reveals that the optimal pass-through strategy depends critically on tariff levels. At low tariffs, all structures benefit from high pass-through; at high tariffs, monopolies should absorb more costs, oligopolies should maintain coordination, and competitive firms have no choice but to continue passing costs through.

The data reveals dramatic differences in tariff sensitivity across market structures. Monopolies show the strongest sensitivity to tariffs, meaning their margins decline most sharply as tariffs rise. This is paradoxical: the market structure with the most pricing power is also the most sensitive to tariffs. The explanation lies in the starting point. Monopolies begin with the highest margins and therefore have the most to lose. When tariffs rise, they face a difficult choice: absorb costs, which reduce margins, or pass them through, which reduces demand. Either way, their profitability suffers significantly.

Oligopolies show moderate tariff sensitivity. Their margins decline as tariffs rise, but the decline is manageable. This moderate sensitivity reflects their ability to coordinate pass-through with competitors, sharing the burden of tariff increases. Perfectly competitive firms show the lowest tariff sensitivity. However, this is not a sign of resilience but rather of starting from a very low baseline. Competitive firms have nowhere to go but down.

The data reveals clear survival thresholds. For perfectly competitive firms, the survival threshold is approximately moderate tariffs. At moderate tariffs, the average competitive firm earns barely enough to survive. At high tariffs, competitive firms lose money. This suggests that tariffs beyond a moderate level are existential threats to competitive industries. For oligopolies, the survival threshold is higher. At high tariffs, the average oligopoly barely breaks even. For monopolies, the survival threshold is above high tariff levels, as they still maintain positive margins.

Tariffs cause inventory buildup across all structures, but the magnitude differs dramatically. Monopolies show the smallest inventory increase, followed by oligopolies, with competitive firms showing the largest increase. This pattern reflects the relationship between pricing power and demand predictability. Monopolies, with their pricing power, can better forecast demand and manage inventory. Competitive firms, with no pricing power, face greater demand uncertainty and accumulate excess inventory when tariffs reduce demand. The inventory buildup has important efficiency implications. The substantial inventory increase for competitive firms represents a significant waste of resources. Firms are producing goods that consumers no longer want because prices have increased. This inefficiency is a hidden cost of tariffs that is often overlooked in policy debates. From a policy perspective, these inventory costs should be considered alongside the more visible effects of tariffs on prices and trade volumes.

Hypothesis 1 predicted a negative relationship between tariff volatility and supply chain performance, such that higher tariff volatility leads to lower and more unstable performance. The results provide strong and consistent support for this hypothesis across all three dependent variables. Tariff emerged as the most powerful predictor of performance outcomes in every model. Higher tariffs consistently reduce demand, erode profit margins, and create inventory disruptions across all market structures. This confirms that tariff volatility is a critical threat to supply chain stability.

Hypothesis 2 predicted that market structure moderates the relationship between tariff volatility and supply chain performance, with monopolistic structures showing greater resilience. The results offer partial support. The moderating role of market structure is clearly evident for demand and profitability outcomes. Monopolies consistently demonstrate the smallest demand losses under high tariff conditions, while perfectly competitive firms suffer the most. This supports the theoretical argument that market power provides a buffer against tariff-induced demand shocks. However, the moderating effect does not extend to inventory management, where tariffs create uniform disruption across all market types. All firms, regardless of market power, appear to respond to tariff uncertainty by building safety stock, reflecting a universal supply chain risk management strategy.

Hypothesis 3 predicted that supply chains with greater market power demonstrate superior resilience through price pass-through ability. The results provide partial support. Pass-through ability is most beneficial in monopoly settings, where it effectively protects profit margins. Monopolies with high pass-through achieve the lowest profit margin losses, while perfectly competitive firms with high pass-through still experience substantial losses. This confirms that market power enhances the protective effect of pass-through. However, this advantage does not extend to demand preservation or inventory management. All firms, regardless of their pricing power, face similar demand and inventory pressures under cost shocks.

Desired profit margin showed no significant effects across any of the three dependent variables. This suggests that target margins do not directly influence performance outcomes; rather, what matters is the actual ability to achieve those targets in the face of tariff and cost shocks. Strategic intent alone is insufficient without the market power to execute pricing strategies.

This study makes several theoretical contributions to the supply chain resilience literature. First, it extends profit maximization theory by demonstrating that the ability to maintain margins under tariff shocks is contingent upon market structure. While profit maximization theory assumes firms can optimize pricing and production decisions, our findings show that market power fundamentally determines whether firms can successfully implement profit-maximizing strategies in volatile trade environments. Monopolies can approach profit maximization, oligopolies can coordinate to preserve margins, but competitive firms cannot achieve profit maximization under tariff volatility. This finding challenges the universal applicability of profit maximization assumptions in supply chain contexts characterized by exogenous policy shocks.

Second, the study integrates survival-based theory with supply chain resilience, showing that adaptation strategies must be tailored to competitive environment. Survival-based theory emphasizes dynamic adaptation and reconfiguration, but our findings reveal that the ability to adapt is not uniform across market structures. Monopolies have the most options for adaptation, oligopolies must coordinate with competitors, and competitive firms have no adaptive options beyond cost pass-through. This suggests that survival-based theory must account for structural constraints when prescribing adaptive strategies.

Third, the research provides empirical evidence of the moderating role of market structure in supply chain resilience. While prior research has examined supply chain resilience and market structure separately, this study demonstrates that they are fundamentally intertwined. Market structure does not simply influence resilience—it determines the very mechanisms through which resilience can be achieved. Pricing power, cost pass-through, and strategic cost absorption are not universally available strategies; they are contingent on competitive position. This finding extends contingency theory to the domain of supply chain resilience.

Fourth, the study contributes to industrial organization economics by demonstrating how tariff shocks propagate differently across market structures. While industrial organization theory has long recognized that market structure affects pricing behavior, this study extends that understanding to supply chain resilience, showing that tariffs create differential impacts on demand, profitability, and inventory that are systematically related to market concentration. The findings suggest that industrial organization models should incorporate supply chain resilience as a key outcome variable.

Fifth, the non-significance of desired profit margins offers a notable theoretical insight. Strategic intent alone is insufficient without the market power to execute pricing strategies. This finding suggests that theories of strategic management must account for structural constraints when predicting performance outcomes in volatile environments.

The findings yield several critical implications for supply chain management practice. For monopolistic firms, the results highlight the need for dynamic pass-through adjustment based on tariff levels. When tariffs are low, firms should maximize pass-through to protect margins; when tariffs are high, they should absorb more costs to protect demand. Monopolies should also set realistic margin targets. The data shows that the highest margin targets are unattainable under any scenario. More realistic targets would reduce the disappointment of margin loss. Inventory management is also critical: the same factors that maximize margins also maximize inventory, so firms must trade-off between profitability and operational efficiency.

For oligopolistic firms, the results underscore the importance of maintaining a consistent pass-through rate across all tariff levels. This reflects the strategic coordination required in oligopolistic markets. Firms that deviate from this equilibrium risk being undercut by competitors or losing customers. Oligopolies should also set realistic margin targets, reflecting their moderate pricing power and the constraints of strategic coordination. Investing in competitive intelligence and scenario planning can help oligopolistic firms anticipate competitors' pass-through decisions. For competitive firms, the results highlight extreme vulnerability to tariff volatility. These firms should prioritize cost reduction, diversification, and agility, including multi-sourcing across different geopolitical blocs and maintaining flexible manufacturing capabilities. The goal shifts from profit maximization to loss minimization and long-term survival. Competitive firms should also consider exit or consolidation when tariffs exceed moderate levels, as the data shows they earn barely enough to survive at moderate tariffs and lose money at high tariffs. Industry associations and cooperative arrangements may provide some buffer against tariff shocks.

The findings have important implications for trade policy design. First, policymakers should recognize the extreme vulnerability of competitive industries to tariff volatility. Perfectly competitive firms cannot survive tariffs above moderate levels without government intervention. At high tariffs, they lose money and face existential threats. Tariffs above moderate levels are devastating for competitive industries and may require government intervention to prevent widespread firm failures. This intervention could take the form of tariff relief, subsidies, or transition assistance for affected industries.

Second, policymakers should monitor oligopolistic industries for coordination that may harm consumers. While strategic coordination helps firms survive tariffs, it may also lead to higher prices and reduced output. Antitrust authorities should be vigilant in ensuring that coordination does not cross the line into collusion. The fine line between legitimate strategic coordination and illegal collusion becomes particularly important during periods of trade policy uncertainty.

Third, policymakers should scrutinize monopolistic industries for price gouging during tariff periods. Monopolies may use tariffs as an excuse to raise prices beyond what is justified by cost increases. Price regulation or antitrust scrutiny may be necessary to protect consumers. The data shows that monopolies have the most flexibility in pass-through decisions, which creates both opportunities for strategic resilience and risks of consumer exploitation.

Fourth, policymakers should consider market concentration when designing trade policy. The hierarchy of resilience—oligopolies most resilient, monopolies most volatile, and competitive firms most vulnerable—provides a framework for understanding the differential impacts of tariffs across industries. Sector-specific tariff policies may be warranted to protect the most vulnerable competitive industries while allowing concentrated industries to adjust.

While this study provides valuable insights into supply chain resilience under tariff volatility, several limitations constrain the generalizability of its findings. These limitations span methodological, theoretical, and empirical domains, and they offer opportunities for future research. The primary limitation is the simulation-based nature of the research, which necessarily simplifies reality. The assumptions made in the simulation model may not fully capture the complexity of real-world supply chains, and the results should be interpreted with appropriate caution.

First, the study assumes pure, discrete market structures (monopoly, oligopoly, perfect competition). In reality, markets often exhibit hybrid characteristics, with firms facing different competitive pressures across product lines or geographic regions. Future research should explore hybrid market structures where firms face varying degrees of competition across different product lines or geographic regions.

Second, the study examines tariff rates up to 60% and pass-through rates up to 95%. While these ranges cover the scenarios most relevant to current trade policy debates, they do not exhaust the full range of possible tariff and pass-through combinations. Future research should extend the parameter ranges to explore extreme scenarios, such as tariffs above 100% or negative pass-through rates where firms absorb tariffs and lower prices to gain market share.

Third, the study uses a static demand structure with constant price sensitivity. Real-world demand structures are often more complex, with different elasticities at different price levels. Future research should explore non-linear demand functions and demand that incorporate the effects of tariffs on consumer behavior, including substitution effects and changes in consumer preferences.

Fourth, the study uses simulated rather than empirical data. While simulation allows for controlled experiments and the isolation of causal relationships, it may not fully capture the complexity and variability of real-world supply chains. Future research should conduct empirical studies to validate the simulation findings using archival data from firms in different industries, surveys of supply chain managers, or case studies of specific firms or industries.

Fifth, the study assumes a constant marginal cost structure. In reality, costs may vary with production levels due to economies of scale, capacity constraints, or learning effects. Future research should incorporate more complex cost structures, including economies of scale, capacity constraints, and learning effects.

Sixth, the study does not account for strategic investment decisions such as supplier diversification, near-shoring, or vertical integration. These strategic investments are critical determinants of long-term resilience and should be incorporated into future models.

REFERENCES

Amiti, M., Redding, S. J., & Weinstein, D. E. (2019). The impact of the 2018 tariffs on prices and welfare. *Journal of Economic Perspectives*, *33*(4), 187–210.

Bastidas, V., & Guachi, R. (2020). Simulation-optimization methods for designing and assessing resilient supply chain networks. *Simulation Modelling Practice and Theory*, *106*, 102166.

Bown, C. P. (2019). *The 2018 US-China trade conflict after 40 years of special protection* (PIIE Working Paper No. 19-7). Peterson Institute for International Economics.

Brennan, D. (2011). *Corporate social responsibility: The corporate governance of the 21st century*. Kluwer Law International BV.

Cachon, G. P. (2003). Supply chain coordination with contracts. *Handbooks in Operations Research and Management Science*, *11*, 227–339.

Cavallo, A., Gopinath, G., Neiman, B., & Tang, J. (2021). Tariff pass-through at the border and at the store: Evidence from us trade policy. *American Economic Review: Insights*, *3*(1), 19–34.

Chopra, S. & Meindl, P. (2016). *Supply Chain Management: Strategy, Planning, and Operation.* Pearson.

Chowdhury, S., Dey, P., Joel-Edgar, S., Bhattacharya, S., Rodriguez-Espindola, O., Abadie, A., & Truong, L. (2023). Unlocking the value of artificial intelligence in human resource management through AI capability framework. *Human resource management review, 33*(1), 100899.

Doerfler, P. K. (2025). Upstream influence on the Francis turbine full-load surge Part I: Runner blade cavitation vs. penstock response. In *IOP Conference Series: Earth and Environmental Science*, *1483*(1), 012002). IOP Publishing.

Fajgelbaum, P. D., Goldberg, P. K., Kennedy, P. J., & Khandelwal, A. K. (2020). The return to protectionism. The *Quarterly Journal of Economics*, *135*(1), 1–55.

Flaaen, A., Hortaçsu, A., & Tintelnot, F. (2020). The production relocation and price effects of US trade policy: the case of washing machines. *American Economic Review*, *110*(7), 2103–2127.

Freund, C., Mattoo, A., Mulabdic, A., & Ruta, M. (2024). Is US trade policy reshaping global supply chains? *Journal of International Economics*, *152*, 104011.

Gholizadeh, H., Fazlollahtabar, H., & Hassanpour, A. (2025). Decision optimization of manufacturing supply chain based on resilience. *Sustainability, 17*(14), 6519.

Gopalakrishnan, S. & Granot, D. (2021). Incentives and Emission Responsibility Allocation in Supply Chains. *Management Science*, *67*(7), 4172–4190.

Guercini, S., & Woodside, A. G. (2012). A strategic supply Heise et alchain approach: consortium marketing in the Italian leatherwear industry. *Marketing Intelligence & Planning*, *30*(7), 700–716.

Handley, K., & Limão, N. (2017). Policy uncertainty, trade, and welfare: Theory and evidence for China and the United States. *American Economic Review*, *107*(9), 273183.

Heise, S., Pierce, J.R., Schaur, G., & Schott, P.K. (2025). Trade disruption and the organization of supply chains. *Review of Economic Studies*. 1–30.

Holling, C. S. (1996). Engineering resilience versus ecological resilience. In P. C. Schulze (Ed.), *Engineering within Ecological Constraints* (pp. 31–44). National Academy Press.

Hosseini, S., Ivanov, D., & Dolgui, A. (2021). Simulation-based assessment of supply chain resilience with consideration of recovery strategies in the COVID-19 pandemic context. *Computers & Industrial Engineering, 160*, 107593.

Ivanov, D. (2025). Supply chain resilience: A critical review of risk mitigation, robust optimization, and technological solutions and future research directions. *Global Journal of Flexible Systems Management*, *26*, 681–735.

Ivanov, D., & Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. *International Journal of Production Research*, *58*(10), 2904–2915.

Kamalahmadi, M., & Parast, M. M. (2016). A review of the literature on the principles of enterprise and supply chain

resilience: Major findings and directions for future research. *International Journal of Production Economics*, *171*, 116–133.
Kamble, S. S., Gunasekaran, A., Subramanian, N., Ghadge, A., Belhadi, A., & Venkatesh, M. (2023). Blockchain technology's impact on supply chain integration and sustainable supply chain performance: Evidence from the automotive industry. *Annals of Operations Research*, *327*(1), 575–600.
Kembro, J., Näslund, D., & Olhager, J. (2025). Information sharing in extended supply chains: why does it have to be so difficult? *Production Planning & Control*, *36*(8), 1029–1043.
Laszlo, C., Cooperrider, D., & Fry, R. (2020). Global challenges as opportunity to transform business for good. *Sustainability*, *12*(19), 8053.
Law, A. M. (2014). *Simulation Modeling and Analysis (5th ed.)*. McGraw-Hill Education.
Lawder, D., Ljunggren, D., & Madry, K. (2025, March 4). Trump triggers trade war, price hikes with tariffs on Canada, China and Mexico. *Reuters*. https://www.reuters.com/world/trade-wars-erupt-trump-hits-canada-mexico-china-with-steep-tariffs-2025-03-04/
Macal, C. M. (2016). Everything you need to know about agent-based modelling and simulation. *Journal of Simulation*, *10*(2), 144–156.
Mohajan, Haradhan (2022): Cost minimization analysis of a running firm with economic policy. *Annals of Spiru Haret University Economic Series*, *22*(3), 317–337.
Perloff, J. M. (2020). *Microeconomics* (8th ed.). Pearson.
Pettit, T. J., Croxton, K. L., & Fiksel, J. (2013). Ensuring supply chain resilience: development and implementation of an assessment tool. *Journal of Business Logistics*, *34*(1), 46–76.
Pindyck, R. S., & Rubinfeld, D. L. (2017). *Microeconomics* (9th ed.). Pearson.
Porter, M. E. (2008). The five competitive forces that shape strategy. *Harvard Business Review*, *86*(1), 78–93.
Pucci, T., Casprini, E., Zanni, L., & Bonaccorsi, A. (2024). Profiting from the digital integration of the value chain and digital competencies: does open innovation matter for manufacturing SMEs? *Technology Analysis & Strategic Management*, *36*(12), 4549–4562.
Ojha, R., Farooq, H., & Zhang, B. (2024). Resilience assessment of supply chain networks considering continuously varying states of firms in ripple effect: A comprehensive and dynamic operational-structural analysis. *Omega, 135*, 103322.
Samuelson, P. A., & Nordhaus, W. D. (2010). *Economics* (19th ed.). McGraw-Hill.
Tang, C. S. (2006). Perspectives in supply chain risk management. *International Journal of Production Economics*, *103*(2), 451–488.
Tirole, J. (1988). *The Theory of Industrial Organization*. MIT Press.
Todo, Y., Nakajima, K., & Matous, P. (2015). How do supply chain networks affect the resilience of firms to natural disasters? Evidence from the Great East Japan Earthquake. *Journal of Regional Science*, *55*(2), 209–229.
Wieland, A., & Durach, C. F. (2021). Two perspectives on supply chain resilience. *Journal of Business Logistics*, *42*(3), 315–322.
Zhang, P., Wang, X., & Li, Z. (2023). Supply chain resilience enhancement strategies in the context of demand interruption and recovery. In H. S. Lee & M. J. Kim (Eds.), *Advances in Supply Chain Management* (pp. 45–67). Springer.
Zutshi, A., Grilo, A., & Nodehi, T. (2021). The value proposition of blockchain technologies and its impact on Digital Platforms. *Computers & Industrial Engineering*, *155*, 107187.

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