

Article

When Exchange Rate Volatility Becomes Supply Chain Risk: Evidence from Chinese Listed Firms

Xinjian Chen , Linna Zhang and Yeying Wu * 

School of Economics, Guangxi University, No. 100 Daxue Road, Nanning 530004, China

* Correspondence: yeyingwu23@st.gxu.edu.cn

Abstract

Amid the profound restructuring of global value chains, supply chain risk has mainly been linked to visible shocks such as pandemics, wars, and geopolitical conflict. Much less is known, however, about whether exchange rate volatility can become a source of operational instability within firms. We examine this question using Chinese A-share listed firms from 2007 to 2021. We construct an industry-level exchange rate volatility measure by combining ADB input–output tables with bilateral real exchange rate volatility, and measure firms' perceived and disclosed supply chain disruption risk from the MD&A sections of annual reports using a word-embedding approach. We find that higher industry-level exchange rate volatility is associated with a significant increase in firms' perceived and disclosed supply chain disruption risk. The mechanism evidence indicates that this effect operates through both supply-side operating frictions and demand-side pressure: higher industry-level exchange rate volatility reduces inventory turnover and weakens overseas revenue realization. The effect is weaker in industries with longer backward production length but stronger among firms facing tighter financing constraints. It is also stronger among firms located in more open regions, firms with overseas-experienced executives, and firms with greater export intensity, but weaker among manufacturing firms. These findings extend research on the real effects of exchange rate volatility by showing how industry-level exchange rate uncertainty can materialize as firm-level perceived and disclosed supply chain disruption risk and undermine the operational continuity and long-term economic sustainability of internationally connected supply chains.

Keywords: exchange rate volatility; supply chain disruption risk; risk disclosure; supply chain security



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1. Introduction

The deepening fragmentation of global production has accelerated Chinese firms' integration into cross-border supply chain networks. FactSet data show that listed Chinese firms maintained 1633 supplier relationships across 40 countries in 2011, including 1309 foreign suppliers. By 2019, this network had expanded to 4593 supplier relationships across 80 countries, with the number of foreign suppliers rising to 2365 [1]. Such expansion provides firms with access to richer resources, broader supplier choices, and larger overseas markets, but it also makes firm operations increasingly dependent on cross-border sourcing, international logistics, foreign sales, and multi-currency settlement. As supply chain relationships extend across more countries and markets, supply chain stability is no longer shaped only by firms' internal production arrangements or domestic operating conditions. It is also increasingly exposed to external price fluctuations, changing trade

conditions, and uncertainty in international markets [2]. Understanding which external factors undermine supply chain stability has therefore become an important issue in firm risk management and supply chain security under economic openness.

Prior studies have linked supply chain disruption risk mainly to external shocks that directly impair production, delivery, or input sourcing, including supplier damage caused by natural disasters [3,4], production shutdowns and logistics restrictions during public health crises [5], trade-policy shocks to intermediate inputs and established supplier relationships, geopolitical conflicts that increase uncertainty in cross-border flows, and transportation, labor, or raw-material bottlenecks that delay delivery [6]. This literature has deepened our understanding of how visible external shocks disrupt supply chain continuity. Yet firms operating in an open economy are also continuously exposed to a less visible source of external risk: exchange rate volatility. Unlike natural disasters, pandemic lockdowns, or tariff shocks, exchange rate volatility may not immediately appear as a discrete disruption event. Instead, it can persistently affect cross-border sourcing costs, contract pricing, settlement arrangements, overseas orders, and revenue realization. Although exchange rate volatility has been shown to affect international trade, export behavior, and global value chain participation, whether it further translates into firm-level perceived supply chain disruption risk remains insufficiently understood. This omission is important from a sustainability perspective, because recurrent financial uncertainty may gradually erode the operating continuity and adaptive capacity on which sustainable supply chain relationships depend.

It is important to distinguish realized supply chain disruptions from firms' *ex ante* perception of disruption risk. Existing studies have primarily characterized realized disruptions using observed shocks and operational failures. Carvalho et al. (2021), for example, combine firms' geographic exposure to the Great East Japan Earthquake with supplier–customer linkages and subsequent sales changes to identify the transmission and operational consequences of disruption shocks across production networks [7]. More recent research employs increasingly granular operational data. De Backker et al. (2026) measure component-level disruptions using historical stockout frequency and the production downtime caused by component shortages [8], whereas Arvis et al. (2026) use vessel-tracking data to quantify maritime disruptions through observed port delays, route diversions, and delayed container-carrying capacity [9]. These approaches capture observable disruption events and their realized operational consequences after shocks have materialized. Supply chain risk is not relevant only after supplier exits, contract terminations, or production stoppages become observable. Before such disruptions materialize, managers may already perceive declining supply chain stability through fluctuations in sourcing costs, difficulties in inventory planning, uncertainty in supplier fulfillment, logistics delays, or changes in overseas orders. Such risk perception may not immediately appear in observed supply chain relationship adjustments, but it can shape firms' assessments of future operating risks and be reflected in the risk disclosures of annual-report MD&A sections. Therefore, this study does not directly examine realized disruption events. Instead, it focuses on firms' perceived and disclosed supply chain disruption risk. This perspective allows us to identify whether exchange rate volatility is translated into firm-level risk perception before supply chain relationships visibly adjust.

This study therefore asks whether exchange rate volatility is transformed from external financial-market uncertainty into firms' perceived and disclosed supply chain disruption risk. To address this issue, we examine three related questions. First, does industry-level exchange rate volatility increase firms' perception of supply chain disruption risk? Second, if such an effect exists, does exchange rate volatility operate through operating pressures on the supply and demand sides, or does it merely capture broader external

market uncertainty? Third, when facing the same exchange rate volatility, do firms respond differently because of differences in resource endowments, supply chain experience, and global value chain embeddedness? By answering these questions, this study explains how exchange rate volatility enters firms' assessments of supply chain risk as a form of external price uncertainty.

To answer these questions, we use a panel of Chinese A-share listed firms from 2007 to 2021 and link industry-level exchange rate volatility exposure to firm-level perceptions of supply chain disruption risk. Our key explanatory variable is an industry-level trade-weighted measure of exchange rate volatility. Building on the measurement of bilateral real exchange rate volatility, we combine bilateral exchange rate fluctuations with industry-partner trade weights to capture the external exchange rate uncertainty firms face through the trade structure of their industries. The dependent variable is firms' perceived and disclosed supply chain disruption risk, constructed from the MD&A sections of annual reports using a word-embedding approach. The results show that industry-level exchange rate volatility increases firms' perceived and disclosed supply chain disruption risk. Further analyses suggest that this effect is related to weaker inventory turnover on the supply side and lower overseas revenue realization on the demand side. At the same time, the translation of exchange rate volatility into supply chain risk perception does not occur uniformly across firms. Financial constraints intensify this risk transmission, whereas deeper backward value chain participation may weaken it; the effect is stronger for firms located in more open regions and for firms with overseas-experienced executives, but relatively weaker for manufacturing firms. Overall, these findings suggest that exchange rate volatility is not merely an external price risk, but can enter managers' assessments of supply chain stability through firms' operating systems. By identifying these operating channels, the results also show how exchange rate uncertainty may undermine the continuity and long-term economic sustainability of internationally connected supply chains.

This study makes three contributions. First, it extends research on the real effects of exchange rate volatility to the domain of firm-level supply chain risk perception. Existing exchange rate studies have mainly focused on outcomes such as trade, exports, investment, and global value chain participation. This study shows that exchange rate volatility may affect firms at an earlier stage, when managers begin to reassess the stability of supply chain operations before these effects are fully reflected in realized trade or performance outcomes. Second, the study connects external exchange rate risk with firms' supply chain risk disclosures through measurement. This perspective contributes to research on sustainable supply chain management by showing that the sustainability of supply chain operations may be threatened not only by observable physical disruptions, but also by persistent financial uncertainty. By constructing an industry-level trade-weighted measure of exchange rate volatility and combining it with an MD&A-based measure of supply chain disruption risk, we identify whether the exchange rate uncertainty firms face through their industry trade structure is reflected in corporate risk disclosure. Third, the study uncovers the operating processes and firm conditions through which exchange rate volatility is translated into supply chain risk perception. The evidence suggests that exchange rate volatility enters firms' operating systems through supply-side inventory turnover and demand-side overseas revenue channels, while this translation varies with financial constraints, value chain embeddedness, regional openness, managerial international experience, and industry attributes. These findings improve our understanding of how external financial uncertainty becomes a firm-level supply chain risk.

The remainder of this paper is organized as follows. Section 2 presents the relevant theoretical background and develops the research hypotheses. Section 3 describes the

model specification, variable construction, and data sources. Section 4 reports the empirical results. The final section concludes and discusses the implications.

2. Theoretical Analysis and Research Hypotheses

2.1. Direct Effect

Industry-level exchange rate volatility may heighten firms' perceived and disclosed supply chain disruption risk. This argument can be understood from the intersection of the exchange rate literature and the supply chain disruption literature. First, research on exchange rate pass-through and firms' exchange rate exposure has shown that exchange rate volatility does not remain confined to nominal prices or accounting outcomes. Instead, it spills over into firms' real operations. Goldberg & Knetter (1996) show that exchange rate changes are not fully absorbed by trading parties, but are instead passed through, albeit incompletely, into import prices, export prices, and firm markups [10]. Along the same line, Campa & Goldberg (1999) and Amiti et al. (2014) show that exchange rate volatility affects firms' input costs, sales revenues, and operating arrangements at the same time [11,12]. Their effects therefore extend beyond trade flows and enter firms' production and operating systems. In this sense, exchange rate volatility is not merely a price signal from external markets; it can alter the operating conditions under which firms organize sourcing, production, and sales. Second, the supply chain disruption literature suggests that whether an external shock develops into supply chain disruption risk depends not only on the magnitude of the shock itself, but also on whether it disrupts the normal linkage among procurement, production, and delivery. Kleindorfer & Saad (2005) distinguish between routine coordination risk and disruption risk, and argue that any external disturbance severe enough to break the continuity of normal business operations may be transformed into supply chain disruption risk [13]. Craighead et al. (2007) further show that the ultimate effect of an external shock also depends on the joint influence of supply chain structural complexity and firms' mitigation capacity [14]. By extension, although exchange rate volatility differs from visible shocks such as pandemics, wars, and natural disasters, it can likewise produce persistent changes in the price relationships and operating conditions faced by firms. Once such changes exceed the absorptive capacity of firms' existing operating systems, the original arrangements for procurement, production, and delivery become more likely to fall out of balance, thereby increasing perceived and disclosed supply chain disruption risk.

More directly, Li et al. (2025) find that greater volatility in the RMB effective exchange rate increases the supply chain separation rate of Chinese firms and raises the likelihood that firms terminate supplier relationships in countries with high exchange rate volatility [1]. This provides direct evidence that exchange rate volatility can affect supply chain stability. However, the existing literature has focused more on how exchange rate volatility shapes supply chain adjustment, supplier switching, and contractual arrangements, and has paid less attention to whether industry-level exchange rate volatility is further translated into firms' perceived and disclosed supply chain disruption risk. This reasoning leads to the first hypothesis:

Hypothesis 1. *Industry-level exchange rate volatility increases firms' perceived and disclosed supply chain disruption risk.*

2.2. Supply Side Channel

On the supply side, industry-level exchange rate volatility may increase firms' perceived and disclosed supply chain disruption risk by disturbing procurement arrangements, replenishment schedules, and inventory positions. Transaction cost theory suggests that

procurement arrangements are determined not only by nominal input prices, but also by the costs of searching for suppliers, negotiating contracts, coordinating delivery across sourcing locations, and maintaining stable input relationships [15]. This logic is particularly relevant in the exchange rate context. When exchange rate volatility rises, firms face greater uncertainty over the future cost of imported intermediate inputs, cross-border settlement values, and the relative attractiveness of alternative sourcing locations. Because imported inputs are closely connected to production continuity in global supply chains, such uncertainty may induce firms to reconsider sourcing origins, adjust order timing, or reorganize established input arrangements [16]. In this sense, exchange rate volatility does not simply change transaction values; it also creates short-run coordination frictions in procurement planning and input configuration.

The difficulty is that such adjustments do not translate smoothly into higher operating efficiency. Inventory and operations coordination theory suggests that inventory is not merely a passive stock, but a key mechanism through which continuity is maintained across procurement, production, and delivery. Once sourcing origins, delivery rhythms, and replenishment timing become less predictable, firms' existing inventory allocation can easily deviate from its normal state [17,18]. For firms that rely on imported raw materials and intermediate goods, exchange rate volatility may lead to precautionary inventory accumulation, delayed replenishment, or changes in the pace at which different inputs are used. When the arrival time of inputs, the speed of inventory depletion, and production schedules cannot be adjusted synchronously, inventory accumulation and structural mismatch become more likely [19]. The result is slower inventory circulation and lower inventory turnover. This mechanism is consistent with recent research on inventory management and supply chain disruption. Guo et al. (2025) argue that inventory allocation is a central channel through which firms respond to supply-side shocks [20], while Alessandria et al. (2023) show that changes in access to imported inputs affect inventory holdings, stockouts, and production continuity [21]. These studies imply that the supply-side effect of exchange rate volatility does not arise simply from changes in import prices. The key mechanism lies in the adjustment frictions created when firms revise sourcing arrangements, replenishment schedules, and inventory positions under uncertainty. If these adjustments are not synchronized with production and delivery schedules, inventory circulation slows, and procurement–production coordination weakens. Lower inventory turnover therefore becomes an early operational signal through which exchange rate volatility may develop into perceived and disclosed supply chain disruption risk. This leads to the following hypothesis:

Hypothesis 2. *Industry-level exchange rate volatility increases firms' perceived and disclosed supply chain disruption risk by reducing firms' inventory turnover.*

2.3. Demand Side Channel

On the demand side, industry-level exchange rate volatility may increase firms' perceived and disclosed supply chain disruption risk by weakening overseas revenue realization. Firms engaged in foreign markets need to make pricing, contracting, and delivery decisions before final revenues are fully realized. When exchange rate volatility increases, the value of overseas orders, the domestic-currency value of foreign sales, and the timing of payment collection become more difficult to predict. The theory of incomplete exchange rate pass-through suggests that firms cannot always fully pass exchange rate fluctuations on to foreign customers through price adjustments. As a result, exchange rate volatility may create uncertainty in export pricing, contract execution, customer demand, and revenue conversion. Foreign customers may delay orders, renegotiate contract terms, or reduce

purchases when exchange rate uncertainty increases. For firms relying on overseas markets, these changes weaken the stability of overseas revenue realization.

The decline or instability of overseas revenue is not merely a sales outcome. It also affects firms' ability to maintain supply chain continuity. Overseas revenue provides an important demand base and cash-flow support for sustaining production plans, financing input purchases, maintaining customer relationships, and fulfilling delivery commitments. Prior studies suggest that firms' ability to cope with supply chain risks depends heavily on the availability of internal resources, operating buffers, and financial slack [22,23]. When overseas revenue becomes less stable, these buffers are weakened, making it more difficult for firms to coordinate procurement, production, and delivery around expected foreign demand. This demand-side pressure can then spill over into the supply chain system. Firms may become less able to maintain stable orders with suppliers, support inventory and production arrangements, or absorb disruptions caused by external uncertainty. This logic is consistent with the view that external shocks develop into supply chain risks when they undermine firms' business continuity and operational resilience [24,25]. In this sense, lower overseas revenue realization becomes a channel through which exchange rate volatility is transformed into perceived and disclosed supply chain disruption risk. Although prior studies have shown that exchange rate volatility affects export behavior and firm performance, less is known about whether it raises supply chain risk perception by weakening firms' overseas revenue base. This leads to the following hypothesis:

Hypothesis 3. *Industry-level exchange rate volatility increases firms' perceived and disclosed supply chain disruption risk by reducing overseas revenue.*

2.4. Boundary Conditions: External Structure and Internal Capability

Backward production length measures the number of upstream production stages an industry undergoes in the global value chain [26]. Specifically, it counts the distinct input transformations required before the final product is formed. A longer backward production length implies that the upstream production process on which the firm depends is more complex, and that inputs must pass through more countries, industries, and production nodes before entering the firm's own production stage. As a result, the firm's supply system becomes more closely connected to changes in the external environment. In China's case, many processing, assembly, and final manufacturing activities are located relatively downstream. Because China absorbs a large share of intermediate inputs, undertakes extensive subsequent processing and assembly domestically, and ultimately serves final product markets, its industries tend to exhibit relatively long backward production length. According to the production-network view of shock transmission [27], changes in external conditions may not be confined to firms' direct procurement links, but may instead be transmitted along a longer upstream production chain. On the one hand, a longer backward production length means that the raw materials, intermediate goods, and components used by firms are embedded in a more complex cross-regional division of labor, so exchange rate volatility may affect firms through multiple upstream stages. On the other hand, the longer the chain, the more difficult it is to coordinate information flows, deliveries, and substitution adjustments across production nodes.

However, this exposure-based logic captures only one side of backward value chain participation. A longer backward production length may also indicate that firms have accumulated more experience in managing international input sourcing, coordinating upstream suppliers, and adjusting input combinations across production stages. Unlike sudden physical disruptions, exchange rate volatility is a recurring form of external uncertainty that firms may partially manage through established procurement routines, supplier relationships, and cross-border coordination experience. Firms embedded in longer backward

value chains may therefore be better able to compare alternative suppliers, adjust sourcing arrangements, smooth temporary currency fluctuations, and prevent upstream uncertainty from immediately turning into supply chain instability. In this sense, backward value chain participation may represent not only external structural exposure, but also supply chain management capability. If this capability effect dominates the exposure effect, a longer backward production length should weaken the positive effect of industry-level exchange rate volatility on firms' perceived and disclosed supply chain disruption risk. Based on this reasoning, we propose the following hypothesis:

Hypothesis 4a. *The positive effect of industry-level exchange rate volatility on firms' perceived and disclosed supply chain disruption risk becomes weaker as backward production length increases.*

Whether firms can absorb exchange rate volatility within their operating systems also depends on their resource buffer capacity, and financing constraints are a key determinant of that capacity [28]. When industry-level exchange rate volatility rises, firms typically need to commit more liquid resources to maintain stable supply chain operations. Such responses may include increasing safety stock, adjusting procurement arrangements, coping with delayed sales payments, managing foreign exchange exposure, or reconfiguring supplier and customer relationships in the short run. All of these adjustments depend fundamentally on sufficient financial flexibility. According to financing constraint theory, firms facing weaker financing constraints generally have more adequate access to external finance and internal funds, and are therefore better able to smooth external uncertainty through inventory adjustment, supplier substitution, hedging arrangements, and cash-flow management. By contrast, firms facing stronger financing constraints are often less able to obtain sufficient resources in a timely manner because they are subject to greater financing frictions and liquidity pressure [29]. Under these conditions, industry-level exchange rate volatility is more likely to evolve from sourcing, settlement, inventory, or revenue uncertainty into internal liquidity strain and supply chain instability. The stronger the financing constraint, therefore, the greater the impact of industry-level exchange rate volatility on firms' perceived and disclosed supply chain disruption risk is likely to be. Based on this reasoning, we propose the following hypothesis:

Hypothesis 4b. *The positive effect of industry-level exchange rate volatility on firms' perceived and disclosed supply chain disruption risk becomes stronger as firms' financing constraints increase.*

3. Model, Variables, and Data

3.1. Research Model

We estimate a two-way fixed effects model to examine the effect of industry-level exchange rate volatility on firm supply chain disruption risk:

$$SCDRisk_{i,t} = \alpha + \beta_1 IndVola_{j,t} + \sum_k \gamma_k Control_{k,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (1)$$

where $SCDRisk_{i,t}$ denotes the supply chain disruption risk of firm i in year t , $IndVola_{j,t}$ denotes the industry-level exchange rate volatility faced by industry j , to which firm i belongs, in year t ; and $Controls_{k,i,t}$ denotes a set of firm-level control variables. μ_i and λ_t capture firm and year fixed effects, respectively; $\varepsilon_{i,t}$ is the error term. Because the core explanatory variable varies at the industry-year level and firms within the same industry may be subject to common shocks in a given year, standard errors are clustered at the industry level to ensure robust statistical inference.

To further identify the mechanisms through which industry-level exchange rate volatility affects supply chain disruption risk, a three-step approach is adopted. As discussed above, industry-level exchange rate volatility may operate through firms' supply-side inventory circulation and demand-side overseas revenue realization. Accordingly, inventory turnover and overseas revenue are used as potential mechanism variables, and Models (2)–(5) are specified as follows:

$$InvTurn_{i,t} = \alpha + \beta_2 IndVola_{j,t} + \sum_k \gamma_k Control_{k,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (2)$$

$$SCDRisk_{i,t} = \alpha + \beta_3 IndVola_{j,t} + \beta_4 InvTurn_{i,t} + \sum_k \gamma_k Control_{k,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (3)$$

$$OverseasRev_{i,t} = \alpha + \beta_5 IndVola_{j,t} + \sum_k \gamma_k Control_{k,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (4)$$

$$SCDRisk_{i,t} = \alpha + \beta_6 IndVola_{j,t} + \beta_7 OverseasRev_{i,t} + \sum_k \gamma_k Control_{k,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (5)$$

where $InvTurn_{i,t}$ denotes the inventory turnover of firm i in year t , measured as operating cost divided by average inventory; and $OverseasRev_{i,t}$ denotes the overseas revenue of firm i in year t . All other variables are defined in the same way as in Model (1). A significantly negative coefficient on $IndVola_{j,t}$ in Model (2), together with a significantly negative coefficient on $InvTurn_{i,t}$ in Model (3), would indicate that exchange rate volatility increases supply chain disruption risk partly by reducing firms' inventory turnover. Similarly, a significantly negative coefficient on $IndVola_{j,t}$ in Model (4), together with a significantly negative coefficient on $OverseasRev_{i,t}$ in Model (5), would indicate that exchange rate volatility increases supply chain disruption risk partly by weakening firms' overseas revenue realization.

Building on this framework, we further examine the boundary conditions under which industry-level exchange rate volatility affects firm supply chain disruption risk. The theoretical analysis suggests that the external production structure in which a firm is embedded and the firm's internal resource capacity may shape the transmission intensity of exchange rate volatility in different ways. To test this possibility, interaction terms between volatility and backward production length, as well as volatility and financing constraints, are introduced. The following moderation models are therefore estimated:

$$SCDRisk_{i,t} = \alpha + \beta_8 IndVola_{j,t} + \beta_9 Ply_{j,t} + \beta_{10}(IndVola_{j,t} \times Ply_{j,t}) + \sum_k \gamma_k Control_{k,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (6)$$

$$SCDRisk_{i,t} = \alpha + \beta_{11} IndVola_{j,t} + \beta_{12} FinConstraint_{i,t} + \beta_{13}(IndVola_{j,t} \times FinConstraint_{i,t}) + \sum_k \gamma_k Control_{k,i,t} + \mu_i + \lambda_t + \varepsilon_{i,t} \quad (7)$$

where $Ply_{j,t}$ denotes the backward production length of industry j in year t , measured following [30], and $FinConstraint_{i,t}$ denotes the degree of financing constraints faced by firm i in year t , measured by the FC index, where a higher index value represents more severe financing constraints. If the coefficient on the interaction term, β_{10} , is significantly negative, this would indicate that the positive effect of exchange rate volatility on supply chain disruption risk becomes weaker as backward production length increases. If β_{13} is significantly positive, this would indicate that the positive effect becomes stronger as financing constraints intensify. Accordingly, Models (6) and (7) are used to test whether backward value chain embeddedness buffers, while internal resource constraints amplify, the transmission of industry-level exchange rate volatility to firm supply chain disruption risk.

3.2. Variables

3.2.1. Industry-Level Exchange Rate Volatility

Following Li et al. (2025), this paper constructs industry-level exchange rate volatility in two steps [1]. First, the monthly bilateral real exchange rate between China and each trading partner country m is calculated using IMF-IFS monthly exchange rates and consumer price indices. The nominal exchange rate is expressed as RMB per unit of partner country (m)'s currency, and an increase in the bilateral real exchange rate indicates a real depreciation of the RMB against partner country (m). Let $RER_{m,k,t}$ denote the bilateral real exchange rate between China and country m in month k of year t . The annual bilateral exchange rate volatility between China and country m , denoted by $Vola_{m,t}$, is measured as the standard deviation of monthly log changes in the bilateral real exchange rate within year t . Next, the ADB input-output tables are used to calculate the share of trade between industry j and country m in industry j 's total trade in year t . This share is used as the trade weight and is denoted by $w_{j,m,t}$. When exchange rate or CPI data are unavailable for a trading partner, that partner is excluded, and the remaining trade weights are re-normalized within each industry-year so that they sum to one. The industry-level exchange rate volatility for industry j in year t is then defined as follows:

$$Vola_{m,t} = \sqrt{\frac{1}{12} \sum_{k=1}^{12} \left[\Delta \ln(RER_{m,k,t}) - \overline{\Delta \ln(RER_{m,t})} \right]^2} \quad (8)$$

$$IndVola_{j,t} = \sum_{m=1}^n w_{j,m,t} \cdot Vola_{m,t} \quad (9)$$

where $w_{j,m,t}$ is calculated based on total trade, namely the sum of exports and imports between industry j and country m . A higher value of $IndVola$ indicates that firms in the industry are exposed to greater exchange rate volatility through their international trade linkages. Compared with an aggregate exchange rate volatility measure, this indicator captures industry-specific exchange rate uncertainty arising from differences in trade partner composition.

3.2.2. Supply Chain Disruption Risk

Using a text-analysis approach, this paper constructs a firm-level measure of managerial perception of supply chain disruption risk as $SCDRisk$, based on the MD&A sections of listed firms' annual reports. Specifically, the MD&A corpus is first used to train a Word2Vec model in order to capture semantic similarity across terms. Seed words such as "supply chain", "supplier", "raw materials" and "disruption" are then selected, and semantically related words are identified on the basis of cosine similarity in the word-vector space. A threshold of 0.5 is used to construct the dictionary of supply chain disruption risk terms. The threshold of 0.5 is used as the baseline because it balances semantic coverage and dictionary precision, while thresholds of 0.6 and 0.7 are used in robustness checks. Finally, this dictionary is matched to firm-level MD&A text, and the frequency of the relevant terms is divided by the total number of words in the text to measure firm i 's supply chain disruption risk in year t , denoted as $SCDRisk_{i,t}$.

$$SCDRisk_{i,t} = \frac{Freq_{i,t}(RiskWords)}{TotalWords_{i,t}(MD\&A)} \quad (10)$$

where $Freq_{i,t}(RiskWords)$ denotes the frequency of supply chain disruption risk terms in firm i 's MD&A text in year t and $TotalWords_{i,t}(MD\&A)$ denotes the total number of words in the corresponding MD&A text. It should be emphasized that $SCDRisk$ captures disclosed

disruption risk rather than realized disruption events. It is not a dummy variable indicating whether a supply chain disruption has actually occurred. Instead, it reflects the extent to which managers recognize, perceive, and disclose supply chain instability in annual reports. Therefore, the analysis examines whether industry-level exchange rate volatility increases firms' perceived and disclosed exposure to supply chain disruption risk, rather than whether it directly triggers observable supply chain breakdowns. The complete list of seed words, the Word2Vec training-sample information, the semantic-similarity screening criteria, and the full dictionaries constructed under the 0.5, 0.6, and 0.7 thresholds are available from the corresponding author upon reasonable request.

3.2.3. Control Variables

We control for a range of firm characteristics that may affect supply chain disruption risk, including the natural logarithm of the number of employees (Size), return on assets (ROA), leverage (Lev), Tobin's Q (TobinQ), revenue growth (Growth), the cash flow ratio (Cashflow), the inventory ratio (INV), and the natural logarithm of listing age (ListAge). To mitigate the potential influence of outliers, all independent variables and control variables are winsorized at the 1st and 99th percentiles.

3.3. Data

The data used in this paper are drawn from four main sources: the IMF database, the ADB-MRIO input-output database, annual reports of Chinese A-share listed firms, and the CSMAR database. Bilateral exchange rates and consumer price indices are obtained from the IMF database. Industry-level import and export weights are taken from the ADB-MRIO input-output database. The dependent variable is constructed from the annual reports of Chinese A-share listed firms. All other firm-level variables are obtained from the CSMAR database. Because the core explanatory variable is constructed at the industry-year level, whereas the dependent variable is measured at the firm-year level, the industries to which listed firms belong are matched to the corresponding industries in the ADB-MRIO database. The industry-year trade-weighted exchange rate volatility measure is then assigned to all listed firms within the corresponding industry. Accordingly, the empirical analysis identifies the effect of industry-level exchange rate volatility on firm-level supply chain disruption risk.

4. Empirical Results and Analysis

4.1. Descriptive Statistics

Table 1 reports the descriptive statistics for the main variables. The mean value of supply chain disruption risk SCDRisk is 0.083, with a standard deviation of 0.026. This distribution indicates that supply-chain-risk-related language is present across the sample but varies substantially in intensity across firms. The core explanatory variable, industry-level exchange rate volatility, has a mean value of 0.017 and ranges from 0.011 to 0.037. The upper bound is more than three times the lower bound, revealing considerable cross-industry variation in exchange rate exposure. Among the control variables, firm size, leverage, Tobin's Q, profitability, revenue growth, cash flow, inventory ratio, and listing age display meaningful dispersion, reflecting substantial heterogeneity in firm characteristics and operating conditions. After winsorization, all variables remain within reasonable ranges, reducing the influence of extreme observations.

Table 1. Descriptive statistics.

Variables	Obs	Mean	SD	Min	Max
<i>SCDRisk</i>	34,889	0.083	0.026	0.029	0.162
<i>IndVola</i>	34,889	0.017	0.004	0.011	0.037
<i>Size</i>	34,889	7.613	1.282	4.205	11.292
<i>ROA</i>	34,889	0.041	0.068	−0.263	0.229
<i>Lev</i>	34,889	0.435	0.216	0.051	0.963
<i>TobinQ</i>	34,889	2.092	1.392	0.866	9.312
<i>Growth</i>	34,889	0.190	0.463	−0.594	3.114
<i>Cashflow</i>	34,889	0.045	0.072	−0.194	0.251
<i>INV</i>	34,889	0.147	0.137	0.000	0.716
<i>ListAge</i>	34,889	2.065	0.907	0.000	3.466

4.2. Baseline Regression Results

Table 2 reports the baseline estimates. Column (1) includes firm fixed effects only, Column (2) further controls for firm-level characteristics, Column (3) adds year fixed effects, and Column (4) includes both firm- and year-fixed effects together with the full set of controls. Across Columns (2)–(4), the coefficient on *IndVola* is positive and statistically significant at the 1% level. In the preferred specification reported in Column (4), the coefficient is 0.4050, indicating that higher industry-level exchange rate volatility is associated with higher firm supply chain disruption risk. In terms of economic significance, a one-standard-deviation increase in industry-level exchange rate volatility, equivalent to 0.004, is associated with a 0.0016 increase in *SCDRisk*. This change corresponds to approximately 1.95% of the sample mean of *SCDRisk* and 6.2% of its standard deviation. Because *SCDRisk* is constructed from supply-chain-disruption-related terms in MD&A disclosures, this result suggests that exchange rate volatility is reflected not only in trade costs or revenue uncertainty, but also in managers' disclosed concerns about procurement, production, delivery, and payment collection. The baseline evidence is therefore consistent with Hypothesis 1.

Table 2. Baseline regression results.

	(1)	(2)	(3)	(4)
VARIABLES	<i>SCDRisk</i>	<i>SCDRisk</i>	<i>SCDRisk</i>	<i>SCDRisk</i>
<i>IndVola</i>	0.1388 (1.0412)	0.3964 *** (5.0987)	0.4136 *** (5.7309)	0.4050 *** (5.5226)
<i>Size</i>		−0.0002 (−0.5778)		−0.0031 *** (−10.6385)
<i>ROA</i>		−0.0246 *** (−5.7134)		−0.0207 *** (−7.6723)
<i>Lev</i>		−0.0179 *** (−5.6028)		−0.0032 ** (−2.1610)
<i>TobinQ</i>		−0.0002 (−1.5321)		0.0004 *** (3.1962)
<i>Growth</i>		−0.0024 *** (−5.8984)		−0.0011 *** (−4.0710)
<i>Cashflow</i>		0.0096 *** (3.1332)		0.0098 *** (6.5651)
<i>INV</i>		−0.0044 (−1.3975)		0.0128 *** (5.4719)
<i>ListAge</i>		0.0149 *** (12.7538)		−0.0031 *** (−3.9553)

Table 2. Cont.

	(1)	(2)	(3)	(4)
VARIABLES	SCDRisk	SCDRisk	SCDRisk	SCDRisk
Constant	0.0802 *** (34.9281)	0.0566 *** (16.9705)	0.0754 *** (60.3110)	0.1053 *** (49.5946)
Observations	34,797	34,797	34,797	34,797
R-squared	0.526	0.620	0.743	0.751
Firm FE	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes

Note: t-statistics are in parentheses; *** $p < 0.01$, ** $p < 0.05$. Standard errors are clustered at the industry level.

4.3. Endogeneity Tests

We address three distinct sources of endogeneity. The first arises from the temporal persistence of SCDRisk. If this dynamic dependence is omitted, a static specification may incorrectly attribute part of the persistence in supply chain disruption risk to IndVola. We therefore estimate a system GMM model that includes lagged SCDRisk and uses appropriate lagged instruments. A further concern relates to potential reverse causality in the construction of IndVola. Although individual firms are unlikely to affect bilateral exchange-rate movements, their responses to perceived supply chain risk may alter industry–country trade patterns and, consequently, the trade weights used to construct the industry-level measure. To address this possibility, we apply the heteroskedasticity-based instrumental-variable approach proposed by Lewbel (2012) [31] as an alternative identification strategy for the potentially endogenous variation in IndVola. Finally, contemporaneous specifications may also be affected by simultaneity arising from common shocks and measurement noise. We therefore replace contemporaneous IndVola with its one-period-lagged value to reduce these concerns and to examine whether exchange rate volatility has a delayed effect on supply chain disruption risk. The corresponding results are reported in Table 3.

Table 3. Endogeneity tests.

	(1) SystemGMM	(2) Lewbel (2012)	(3) L_IndVola
VARIABLES	SCDRisk	SCDRisk	SCDRisk
<i>L.SCDRisk</i>	0.6010 *** (7.4714)		
<i>IndVola</i>	0.8794 * (1.8446)	0.4217 * (1.7546)	
<i>L_IndVola</i>			0.1584 * (1.8785)
<i>Constant</i>	0.0263 * (1.8699)		0.1011 *** (34.4500)
Observations	30,715	34,797	28,165
R-squared		0.036	0.726
Firm Fixed	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Hansen J p	0.550	0.215	
AR(1) p	0		
AR(2) p	0.270		
Cragg-Donald F		875.6	
Kleibergen-Paap rk Wald F		11.03	

Notes: *** $p < 0.01$, * $p < 0.1$. The z-statistics are reported in parentheses in Column (1), while the t-statistics are reported in parentheses in Columns (2) and (3).

4.3.1. System GMM Test

Because firm supply chain disruption risk may exhibit persistence over time, we first estimate a dynamic panel model using system GMM. This approach controls for the lagged dependent variable and helps mitigate potential endogeneity in the explanatory variable. Specifically, we use a two-step system GMM estimator, restrict the lag windows to the second lag for lagged SCDRisk and lags two to three for the selected controls, and collapse the instrument matrix to limit instrument proliferation. The final specification contains 26 instruments for 3930 firms. As shown in Column (1), the coefficient on lagged SCDRisk is 0.6010 and significant at the 1% level. The significant coefficient on lagged SCDRisk confirms strong persistence in supply chain disruption risk. More importantly, the coefficient on IndVola remains positive and statistically significant after this persistence is controlled for. Although its estimated coefficient is larger than the baseline fixed-effects estimate, the coefficients are not directly comparable because the system GMM specification includes a lagged dependent variable, is estimated on a different sample, and relies on a different estimation procedure. We therefore interpret the GMM estimate as evidence of the robustness of the positive relationship after accounting for the dynamic persistence of SCDRisk, rather than as evidence that the economic effect is proportionally larger. The significant AR(1) statistic, insignificant AR(2) statistic, and Hansen J p -value of 0.550 indicate that the dynamic specification is empirically acceptable.

4.3.2. Lewbel (2012) Heteroskedasticity-Based Instrumental Variable Approach

We next apply the Lewbel (2012) heteroskedasticity-based identification strategy to address potential measurement-related endogeneity in the industry-level exchange rate volatility variable [31]. Since IndVola is constructed from trade weights that may themselves respond to changes in industry conditions, this method provides an additional source of identification by generating instruments from heteroskedasticity in the error term. The heteroskedasticity LM test rejects homoskedasticity in the first-stage disturbance, supporting the heteroskedasticity condition underlying the Lewbel construction. The excluded-instrument first-stage F-statistic is 11.03. Column (2) reports the Lewbel estimate. The coefficient on IndVola remains positive and statistically significant at the 10% level. The Hansen J p -value of 0.215, together with the Cragg–Donald F statistic of 875.6 and the Kleibergen–Paap rk Wald F statistic of 11.03, provides no evidence of overidentification failure or serious weak-instrument concerns. This pattern reduces the concern that the baseline result is driven by measurement-related endogeneity in IndVola.

4.3.3. Test Using Lagged Industry-Level Exchange Rate Volatility

Finally, we replace contemporaneous IndVola with its one-period lag. This specification is motivated by the fact that exchange rate volatility may affect firm operations gradually through procurement, inventory adjustment, order execution, and payment collection. Column (3) shows that the coefficient on lagged IndVola is 0.1584 and statistically significant at the 10% level. This result is consistent with the view that exchange rate exposure affects firms gradually rather than only contemporaneously.

4.4. Robustness Checks

We assess robustness along four dimensions: alternative measures of industry-level exchange rate volatility, alternative measures of supply chain disruption risk, alternative correction of standard errors, and the exclusion of special-year observations. Tables 4 and 5 report the results.

Table 4. Robustness checks.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	SCDRisk	SCDRisk	SCDRisk	SCDRisk	SCDRisk1	SCDRisk2
<i>IndVola1</i>	0.3292 ** (2.7275)					
<i>IndVola2</i>		0.8069 *** (5.7266)				
<i>IndVola2_im</i>			0.5024 *** (3.4265)			
<i>IndVola2_ex</i>				0.4763 ** (2.0855)		
<i>IndVola</i>					0.0806 *** (2.7868)	0.0642 *** (3.4944)
Constant	0.0764 *** (33.8263)	0.0731 *** (43.9965)	0.0766 *** (44.6379)	0.0772 *** (28.7958)	0.0188 *** (37.5204)	0.0108 *** (33.7144)
Observations	34,797	34,797	34,797	34,344	34,797	34,797
R-squared	0.742	0.743	0.742	0.743	0.729	0.701
Firm Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Note: t-statistics are in parentheses; *** $p < 0.01$, ** $p < 0.05$. Standard errors are clustered at the industry level.

Table 5. Robustness checks.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	SCDRisk	SCDRisk	SCDRisk	SCDRisk	SCDRisk
<i>IndVola</i>	0.4136 *** (5.4460)	0.6418 *** (9.9650)	0.3858 *** (5.3543)	0.4569 *** (4.8416)	0.3947 *** (5.6351)
Constant	0.0754 *** (57.9819)	0.0715 *** (64.0557)	0.0766 *** (62.8613)	0.0741 *** (45.1422)	0.0728 *** (60.4866)
Observations	34,797	34,797	33,031	32,400	27,535
R-squared	0.743	0.686	0.752	0.746	0.745
Firm Fixed	Yes	Yes	Yes	Yes	Yes
Year Fixed	Yes	No	Yes	Yes	Yes
Industry-specific trends	No	Yes	No	No	No
Controls	Yes	Yes	Yes	Yes	Yes

Note: t-statistics are in parentheses; *** $p < 0.01$. Columns (2)–(5) report standard errors clustered at the industry level, while Column (1) reports two-way clustered standard errors at the industry and year levels.

4.4.1. Alternative Measures of Exchange Rate Volatility

We first examine whether the baseline result is sensitive to the construction of the core explanatory variable. In the baseline analysis, *IndVola* is measured using the standard deviation of monthly bilateral real exchange rate changes within a one-year window. As an alternative measure, we construct *IndVola1*, which extends the volatility window to two years and uses the monthly real exchange rate changes from year ($t - 1$) to year (t). This measure captures more persistent exchange rate uncertainty and reduces the possibility that the result is driven by short-term fluctuations within a single year. We also construct *IndVola2*, a counterfactual volatility measure that reduces observations above the sample median of baseline volatility by 50%. This adjustment weakens the influence of high-volatility observations and allows us to test whether the baseline result is driven mainly by extreme exchange rate volatility. Building on the construction of *IndVola2*, we further separate the trade component into imports and exports and construct *IndVola2_im* and

IndVola2_ex, respectively. This distinction allows us to examine whether the robustness of the results holds when exchange rate volatility is measured separately through import-side and export-side trade exposure. The results reported in Columns (1)–(4) of Table 4 remain positive and statistically significant, confirming the robustness of the baseline findings.

4.4.2. Alternative Measures of Supply Chain Disruption Risk

We next examine whether the baseline result is sensitive to the construction of the dependent variable. In the baseline analysis, SCDRisk is measured using the risk dictionary constructed with a cosine-similarity threshold of 0.5. To address the concern that the result may depend on this specific threshold, we replace the dependent variable with two alternative measures of supply chain disruption risk. Specifically, SCDRisk1 is constructed using a stricter threshold of 0.6, while SCDRisk2 is constructed using a threshold of 0.7. These alternative measures allow us to test whether the baseline finding is robust to different definitions of supply-chain-disruption-related terms in the MD&A text. Columns (5) and (6) of Table 4 report the results, which are consistent with the baseline findings and confirm the robustness of our conclusions.

4.4.3. Alternative Clustering and Industry-Specific Trends

We further examine whether the baseline result is sensitive to the clustering of standard errors. Since the core explanatory variable varies at the industry-year level, firms within the same industry may be exposed to common exchange rate volatility, while firms in the same year may also be affected by common macroeconomic shocks. To address this concern, we re-estimate the baseline model using two-way clustered standard errors at the industry and year levels.

Column (1) of Table 5 reports the result. The coefficient on IndVola remains positive and statistically significant, indicating that the baseline finding is robust to alternative correction of standard errors. We also account for potentially heterogeneous trends across industries by including interactions between industry indicators and a linear time trend ($\text{Industry } i \times t$). This specification allows industries with different technological trajectories, life-cycle stages, and demand structures to follow distinct temporal trends. As shown in Column (2), the coefficient on IndVola remains positive and statistically significant after controlling for these industry-specific linear trends.

4.4.4. Exclusion of Special-Year Observations

Finally, we further test the baseline conclusion by excluding special-year samples. The global financial crisis in 2008–2009 and the sharp RMB exchange rate adjustment in 2015 may have exerted unusual effects on both industry-level exchange rate volatility and firm supply chain disruption risk. In addition, the COVID-19 pandemic during 2020–2021 generated exceptional disruptions to production, logistics, and international trade, which may confound the relationship examined in this study. It is therefore necessary to exclude these periods to assess whether the main findings are driven only by extreme external shocks. Column (3), which excludes the 2008–2009 observations, still yields a significantly positive coefficient on IndVola. Column (4), which excludes the 2015 observations, produces the same result. Column (5) further excludes observations from 2020–2021, and the coefficient on IndVola remains positive and statistically significant. These findings indicate that the positive effect of industry-level exchange rate volatility on firm supply chain disruption risk does not depend on special periods such as the global financial crisis, episodes of sharp RMB exchange rate adjustment, or the COVID-19 pandemic, and is therefore robust across samples.

4.5. Heterogeneity Analysis

The baseline results show that industry-level exchange rate volatility increases firm supply chain disruption risk. However, this effect may differ across firms depending on their external exposure, operating characteristics, and managerial background. We therefore examine heterogeneity along four dimensions: regional openness, manufacturing status, executives' overseas experience, and export intensity. The results are reported in Table 6.

Table 6. Heterogeneity analysis.

	(1) Openness	(2) Manufacturing	(3) OverseaBack	(4) Export Intensity
VARIABLES	SCDRisk	SCDRisk	SCDRisk	SCDRisk
<i>IndVola</i>	0.3761 *** (5.0816)	0.4296 *** (5.3317)	0.3634 *** (4.7336)	0.3580 *** (4.9475)
<i>Openness × IndVola</i>	0.0971 ** (2.0639)			
<i>Manufacturing × IndVola</i>		−0.1030 * (−1.8347)		
<i>OverseaBack × IndVola</i>			0.0863 ** (2.5942)	
<i>Export Intensity × IndVola</i>				0.0635 ** (2.1780)
Constant	0.1061 *** (49.3275)	0.1005 *** (48.4857)	0.1063 *** (48.7015)	0.1055 *** (50.8977)
Observations	34,797	34,770	34,770	34,797
R-squared	0.751	0.753	0.751	0.751
Firm Fixed	Yes	Yes	Yes	Yes
Year Fixed	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Note: t-statistics are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard errors are clustered at the industry level.

4.5.1. Regional Openness

We first examine whether the effect varies with the openness of the firm's regional environment, measured by whether the firm is registered in a special economic zone or a coastal open city. Column (1) shows that the coefficient on *IndVola* is 0.3761, while the interaction term is 0.0971; both are statistically significant. This implies that the positive effect of industry-level exchange rate volatility on supply chain disruption risk remains significant across firms, but is stronger for firms located in more open regions. Specifically, the estimated effect increases from 0.3761 for firms outside core open areas to 0.4732 for firms within them. This pattern is consistent with the view that firms in more open regions are more deeply involved in international trade, cross-border procurement, overseas sales, and global logistics, making exchange rate volatility more likely to be transmitted into supply chain risk exposure and disclosed in MD&A sections.

4.5.2. Manufacturing Versus Non-Manufacturing Firms

We next examine heterogeneity by industry type. Column (2) shows that industry-level exchange rate volatility has a significantly positive effect on supply chain disruption risk, while the interaction term between exchange rate volatility and the manufacturing indicator is negative and statistically significant. This indicates that the effect of exchange rate volatility on supply chain disruption risk is weaker among manufacturing firms than among non-manufacturing firms.

This pattern does not imply that manufacturing firms are less exposed to supply chain shocks. Manufacturing firms depend heavily on the continuous supply of raw materials, intermediate goods, and components, and their operations require close coordination among procurement, production, inventory management, and delivery. Precisely because of this reliance, manufacturing firms may have developed more stable procurement routines, more systematic inventory management practices, and stronger supplier coordination mechanisms. These operating arrangements may help them absorb part of the uncertainty caused by exchange rate volatility before it is translated into disclosed supply chain disruption risk. By contrast, non-manufacturing firms may have less standardized supply chain adjustment routines, making exchange rate volatility more likely to be reflected in their risk disclosures.

4.5.3. Executives with Overseas Experience

Finally, we examine whether managerial international background moderates the effect of industry-level exchange rate volatility. *OverseasBack* is a dummy variable equal to one if at least one member of the firm's senior management team has overseas education or work experience in a given year, and zero otherwise. Overseas experience includes degree study, visiting-scholar or postdoctoral experience, and employment outside mainland China, including Hong Kong, Macao, and Taiwan. Short-term visits, exchanges, or training programs are excluded. Column (3) shows that the coefficient on *IndVola* remains positive, while the interaction term with the indicator for executives with overseas experience is also positive and statistically significant. This suggests that executives with overseas experience strengthen, rather than weaken, the relationship between exchange rate volatility and supply chain disruption risk.

A plausible explanation is that such executives are more familiar with international market conditions, cross-border transactions, foreign-currency settlement, and overseas customer relationships. This experience may make them more sensitive to the operational consequences of exchange rate volatility and better able to identify how such uncertainty affects procurement, delivery, order execution, and payment collection. Since *SCDRisk* is constructed from risk-related disclosures in MD&A sections, the stronger effect observed among firms with overseas-experienced executives may reflect their greater awareness of international supply chain uncertainty and a higher tendency to disclose such risks [32–34]. In contrast, firms lacking such managerial experience may be less likely to recognize or report exchange-rate-related supply chain pressures in a timely manner.

4.5.4. Export Intensity

We further examine whether firms' export intensity affects the relationship between industry-level exchange rate volatility and supply chain disruption risk. Export intensity is measured as the ratio of overseas business revenue to total operating revenue. Column (4) shows that the coefficient on *IndVola* is 0.3580, while the interaction term between *IndVola* and export intensity is 0.0635; both are statistically significant. This finding suggests that greater exposure to overseas markets increases the sensitivity of firms' supply chain operations to exchange rate uncertainty.

Firms with higher export intensity are more dependent on foreign demand, cross-border order execution, foreign-currency settlement, and overseas payment collection. Exchange rate volatility may therefore create greater uncertainty in contract pricing, revenue realization, and production–delivery coordination, making such pressures more likely to be perceived and disclosed as supply chain disruption risk in MD&A sections.

4.6. Mechanism Analysis

We next examine whether the baseline effect operates through the proposed supply- and demand-side channels. Following the three-step mechanism test, we first verify the baseline relationship between industry-level exchange rate volatility and firm supply chain disruption risk. We then examine whether *IndVola* affects the proposed mechanism variables, and finally include both *IndVola* and the mechanism variable in the supply chain disruption risk equation. Inventory turnover captures the efficiency of procurement–production–sales coordination, while overseas revenue reflects firms’ demand realization and revenue support in external markets. Table 7 reports the results. Panel A presents the three-step mechanism estimates. To improve interpretability, inventory turnover is standardized, while overseas revenue is rescaled in units of RMB 100 billion. Panel B reports the estimated indirect effects and their bias-corrected 95% confidence intervals based on 1000 bootstrap replications.

Table 7. Panel A. Mechanism tests. Panel B. Bootstrap tests.

(A)				
	(1)	(2)	(3)	(5)
VARIABLES	SCDRisk	InvTurn	SCDRisk	SCDRisk
<i>InvTurn</i>			−0.0004 ** (−2.6352)	
<i>IndVola</i>	0.4050 *** (5.5226)	−6.3971 ** (−2.1306)	0.3938 *** (5.3995)	0.2875 *** (3.4417)
<i>OverseasRev</i>				−0.0035 ** (−2.2326)
Constant	0.1053 *** (49.5946)	0.7260 *** (3.8187)	0.1060 *** (49.4623)	0.1102 *** (27.5590)
Observations	34,797	34,443	34,443	17,334
R-squared	0.751	0.676	0.749	0.758
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
(B)				
	(1)	(2)		
VARIABLES	InvTurn	OverseasRev		
Indirect effect	0.0137	0.0028		
Direct effect: BC 95% CI lower	0.6583	0.6572		
Direct effect: BC 95% CI upper	0.7737	0.8435		
Indirect effect: BC 95% CI lower	0.0095	0.0004		
Indirect effect: BC 95% CI upper	0.0186	0.0065		

Note: t-statistics are in parentheses; *** $p < 0.01$, ** $p < 0.05$. Standard errors are clustered at the industry level. Bias-corrected 95% confidence intervals are based on 1000 bootstrap replications.

4.6.1. Inventory Turnover

A supply chain disruption risk does not arise only when production or delivery has already been interrupted. It may also emerge when firms begin to experience difficulties in maintaining normal procurement, inventory circulation, and fulfillment schedules. For this reason, inventory turnover provides a useful window into the supply-side mechanism. A smooth inventory cycle usually indicates that inputs can be procured, processed, and delivered in a relatively coordinated manner, whereas a decline in inventory turnover may signal slower stock circulation, greater inventory occupation, and weaker coordination between procurement, production, and sales.

Column (1) of Table 7 first confirms the baseline result that industry-level exchange rate volatility significantly increases firm supply chain disruption risk. Column (2) then shows that IndVola significantly reduces inventory turnover, suggesting that exchange rate volatility weakens the smoothness of firms' supply-side operations. This result is consistent with the view that exchange rate volatility raises uncertainty in input costs, replenishment decisions, and procurement timing, thereby disturbing the normal pace of inventory circulation.

Column (3) further includes inventory turnover in the supply chain disruption risk equation. The coefficient on inventory turnover is significantly negative, indicating that firms with lower inventory turnover tend to report higher supply chain disruption risk. Meanwhile, the coefficient on IndVola remains positive and significant, although its magnitude declines relative to the baseline estimate. The bootstrap results in Panel B further show that the indirect effect through inventory turnover is positive and that its bias-corrected 95% confidence interval excludes zero. These results suggest that inventory turnover accounts for part, but not all, of the effect of exchange rate volatility and is consistent with a partial supply-side transmission channel. The evidence is therefore consistent with Hypothesis 2.

4.6.2. Overseas Revenue

Exchange rate volatility may also affect supply chain disruption risk through the demand side. For firms engaged in overseas business, supply chain stability depends not only on whether inputs can be procured and delivered smoothly, but also on whether foreign orders can be converted into stable revenue. When exchange rate volatility rises, overseas customers may delay orders, renegotiate contracts, adjust purchase quantities, or become more cautious about future transactions. At the same time, uncertainty in foreign-currency settlement may weaken the domestic-currency value and predictability of overseas sales. Overseas revenue therefore reflects the extent to which external demand can provide stable support for firms' normal operations.

Column (4) of Table 7 shows that IndVola significantly reduces overseas revenue, indicating that exchange rate volatility weakens firms' revenue realization in external markets. This result suggests that the demand-side effect of exchange rate volatility is not limited to price fluctuations. It may also appear through weaker overseas orders, less predictable sales proceeds, and reduced cash-flow support from foreign markets. For firms with international business, such revenue pressure can directly affect their ability to sustain procurement, production scheduling, and delivery commitments.

Column (5) further shows that overseas revenue is negatively associated with supply chain disruption risk after it is included in the risk equation. This result indicates that firms with weaker overseas revenue are more likely to disclose higher supply chain disruption risk. Unlike inventory turnover, which captures the internal circulation of materials and products, overseas revenue captures the external demand and cash-flow foundation that supports supply chain continuity. When overseas revenue declines, firms may have less financial flexibility to maintain input purchases, fulfill existing orders, or absorb temporary disruptions in logistics and settlement. The coefficient on IndVola remains positive and significant, indicating that overseas revenue does not exhaust the effect of exchange rate volatility, but it represents an important demand-side transmission channel. Panel B further shows that the indirect effect through overseas revenue is positive and that its bias-corrected 95% confidence interval excludes zero. The bias-corrected confidence intervals for both channels exclude zero, indicating that both constitute statistically significant transmission paths. The quantitative comparison nevertheless shows that the supply-side inventory-turnover channel carries a greater explanatory weight in transmit-

ting exchange rate volatility into firms' perceived and disclosed supply chain disruption risk. A possible explanation is that exchange rate volatility affects inventory circulation across a broader range of firms through procurement-cost uncertainty, replenishment delays, and production–sales coordination frictions, whereas the overseas-revenue channel is concentrated mainly among firms with substantial foreign-market exposure. Overall, the results are consistent with the proposition that exchange rate volatility increases supply chain disruption risk partly by weakening overseas revenue realization and reducing the external demand support available to firms, thereby providing evidence consistent with Hypothesis 3.

4.7. Moderating Effects

The preceding results show that industry-level exchange rate volatility significantly increases firm supply chain disruption risk. A further question is whether this effect varies systematically with firms' external production structure and internal resource conditions. To address this issue, this paper examines two boundary conditions: backward production length in the value chain and financing constraints. The results are reported in Table 8.

Table 8. Moderating effect analysis.

	(1)	(2)
VARIABLES	<i>SCDRisk</i>	<i>SCDRisk</i>
<i>IndVola</i>	0.3976 *** (5.8803)	0.4259 *** (5.7724)
<i>PLy</i> × <i>IndVola</i>	−0.0716 * (−1.9536)	
<i>PLy</i>	0.0033 *** (5.6286)	
<i>FinConstraint</i>		0.0037 ** (2.1975)
<i>FinConstraint</i> × <i>IndVola</i>		0.2510 *** (2.8140)
Constant	0.0955 *** (36.3971)	0.0964 *** (45.7486)
Observations	34,787	34,489
R-squared	0.752	0.751
Firm Fixed	Yes	Yes
Year Fixed	Yes	Yes
Controls	Yes	Yes

Note: t-statistics are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Standard errors are clustered at the industry level.

4.7.1. The Moderating Role of Backward Production Length

Column (1) shows that backward production length significantly alters the effect of industry-level exchange rate volatility. Specifically, the coefficient on the interaction between *IndVola* and backward production length is negative and significant at the 10% level, indicating that the effect of industry-level exchange rate volatility on firm supply chain disruption risk becomes weaker as the number of upstream production stages increases. At the same time, the coefficient on backward production length itself is significantly positive, suggesting that firms embedded in longer upstream production chains are generally more exposed to supply chain disruption risk.

This finding suggests that industry-level exchange rate volatility does not operate in the same way across all production networks. Longer backward production length implies more upstream production stages and a more complex division of labor, which may increase firms' baseline exposure to supply chain instability. However, firms embedded in longer

upstream chains may also have more experience in supplier coordination, input adjustment, and cross-stage production management. These accumulated coordination capabilities may help firms absorb part of the uncertainty caused by exchange rate volatility before it develops into higher supply chain disruption risk. In this sense, backward production length reflects not only external structural complexity, but also a certain degree of upstream coordination capacity, thereby supporting Hypothesis 4a.

4.7.2. The Moderating Role of Financing Constraints

Unlike backward production length, which captures firms' external production structure, financing constraints reflect firms' internal resource conditions. Column (2) shows that the coefficient on the interaction between *IndVola* and the financing constraint index is 0.2510 and significantly positive at the 1% level. Since a higher value of the financing constraint index indicates tighter financing constraints, this result suggests that the positive effect of industry-level exchange rate volatility on firm supply chain disruption risk is stronger among firms facing more severe financing constraints. The coefficient on the financing constraint index itself is also significantly positive, indicating that financially constrained firms are generally more likely to be exposed to supply chain instability.

This finding indicates that whether exchange rate volatility is translated into supply chain pressure depends not only on the external shock itself, but also on the firm's internal capacity to absorb it. Firms with lower financing constraints usually have greater financial flexibility and are better able to smooth external fluctuations through procurement adjustment, inventory support, and operating coordination. By contrast, firms facing tighter financing constraints have fewer resources to maintain existing arrangements or make timely adjustments when exchange rate volatility rises. Financing constraints therefore reflect differences in firms' internal buffering capacity. Such differences significantly strengthen the effect of industry-level exchange rate volatility on supply chain disruption risk, thereby supporting Hypothesis 4b.

5. Conclusions and Policy Implications

This study examines whether industry-level exchange rate volatility is translated into firms' perceived and disclosed supply chain disruption risk. Using Chinese A-share listed firms from 2007 to 2021, we construct an industry-level exchange rate volatility measure and combine it with a text-based measure of supply chain disruption risk from firms' MD&A disclosures. The empirical results show that higher industry-level exchange rate volatility is associated with higher firm supply chain disruption risk. This finding is robust to alternative measures of exchange rate volatility, alternative constructions of the dependent variable, alternative clustering of standard errors, and the exclusion of special-year observations. Further analyses suggest that this effect operates through both supply- and demand-side channels: exchange rate volatility reduces inventory turnover and weakens overseas revenue realization. The effect is also heterogeneous across firms. It is stronger among firms located in more open regions, firms with overseas-experienced executives, and firms with greater export intensity, but weaker among manufacturing firms. In addition, financing constraints amplify the effect, whereas longer backward production length appears to buffer part of the marginal impact of exchange rate volatility. These findings suggest that exchange rate volatility is not only a source of external price uncertainty, but may also enter firms' assessments of supply chain stability through concrete operating channels. More broadly, the results indicate that persistent exchange rate uncertainty may weaken the economic and operational sustainability of cross-border supply chains by disrupting inventory circulation, overseas revenue realization, and firms' capacity to maintain continuous production and delivery.

Relative to existing studies, this paper supports the broader view that exchange rate volatility has real effects on firms, but it extends this literature in a different direction. Prior research has mainly examined trade flows, export decisions, global value chain participation, supplier switching, or realized supply chain adjustments. This study shows that exchange rate volatility may also be reflected at an earlier stage, when managers perceive and disclose higher supply chain disruption risk before actual supply chain breakdowns become observable. In this sense, the paper links exchange rate volatility with firm-level supply chain risk perception and corporate risk disclosure. It also contributes to the supply chain risk literature by showing that financial-market uncertainty can be transformed into supply chain risk through procurement, inventory circulation, overseas demand, and resource constraints. The evidence therefore helps explain not only whether exchange rate volatility matters for supply chain stability, but also how and under what conditions this transmission is more likely to occur.

The findings have several practical implications. For firms, exchange rate volatility should not be treated only as a financial or accounting issue. Firms with cross-border sourcing, overseas sales, or foreign-currency settlement should incorporate exchange rate volatility into their supply chain risk management systems. On the supply side, firms may need to improve inventory planning, supplier coordination, replenishment arrangements, and input substitution capacity, so that exchange rate volatility does not easily evolve into procurement delays or inventory mismatch. On the demand side, firms should strengthen the management of overseas orders, contract pricing, settlement currency, and payment collection, because unstable overseas revenue may weaken the financial support needed to maintain production and delivery continuity. Enterprises with substantial overseas trade exposure may also adopt exchange-rate adjustment clauses, diversify settlement currencies, and strengthen information sharing with overseas suppliers and customers. These actions are particularly important for firms in open regions and firms that are more sensitive to international market uncertainty. Such measures can improve not only short-term risk absorption but also the long-term sustainability of supplier relationships, inventory systems, and cross-border operations.

The results also imply that financial flexibility is an important buffer against external shocks. Since financing constraints strengthen the effect of exchange rate volatility on supply chain disruption risk, financial institutions should provide more accessible hedging products, supply chain finance, trade credit, and working-capital support for highly constrained firms. Governments, in turn, can improve exchange-rate risk information services, reduce firms' access costs to hedging instruments, and strengthen policy support for internationally exposed enterprises. At the same time, firms embedded in longer backward production chains should not only recognize their higher baseline exposure to supply chain instability, but also make use of their accumulated supplier coordination experience to build more resilient upstream production arrangements, including safety-stock planning, alternative sourcing, and closer coordination with multi-tier suppliers. Together, these measures can support more resilient and economically sustainable supply chain networks by reducing the likelihood that temporary financial volatility develops into prolonged operational disruption.

This study also has several limitations that suggest useful directions for future research. The analysis focuses on Chinese listed firms, whose exchange rate environment, trade structure, and position in global supply chains may differ from those of firms in other economies. Accordingly, the extent to which industry-level exchange rate volatility is translated into supply chain disruption risk may depend on country-specific institutional and market conditions. Future research could therefore examine whether similar patterns hold across economies with different exchange rate regimes, trade structures, and degrees

of global value chain participation. In addition, the text-based SCDRisk measure may be affected by cross-sectional differences in firms' disclosure styles and industry-specific terminology, while the matching of listed firms to input–output industries may introduce classification errors into IndVola. Future studies could address these measurement concerns through refined text validation and more firm-specific measures of exchange rate exposure.

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