# Corporate risk-taking under foreign demand uncertainty: Evidence from China

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**Abstract**

We examine the impact of foreign demand uncertainty on corporate risk-taking using panel data of over 1,700 Chinese firms spanning 2001 to 2016. Employing various indicators of corporate risk-taking and a firm-specific time-variant measure of heterogeneous foreign demand uncertainty, we find consistent and significant evidence for a positive relationship: firms engage in riskier ventures in response to higher foreign demand uncertainty. Such uncertainty exerts impacts on firms' risk-taking behaviors by fueling their incentive to seek substitute profits and tightening their financing constraints. Additionally, firms with superior management capacity and higher technological intensity are more conspicuously impacted by changes in foreign demand uncertainty.

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## 1. Introduction

Firms engaged in international trade invariably face challenges arising from external demand uncertainty. However, the intricate relationship between such uncertainty and corporate risk-taking remains a critical yet understudied area in both international economics and corporate finance. Over the past few decades, China has emerged as the world's largest exporter. According to Chinese National Bureau of Statistics (NBS), its total foreign trade volume reached 5.94 trillion US dollars in 2023, with exports worth 3.38 trillion. China's international trade transaction has accounted for approximately 15% of the global aggregate value.[1] However, as Chinese exporters have witnessed increasing protectionism in key markets, escalating trade tensions, the reconfiguration of global supply chains, and volatility in major currencies' exchange rates over the past decade, assessing how firms respond and adjust their behaviors in the face of foreign demand uncertainty can provide valuable insights into the mechanisms of corporate adaption under complex international trade conditions.

Demand-side factors have been widely recognized as crucial determinants of exporters' success (e.g., Hottman et al. (2016), Kramarz et al. (2019), and Fitzgerald et al. (2023)). Amid the emergence of demand uncertainty, firms may rapidly adjust operations as this adaption can not only minimize their potential losses, but also allow them to gain a "first-mover" advantage compared to peers who face similar uncertainty (Kulatilaka and Perotti, 1998). If firms' appetite for risky activities alters due to heightened demand uncertainty, their risk-taking behavior is likely to change accordingly. Despite the voluminous literature investigating the economic effects of demand uncertainty, only few works assess its impact on corporate risk-taking. This paper, employing Chinese exporting firms as sample, aims to contribute to the literature by focusing on how corporate risk-taking changes in the context of higher foreign demand uncertainty.

From a theoretical perspective, the relationship between foreign demand uncertainty and corporate risk-taking is multifaceted and ambiguous. On one hand, increased foreign demand uncertainty may prompt a more cautious response from exporting firms, leading to reduced corporate risk-taking decisions. Firstly, due to the irreversibility of investments, the "real option" theory suggests that the information problems fueled by uncertainty may lead firms to adopt a "wait and see" stance, postponing investment or other risky decisions until the uncertainty dissipates (Bernanke, 1983; McDonald and Siegel, 1986; Pindyck, 1988,

[1]For more detailed information, refer to the website of NBS at https://www.stats.gov.cn/sj.

1991). Secondly, based the "agency theory," should uncertainty generate a wedge between the managers' and shareholders' optimal decisions, managers may underinvest and take sub-optimal risks for the sake of their own benefit (Hirshleifer and Thakor, 1992; Panousi and Papanikolaou, 2012). Furthermore, the emergence of foreign demand uncertainty may compel firms to hoard cash reserves as a precautionary measure (Carroll and Samwick, 1998; Giavazzi and McMahon, 2012; Sinha, 2016), which consequently reduces the funds available for risky projects.

Nonetheless, on the other hand, heightened foreign demand uncertainty may induce higher corporate risk-taking due to several reasons. Firstly, such uncertainty makes it more challenging for firms to predict their revenue from overseas, which could obscure their outlook for aggregate revenue. Given the typically rigid return targets required by shareholders, firms may become more inclined to undertake riskier activities, such as expanding into unfamiliar areas, diversifying product lines, or intensifying R&D efforts (Demir, 2009; Esposito, 2022). While these activities may generate compensatory income when overseas revenue decreases, they also elevate the firm's risk profile. Similarly, the "growth option" theory suggests that, although causing some adverse problems, uncertainty may also represent a potential of opportunities. Firms with adventurous spirit (or those under competition pressure) may preemptively seize this opportunity and increase their engagement in riskier activities, in order to gain favorable market positions compared to their conservative competitors (Kulatilaka and Perotti, 1998; Grenadier, 2002; Baum et al., 2010). Lastly, firms may face higher financing costs as creditors adjust risk premiums in the event of increased foreign demand uncertainty (Popp and Zhang, 2016; Arellano et al., 2019; Correa et al., 2023; Alfaro et al., 2024). This, in turn, may drive firms to engage in riskier projects in an effort for higher returns to cover increased financing costs. If the risk-increasing effects outweigh the risk-mitigating ones, we would observe an increase in risk-taking among firms affected by higher foreign demand uncertainty, and vice versa.

Given the challenge of drawing definitive conclusions from competing theories, we examine the median levels of corporate risk-taking and foreign demand uncertainty over the period from 2000 to 2016, as illustrated in Figure 1, to shed light on their relationship. Overall, foreign demand uncertainty faced by Chinese exporters heightened during this period, albeit with occasional fluctuations. In contrast, corporate risk-taking exhibited a more varied pattern, characterized by distinct phases of increase and decrease. While there were periods of synchronization between these two variables, there were also times when their trajectories

diverged. The absence of perfect correlation seemingly suggests that additional factors may be influencing their relationship, underscoring the need for a more rigorous analysis.

[Figure 1 about here.]

We contribute to the current literature by empirically assessing the impact of foreign demand uncertainty on corporate risk-taking. To achieve this, we combine the information provided by CEPII's *BACI* database and detailed exporter-product-destination information from Chinese customs, constructing a firm-specific, time-varying indicator of external demand uncertainty faced by individual Chinese exporters. Differed from some similar indicators in prior literature, such as those measuring trade policy uncertainty, which could be uniform across firms, our indicator captures the heterogeneous nature of demand uncertainty exposure among firms due to differences in their portfolios of exported goods, reliance on foreign markets, and the substitutability of their products. Additionally, given the product-level trade flow information between various countries, we excluded the influence of a series of factors, such as potential supply shocks from exporting countries, an importing country's aggregate demand for a good irrespective of exporters, and bilateral patterns in the trade flow of various goods. This approach allows us to better capture the idiosyncratic shocks on an importing market's demand for a specific good, which we then aggregate into a firm-level measure of demand uncertainty for firms with multiple products and external markets.

The snapshots of our main findings include: Firstly, our results indicate higher (lower) corporate risk-taking when firms experience escalated (declined) foreign demand uncertainty. This finding remains consistently significant even after controlling for various firm-specific factors that may shape their risk-taking decisions and unobservable time-variant shocks from the industries and locations where they operate. These results seemingly imply fuelled incentives among firms to engage in riskier activities when they are susceptible to heightened foreign demand uncertainty. While we cannot completely negate such uncertainty's possible effects to mitigate corporate risk-taking, these effects are likely subdued by those increasing corporate risk-taking. By employing several approaches to address endogeneity concerns and alternative measures of key variables to ensure the robustness of our results, this finding remains qualitatively unchanged. Nonetheless, the estimates for firms' dynamic responses suggest that their risk-taking adjustments under foreign demand uncertainty appear to be a transitory adaptation rather than a permanent shift.

Secondly, we explore the potential mechanisms through which foreign demand uncertainty

impacts corporate risk-taking. Our results suggest at least two mechanisms. First, We hypothesize that firms' incentive to seek alternative profit sources when foreign demand uncertainty reduces their revenue might compel them to engage more greatly in high-risk behaviors. Using either firms' revenue from core business or their profit reliance on financial transactions as mediating variables, we find consistent results indicating that these variables play a significant role in translating the effects of foreign demand uncertainty into corporate risk-taking. Furthermore, we propose that firms' exacerbated financing constraints induced by greater foreign demand uncertainty lead them to assume higher risks to overcome the adverse effects of increased financing costs. By employing both firms' interest payments and offered trade credit as indicators of financing constraints, we find consistent results supporting this hypothesis.

Lastly, for a more nuanced understanding for potentially heterogeneous effects of foreign demand uncertainty on different firms, we specifically investigate the roles of firms' managerial capacity and technological intensity. We find that firms with superior managerial capacities exhibit greater tendency to undertake higher risk when facing increased uncertainty in external markets. This is likely attributable to their expertise in coping with operational risks, agility in adapting to changing market conditions, and navigating complex environmental uncertainties, which consequently emboldens them to assume higher risk to exploit growth opportunities that exist within uncertainty shocks. Additionally, we find that the risk-taking of firms with higher technological intensity also increases more conspicuously with foreign demand uncertainty.

This study differs from some previous ones in the following dimensions. Firstly, many prior works focused on internal or domestic factors that affect corporate risk-taking behaviors, e.g., firms' size, ownership identity, creditor protection, religious tradition, etc. However, the existing literature leaves the impact of external or foreign factors under-explored. Based on these earlier studies, we incorporate foreign demand uncertainty, a ubiquitous concern of exporting firms, into analysis. Secondly, our work also belongs to the literature of "second moment shocks" (Bloom, 2009; Baker and Bloom, 2013), which emphasizes changes in the uncertainty (or say, volatility), rather than the mean, of foreign demand for exported goods. Many works have documented significant effects of uncertainty on various economic activities, such as production, investment, consumption, and social welfare (Bloom et al., 2007; Gilchrist et al., 2014; Christelis et al., 2020; Ludvigson et al., 2021; Chikhale, 2023). However, how uncertainty stemming from external markets affects firms' risk-taking remains a question to

be answered.

Thirdly, while the concept of trade *policy* uncertainty has been widely explored in the literature (Caldara et al., 2020; Handley and Limão, 2017, 2022), our notion of foreign demand uncertainty implicitly encompasses a broader range of factors that could affect the volatility of external demand for exported goods. More than the unpredictability of governmental trade-related decisions and regulations, it can also capture other sources of uncertainty, such as shifts in consumer preferences, fluctuations in exchange rates, supply-chain instabilities, and geopolitical events. Nonetheless, we also recognize that foreign demand uncertainty is not entirely divorced from trade policy uncertainty. Rather, our approach may offer a valuable intermediary link between broad trade policy uncertainty shocks and individual firm behaviors: Uniform trade policy uncertainty may be translated into heterogeneous firm-specific foreign demand uncertainty shocks, which in turn lead to varying responses.

Lastly, our study also enriches the literature associated with the effects of trade uncertainty on Chinese firms (Feng et al., 2017; Facchini et al., 2019; Alessandria et al., 2024; Rodrigue et al., 2024). While predominantly focused on trade policy uncertainty, previous literature has documented rich evidence regarding its impact on various corporate activities, such as export participation, production input allocation, and investment decisions. In contrast, our study provides a novel perspective by examining the effects of demand uncertainty on firms' risk-taking behavior. As firms' reduced investments and other economic activities in response to increased uncertainty might mask the underlying risk in their decisions, our research provides insights into Chinese firms' potential stability in uncertain market environments.

The rest of this paper is organized as follows. Section 2 provides a concise review of existing literature, which forms the basis for developing our research hypotheses. Section 3 introduces our data, model, and key variables. In Section 4, we present our baseline results, followed by analyses to address endogeneity concerns and secure the robustness of our findings. Section 5 further explores some potential mechanisms through which foreign demand uncertainty could influence corporate risk-taking. Section 6 examines heterogeneous effects of foreign demand uncertainty across firms with heterogeneous managerial capacity and technological intensity. Section 7 concludes.

## 2. Literature and hypotheses

### *2.1. Related literature*

Despite varied definitions in the existing literature, corporate risk-taking generally refers to firms' decisions to engage in activities, projects, or investments that have the potential for lucrative returns but also carry the possibility of significant losses.[2] Prior studies have widely acknowledged that firms' risk-taking preferences underlie their heterogeneous decisions regarding investments, hiring, market participation, business diversification, R&D, among others (Bromiley, 1991; Shapira, 1995). These decisions, in turn, impact not only the firms' value (e.g., Shin and Stulz (2000); John et al. (2008)) but also broader economic growth (e.g., Acemoglu and Zilibotti (1997)).

A long list of studies has extensively explored various determinants that explain firms' risk-taking behavior. A significant portion of these works examines the influence of institutional strength, such as the power of institutional investors (Wright et al., 1996), investor protection (John et al., 2008), creditor rights (Acharya et al., 2011), national culture and religiosity (Li et al., 2013; Illiashenko, 2019; Hilary and Hui, 2009; Jiang et al., 2015). Some other works study the relationship between firms' risk-taking and their specific characteristics, e.g., ownership identity (Boubakri et al., 2013a), political connectedness (Boubakri et al., 2013b), firm size (Bhagat et al., 2015), leverage (Milidonis and Stathopoulos, 2014), CEO gender (Faccio et al., 2016), board composition (Berger et al., 2014), etc. Additionally, a few works examine the effects of macroeconomic conditions; for example, Gupta and Krishnamurti (2018) find that firms' risk-taking in response to oil price changes is conditional on different macroeconomic outlooks. While these studies provide valuable insights into how internal and domestic contexts shape corporate risk-taking, the influence of *external* factors—particularly those arising from firms' *foreign* markets—remains unclear.

Despite the widely recognized importance of market demand for exporters' wealth and success (e.g., Hottman et al. (2016); Kramarz et al. (2019); Fitzgerald et al. (2023)), the impact of demand uncertainty, also known as "second moment shocks", on these firms' decision-making is a question to be fully answered.[3] Particularly, within the relatively

[2]We implicitly assume that firms' risk-taking behaviors indicate their risk-taking attitudes. See Schoemaker (1993) for an example distinguishing risk-taking behaviors from risk-taking propensities.

[3]Some extant works address the effects of "first moment shocks", i.e., fluctuations in the mean level of demand for exported goods, on exporters' performance (e.g., Dhyne et al. (2021), Aghion et al. (2018), and Panon (2022)).

modest body of research on the effects of foreign uncertainty on exporters, Esposito (2022) theoretically analyzes the impetus of demand uncertainty on firms' strategies to diversify export destinations.[4] Grier and Smallwood (2007) evaluate the effects of uncertainty arising from foreign income and real exchange rates. They find that both types of uncertainty significantly influence export growth. Cheung and Sengupta (2013) also explore the effects of exchange rate volatility—an indicator often used for uncertainty in exchange rates—on firms' export shares. Lewis (2014) identifies a positive association between inflation volatility in foreign markets and exports from producer countries. De Sousa et al. (2020) and Fan et al. (2023) provide supportive evidence that foreign demand uncertainty affects both market participation decisions and export sales of firms.[5]

While foreign demand uncertainty may originate from various sources, a substantial number of studies have focused on trade policy uncertainty, as it has become "a major source of economic uncertainty" (Handley and Limão, 2022). Many researchers, such as Handley (2014), Feng et al. (2017), Handley and Limão (2017), Crowley et al. (2018), Liu and Ma (2020), and Cui and Li (2023), examined the effects of trade policy uncertainty on export flows through the "extensive margin" (i.e., firms increase investments to enter new markets) and the "intensive margin" (i.e., incumbent firms upgrade technology). Commonly using China's accession to the WTO as an event that significantly mitigated trade policy uncertainty, they find that the reduction of trade policy uncertainty facilitates firms' market entry decisions, increases their investment, and leads to technological upgrades. These effects not only promote cross-border trade but also enhance consumer welfare.[6] Diverging from this stream of works, Facchini et al. (2019) address the impact of reduced trade policy uncertainty on the cross-city labor migration in China. Rodrigue et al. (2024) find that a reduction in trade policy uncertainty leads to a decrease in the "efficiency gap" in Chinese firms' input holding and a significant increase in firms' productivity. Caldara et al. (2020) construct a theoretical framework indicating sizable declines in consumption, output, exports, inflation, and interest rates in reaction to increased trade tensions. Rather than being limited to

[4] Esposito (2022) defines *uncertainty* as the variation in consumers' demand for firms' products, aligning this concept more closely with the notion of "first moment shocks".

[5] Novy and Taylor (2020), Nana et al. (2024), and some others have examined how a country's export changes with uncertainty in *domestic* environments, rather than uncertainty arising from external sources. Some researchers have also examined how uncertainty in the availability of imported inputs on international trade, e.g., Gervais (2018).

[6] In contrast, Steinberg (2019) assessed the impact of trade policy uncertainty introduced by Brexit, finding that the uncertainty had only a modest impact on macroeconomic dynamics and consumer welfare.

uncertainty associated with trade policy, the foreign demand uncertainty in our study can be implicitly attributed to various sources, such as government policy, exchange rate volatility, geopolitical tensions, etc.

### *2.2. Hypothesis development*

We contribute to the existing literature by investigating the impact of uncertainty arising from foreign markets to firms' risk-taking behavior. Extant theories offer competing predictions regarding this relationship. The theory of "real option" (Bernanke, 1983; McDonald and Siegel, 1986; Pindyck, 1988, 1991) suggests that, due to the irreversibility of investment, greater uncertainty increases the value of waiting, leading firms to postpone decisions related to investment and employment. Previous studies have documented theoretical and empirical findings that suggest a negative association between uncertainty and corporate investments (see Guiso and Parigi (1999), Carruth et al. (2000), Bloom et al. (2007), Bloom (2009), Kellogg (2014), Gulen and Ion (2016), Bloom et al. (2018), among many others). In line with the "real option" theory, if uncertainty from foreign markets obscures the outlook of exporting firms' revenues, these firms are likely to delay investment in risky projects until uncertainty diminishes. However, the theory of "real option" is questioned due to its premise that product markets are less competitive or even monopolistic (Kulatilaka and Perotti, 1998). Contrary to this theory, some studies propose an increase in investment amid higher uncertainty. Hartman (1972) provides a theoretical model in which firms increase or maintain their current investment levels when facing uncertainty in future output prices, wage rates, or investment costs. Abel (1983) suggests that the optimal rate of investment increases as heightened uncertainty raises the expected value of the future marginal valuation of capital. Bar-Ilan and Strange (1996) also point out that increased uncertainty can hasten firm investment when investment lags are present. Furthermore, while the "real option" view suggests a reduction in corporate investment under uncertainty, this does not necessarily imply a decrease in firms' risk-taking, as firms may compensate for reduced investment by assuming higher risks in the projects they choose to pursue.

Some perspectives based on "agency theory" also posit that increased uncertainty may lead to lower corporate risk-taking if it creates a business environment unfavorable to managers' interests. Jensen and Meckling (1976) argue that the "agency problem" is a core reason for a firm's under-investment decisions, leading to a value lower than optimal. Myers and Majluf (1984) present a model explaining how a firm might forgo valuable investment opportunities

when managers possess more information about the firm's value than investors. Hirshleifer and Thakor (1992) and Panousi and Papanikolaou (2012) suggest that when uncertainty creates a wedge between the managers' and shareholders' benefits, managers may underinvest and forgo value-enhancing risks for their own interests. In contrast, some other studies argue that managers with incentives to cause firms to overly grow in order for more power could make excessive investments (e.g., Harford (1999), Bates (2005), and Richardson (2006)). Despite the theoretical debates on whether managers are motivated to under- or over-invest, the existing literature suggests that the divergence between managers' and shareholders' interests can be mitigated by appropriate compensation policies or financing strategies that align managers' interests with those of shareholders (e.g., Jensen (1986) and Low (2009)). Therefore, from the perspective of "agency theory," it remains ambiguous whether managers would assume higher or lower risk amid increased uncertainty.

Firms might adopt a precautionary approach in the face of foreign demand uncertainty by increasing their cash reserves. Carroll and Samwick (1998), Giavazzi and McMahon (2012), and Sinha (2016) all document evidence that households increase precautionary savings in response to various uncertainty shocks. As the increase in precautionary savings reduces available funding for high-risk investments, this saving-increasing effect of uncertainty may represent a lower risk-taking incentive among economic agents. However, uncertainty might also increase firms' financing costs as creditors may charge higher risk premiums during uncertain periods. A series of studies, such as Popp and Zhang (2016), Arellano et al. (2019), Correa et al. (2023), and Alfaro et al. (2024), find that uncertainty shocks lead to a significant widening in credit spreads. This, in turn, may drive firms to engage in riskier projects or investments in an effort for higher returns to cover increased financing costs if their precautionary savings are insufficient. In other words, increased financing costs amid uncertainty could yield a risk-increasing effect, which offsets the risk-reducing effect associated with precautionary savings.

Some studies provide underpinnings for a positive relationship between foreign demand uncertainty and corporate risk-taking. Amid increasing demand uncertainty from firms' export destination markets, they face heightened challenges in accurately forecasting revenues from overseas and, consequently, their aggregate revenues. This uncertainty, coupled with the typically rigid return targets set by shareholders, creates a predicament that may compel firms to engage in more "high-risk, high-return" projects to compensate for potential shortfalls. While these activities could offer the prospect of additional income, they inherently

elevate the firm's overall risk profile. Esposito (2022) suggests that firms mitigate demand shock originating from a market by exporting goods to alternative markets with imperfectly correlated demand. Similarly, Kim et al. (2006) suggest that multinational firms can leverage diversified geographical presence to hedge risks. Aivazian et al. (2019) find that firms can diversify their products to mitigate the detrimental impact of unanticipated economic disruptions. Demir (2009) examines the investment decisions of firms in the context of increasing uncertainty. He finds that, rather than investing in irreversible long-term fixed assets, firms may invest in reversible short-term financial assets, thereby increasing their exposure to financial risk. Based on a sample of banks in emerging economies, Wu et al. (2020) find supportive evidence that banks proactively assume higher risk when economic uncertainty soars. This effect is particularly more pronounced in banks under greater return pressures. These empirical works all shed light on the possibility that firms may opt for risky activities to seek higher payoffs to offset the potential income reduction from overseas.

The "growth option" theory also proposes an increase of corporate risk-taking amid higher uncertainty in foreign demand. In contrast to the "real option" theory, this view argues that uncertainty represents opportunities and hence encourages firm to increase investment to gain advantageous status in the future. Furthermore, the value of option to wait during uncertain periods can be considerably eroded due to competition, which allows "first movers" to gain preemptive advantages vis-a-vis their slower competitors. Kulatilaka and Perotti (1998) point out that when product markets are competitive, "immediate action may discourage entrants and enhance market share and profits." Grenadier (2002) suggests that in a context where competitors consider others' decisions, uncertainty leads firms to make investments on projects with near-to-zero net present values, rather than those with large positive net present values as predicted by the "real option" theory. Baum et al. (2010) find that uncertainty creates an investment-increasing impetus in firms with richer cash flows, seemingly implying that these firms have a stronger motivation to exploit the "growth option" of uncertainty. Aligning with these documented results, we posit that the urgency to secure a "first mover" advantage in an uncertain environment may drive firms to act swiftly, investing in projects that may increase their overall risk profile.

Based on the above literature, we propose our baseline hypothesis as follows:

***H1.a:*** *Higher (lower) foreign demand uncertainty leads to an increase (decrease) in firms' risk-taking.*

***H1.b:*** *Higher (lower) foreign demand uncertainty leads to an decrease (increase) in*

*firms' risk-taking.*

We also investigate whether firms adjust their risk-taking behavior for the purpose of profit substitution. If demand uncertainty from foreign markets leads to decreased revenues, it may prompt firms to seek alternative income sources, even if this may increase their risk exposure. First, we assess whether a rise in foreign demand uncertainty results in reduced revenues from firms' core businesses and then determine if this reduction in core revenues contributes to increased corporate risk-taking. Second, we specifically examine whether heightened foreign demand uncertainty enhances the significance of financial assets in generating firms' profits. Some studies suggest that firms may turn to financial transactions in search of higher returns to compensate for diminished conventional income (Krippner, 2005; Demir, 2009; Tori and Onaran, 2018; Jin et al., 2022), which could, in turn, expose them to greater risks in financial markets. We propose the following hypothesis:

***H2:*** *Higher (Lower) foreign demand uncertainty leads to an increase (decrease) in firms' risk-taking by fueling (mitigating) their incentives of profit substitution.*

Lastly, we test whether financing constraints may also drive firms to assume higher risk when facing foreign demand uncertainty.[7] Gulen and Ion (2016) highlight that an uncertain environment can significantly exacerbate firms' financial constraints. As the increasingly obscure prospects in a firm's income from abroad may make it arduous for creditors (e.g., banks) to evaluate its creditworthiness, this firm may face widening credit spreads when seeking external financing. However, how firms' risk-taking would vary in response to tightened credit constraints remains unclear in the literature. Firms might engage in risky ventures for speculative returns to cover rising financing costs, or become more cautious and forgo valuable investment opportunities (Campello et al., 2010). Employing firms' financing costs as a proxy of financial constraints, we examine whether foreign demand uncertainty increases their financing costs, which, consequently, induces higher risk-taking. To secure our findings, we also use trade credit as an alternative indicator of corporate financing constraints. We propose the following hypothesis:

***H3:*** *Higher (Lower) foreign demand uncertainty leads to an increase (decrease) in firms'*

[7]It is important to note that a single paper cannot capture all possible mechanisms through which foreign demand uncertainty affects firms' risk-taking behavior. For instance, we do not specifically address the potentially competing effects of "agency problems" in either facilitating or hindering these impacts due to the challenge of obtaining precise indicators to measure the severity or complexity of agency problems. We will explore alternative channels in future research.

*risk-taking by exacerbating (alleviating) their financial constraints.*

## 3. Data, model, and variables

### *3.1. Data*

Given the availability of required data, we employ Chinese listed companies as the sample. We utilize various data sources to construct our main variables. Information on firms' financial performance and corporate governance is provided by the China Stock Market and Accounting Research Database (*CSMAR*). Our sample selection follows common practices in related literature. First, we exclude firms labeled as special treatments (e.g., ST, *ST). Second, we eliminate financial firms, such as commercial banks, insurance companies, securities companies, and other financial intermediaries. We also exclude firms that do not participate in international trade, specifically those without any export records over the years. Lastly, we remove firms that lack the necessary information for key variables.

We gauge foreign demand using information on the HS 6-digit products from the CEPII's *BACI* database.[8] This database tracks the trade flow of individual products from their respective home countries to various destination markets over the years. Additionally, we gather data from Chinese customs to obtain information on various products from specific Chinese firms over the sample years. This enables us to construct firm-level indicators of foreign demand uncertainty based on product-destination-year-specific information. By merging data on firms' risk-taking and other characteristics with data on the foreign demand uncertainty that these firms face, we obtain a sample set comprising 19,981 firm-year-specific observations from 1,784 non-financial firms in China.[9]

Note that after 2016, Chinese customs discontinued providing detailed information regarding firms' product-specific exports to individual destination markets. This limitation prevents us from constructing firm-specific foreign demand uncertainty indicators based on the varieties of exported goods and the significance of foreign markets. Recognizing these constraints, we have truncated our sample period to cover the years from 2001 to 2016.[10]

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[8]The Harmonized System (HS), administrated by the World Customs Organization (*WCO*) and used by customs authorities worldwide, assigns standard 6-digit codes to classify traded products.

[9]To minimize the influence of outliers, we have winsorized the firm-specific variables (except binary variables) at the 1% level in each tail of the sample distribution.

[10]To mitigate potential concerns on the robustness of our findings beyond the sample period, we alternatively

### *3.2. Model*

We employ a two-way fixed-effects estimator to assess the influence of foreign demand uncertainty on firms' risk-taking behavior. The specification of our empirical model is presented below:

$$Risk_{it} = \alpha + \beta ForeignUncertainty_{it} + \sum_{n} \mu_n CV_{it} + \gamma_i + \delta_t + \theta_{jt} + \vartheta_{pt} + \varepsilon_{it} \qquad (1)$$

where $i$ and $t$ refer to firm and year, respectively. The dependent variable, $Risk_{it}$, denotes the level of risk-taking for firm $i$ in year $t$. $ForeignUncertainty_{it}$ represents firm-specific, time-varying demand uncertainty arising from the destination markets of exporting firms. $CV_{it}$ is a vector of firm-specific characteristics that may influence their risk-taking appetites. To control for the effects of unobservable firm characteristics and temporal factors, we incorporate firm-specific fixed effects $\gamma_i$ and year-specific fixed effects $\delta_t$ in our specification. Additionally, we include industry-year fixed effects $\theta_{jt}$ and province-year fixed effects $\vartheta_{pt}$ to mitigate the influence of unobservable or unmeasurable shocks emerging from the industries in which firms operate and the locations where they are based. The term $\varepsilon_{it}$ represents idiosyncratic errors. In our estimations, we use heteroskedasticity and within-panel serial correlation robust standard errors, and cluster standard errors at the industry-level.[11]

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develop an *industry*-level indicator for foreign demand uncertainty and extend our sample period to 2022. Refer to Section 4.4 for details.

[11]We acknowledge both the advantages and limitations of using a sample of firms exclusively from China in this research, compared to existing cross-country analyses in the related literature. On the one hand, focusing on a single country allows us to exclude country-specific determinants of corporate risk-taking, such as variations in creditor protection, cultural norms, or religious traditions, which can differ significantly across countries but remain stable within one country over a relatively short period. Our approach also enables us to use time-varying year effects to control for country-level macroeconomic conditions (e.g., business cycles) and industry-year and province-year fixed effects to control for unobservable or unmeasurable factors that uniformly influence different firms within the same industry or location. On the other hand, however, limiting our sample to firms from one country raises concerns about the generalizability of our findings. While China, as the world's largest exporter, provides a suitable context for this research, our results may not be fully applied to firms in other countries (with different legal systems, institutional environments, or other country-specific risk determinants). Therefore, although our results offer valuable insights into the relationship between foreign demand uncertainty and corporate risk-taking, we recognize that they should be interpreted with caution. Further cross-country research is necessary to appraise the robustness of our findings in alternative national contexts.

### *3.3. Variables*

#### *3.3.1. Corporate risk-taking*

Following prior studies (e.g., John et al. (2008); Hilary and Hui (2009); Faccio et al. (2011); Boubakri et al. (2013a,b); Li et al. (2013); Ding et al. (2017) and many others), we posit that firms' risk-taking propensities play a pivotal role in their business decisions, such as venturing into projects with uncertain outcomes, expanding into unfamiliar areas, engaging in financial transactions, or increasing expenditure on R&D.[12] These activities, in turn, can create significant fluctuation in their returns. We use the industry-adjusted volatility of a firm's earnings over a four-year overlapping period, denoted as ($Risk1$), as the primary measure of its risk-taking. Specifically, this measure is based on firms' return on assets (earnings before interest and taxes ($EBIT$) as a share of total assets) and computed as follows:

$$Risk1_{it} = \sqrt{\frac{1}{T-1}\sum_{t-1}^{T}\left(E_{it} - \frac{1}{T}\sum_{t-1}^{T} E_{it}\right)^2}\Big|_{T=4} \tag{2}$$

where industry-adjusted earnings $E_{it} = \frac{EBIT_{it}}{TotalAssets_{it}} - \frac{1}{N_{kt}}\sum_{j=1}^{N_{kt}} \frac{EBIT_{jkt}}{TotalAssets_{jkt}}$. Here, $N_{kt}$ denotes the number of firms within industry $k$, to which firm $i$ belongs, in year $t$.[13]

Note that $Risk1$ possesses some attractive merits as a measure of corporate risk-taking. As it is based on earnings *before* interest and taxes, this indicator better reflects the risk-taking inherent in firms' business decisions, rather than financial risks (such as interest risk) or risks introduced by government tax policies (Ljungqvist et al., 2016). Moreover, unlike some indicators that incorporate the information about firms' liabilities (e.g., the distance to default metric proposed by Merton (1974)), the volatility of returns is less susceptible to variations in firms' leverage and debt. Additionally, adjusting a firm's earnings by using the industrial mean level facilitates more meaningful comparisons of corporate risk-taking across different industries.

To secure the robustness of our findings, we follow prior literature (e.g., Cheng (2008);

[12]Firms' expenditure on R&D is often employed as a measure of corporate risk-taking in earlier studies (e.g., Coles et al. (2006); Bargeron et al. (2010); Li et al. (2013)).

[13]The industry in which a firm operates is identified according to *China National Industry Classification*.

Low (2009); Boubakri et al. (2013a,b)) by employing some alternative indicators of corporate risk-taking, namely $Risk2$, $Risk3$, and $Risk4$. A more detailed explanation of their definitions and construction is provided in Section 4.3.

### *3.3.2. Foreign demand uncertainty*

Our methodology for measuring foreign demand uncertainty aligns with the practices established in Bricongne and Gigout (2019), Esposito (2022), and Garin and Silvério (2023). Utilizing information from CEPII's *BACI* database, we observe a set of destination foreign markets $N$ that import a variety of products $P$ from exporting countries $M$ (except China) over $T$ years. Let $V_{pmnt}$ denote the imports of product $p$ from a non-China exporting country $m$ to importing country $n$ in year $t$, which reflects the size of the $(p, n)$ export market in year $t$. It is important to note that excluding China's exports from $V_{pmnt}$ helps eliminate sources of variation originating from China. This mitigates potential endogeneity concerns as the subsequently estimated idiosyncratic shocks on $V_{pmnt}$—and then our indicator of foreign demand uncertainty—are not correlated with Chinese firms. As recommended by previous research (e.g., Barrows and Ollivier (2021) and Aghion et al. (2024)), this approach allows the changes in country $n$'s imports of product $p$ from all countries other than China to be a proper proxy for exogenous changes in foreign demand faced by Chinese firms.[14] We calculate the Davis-Haltiwanger growth rate, i.e., $\Delta V_{pmnt} = \frac{(V_{pmnt} - V_{pmnt-1})}{\frac{1}{2}(V_{pmnt} + V_{pmnt-1})}$, to capture the year-to-year growth in market demand for product $p$ in country $n$.

We assume that the variation in $\Delta V_{pmnt}$ can be attributed to market fundamentals, a bilateral product trend and idiosyncratic demand shocks:

$$\Delta V_{pmnt} = \beta_1 \Delta V_{pmt} + \beta_2 \Delta V_{pnt} + \gamma_{nt} + \delta_{pmn} + \mu_{pmnt} \tag{3}$$

In this equation, $\Delta V_{pmt}$ represents the growth rate of exports of product $p$ from country $m$ to all other countries, thereby controlling for the supply shocks in the exporting country $m$. $\Delta V_{pnt}$ denotes the growth rate of imports of product $p$ by country $n$ from the rest of the world, which accounts for the aggregate demand for good $p$ regardless of the exporting countries. $\gamma_{nt}$ is a country-year time-invariant factor that controls for national conditions in

[14] One potential concern is that a Chinese exporter might have a dominant market position in importing country $n$. To mitigate this concern, we experiment with excluding Chinese firms with a market share exceeding 10% in a foreign market. The result is presented in Section 4.3.

the importing country $n$ in year $t$.[15] The term $\delta_{pmn}$ is a time-invariant fixed effect for the export of product $p$ from country $m$ to country $n$, which controls for the specific bilateral pattern in the trade flow of $p$ between these two countries.[16] The residual term, $\mu_{pmnt}$, represents the unanticipated shocks in the demand growth of product $p$ in importing country $n$, which cannot be explained by market fundamentals or bilateral trade patterns.

To validate that our model specified in Eq.(3) effectively captures the idiosyncratic demand shocks for imported good $p$ in country $n$, we check whether the distribution of the residual term $\mu_{pmnt}$ exhibits some expected properties. In Figure 2, we present the cumulative distribution of $\mu_{pmnt}$ (see Panel A) and then the distribution of this term after further excluding the product-specific and the industry-year-specific fixed effects (see Panel B). For both distributions, we observe that the mean value is indifferent from zero. Moreover, the distribution closely approximates a normal distribution, without noticeable skewness or concentration patterns. These observations are consistent with our anticipations, providing supportive evidence that our model adequately accounts for the relevant factors influencing demand in foreign markets and thus effectively estimates the idiosyncratic demand shocks.

[Figure 2 about here.]

We next measure the dispersion of $\mu_{pmnt}$ as it reflects the extent of uncertainty to which this shock appears. Specifically, we calculate the "first moment", i.e., the sector-destination-year mean value of $\mu_{pmnt}$ as $\bar{\mu_s} \equiv \frac{1}{N_f} \sum_{p \in s} \mu_{pmnt}$, where $s$ denotes the sector in which product $p$ is classified by *BACI*, and $N_f$ represents the number of non-zero trade flows in the sector-destination-year triplet. We then compute the "second moment" of the distribution of $\mu_{pmnt}$, which is interpreted as the uncertainty of the idiosyncratic demand shocks for product $p$ in country $n$:

$$Dispersion_{psnt} = \sqrt{\frac{1}{N_f - 1} \sum (\mu_{pmnt} - \bar{\mu_s})^2} \tag{4}$$

Note that Eq.(4) measures the deviation of an idiosyncratic demand shock on product $p$ from the *sector*-level average. This is because products classified within the same sector are

[15] $\Delta V_{pmt}$, $\Delta V_{pnt}$, and $\gamma_{nt}$ can be considered market fundamentals that explain the demand growth for product $p$ in importing country $n$.

[16] For example, $\delta_{pmn}$ may capture country $n$'s tendency for importing product $p$ from country $m$ due to a technology gap between these two countries (Bricongne and Gigout, 2019). To distinguish the *uncertain* variation in demand for product $p$, we remove this stable trade flow pattern as it is *certain*. Furthermore, failure to remove this pattern could artificially inflate the dispersion of the idiosyncratic demand shocks.

highly similar and likely treated as substitutes.[17] The intuition underlying our approach is that demand uncertainty for a product may be influenced by idiosyncratic demand shocks on its close substitutes. We also compute alternative measures for $Dispersion_{psnt}$ using the distance between different distributional percentiles. Specifically, we calculate the spread between the $75^{th}$ and $25^{th}$ percentiles (i.e., $\mu^{75}_{psnt} - \mu^{25}_{psnt}$).[18] We denote our indicator based on this alternative spread as $ForeignUncertainty2$, and use it in Section 4.3 to confirm our findings.

Following common practices in the literature (e.g., Mayer et al. (2021) and Aghion et al. (2024)), we convert the product-sector-destination-year measure of demand uncertainty (i.e., $Dispersion_{psnt}$) into a firm-year-specific indicator of foreign demand uncertainty faced by Chinese exporting firms. This is done by weighting $Dispersion_{psnt}$ according to a firm's market share in importing countries and its export dependency, as represented by the following equation:

$$ForeignUncertainty1_{it} = \left(\frac{\bar{X}_{it}}{R_{it}}\right)\left(\frac{1}{N^i}\right)\sum_{n=1}^{N^i}\left(\frac{\bar{X}_{ipnt}}{X_{ipt}}|_{p\in s} \times Dispersion_{psnt}\right) \tag{5}$$

Specifically, we first weight $Dispersion_{psnt}$ using $\frac{\bar{X}_{ipnt}}{X_{ipt}}$, which denotes the averaged value of exports of products $p$ (belonging to sector $s$) by firm $i$ to destination market $n$ as a share of the firm's total exports of product $p$ over the sample period. This term reflects the exposure of destination market $n$ within the export portfolio of Chinese firm $i$. We then average the weighted $Dispersion_{psnt}$ across firm $i$'s export portfolio, which includes $N^i$ different products. Lastly, we weight the results by the firms' dependency on foreign sales, proxied by the averaged value of firm $i$'s foreign sales ($X_{it}$) as a share of its total revenue ($R_{it}$) over the

[17] We identify the products within the same sector by using the first four digits of HS codes. For instance, products classified under HS code 6101 include woolen knitted or crocheted men's overcoats, carcoats, windbreakers, capes, cloaks, anoraks, raincoats, and similar articles. We also experiment with using the first three digits to define products within the same sector. For instance, the goods categorized under HS code 610 encompass not only those initially classified under HS code 6101 but also those under 6102, which include woolen knitted or crocheted women's overcoats, carcoats, windbreakers, capes, cloaks, anoraks, raincoats, and similar articles. Analogously, products initially grouped under HS codes 6103, 6104, and so forth are also classified within the same sector. We find that our results remain qualitatively unchanged and statistically significant.

[18] Using the spread betwee the $90^{th}$ and $10^{th}$ percentiles (i.e., $\mu^{90}_{psnt} - \mu^{10}_{psnt}$) does not significantly change our conclusions.

sample years.[19]

We anticipate that uncertainty shocks arising from a firm's exposure to multiple foreign markets are infrequent rather than regular occurrences. These shocks are expected to be modest most of the time, reflecting general stability in foreign markets. However, certain firms may experience rare but substantial spikes in uncertainty during specific periods. This pattern is likely to result in a distribution of foreign demand uncertainty where the majority of observations cluster at lower levels, with a relatively fat tail representing the occasional severe shocks. Consistent with our expectations, we observe noticeable skewness in the distribution of $ForeignUncertainty1$ (refer to Table 1), as evidenced by a mean value that notably exceeds the median. While our fixed effects estimator remains unbiased and consistent, the skewness in $ForeignUncertainty1$ impacts the efficiency of our estimates, leading to the problem of heteroskedasticity and inefficiency. To address these issues and secure the reliability of our findings, we employ two approaches. First, as mentioned before, we use heteroskedasticity and within-panel serial correlation robust standard errors, and cluster standard errors at the industry-level. Second, we apply the Box-Cox transformation (Box and Cox, 2018) to reduce non-normality and heteroskedasticity in $ForeignUncertainty1$. Specifically, we denote the transformed variable as $ForeignUncertainty3$, calculated as: $ForeignUncertainty3_{it} = \frac{ForeignUncertainty1_{it}^{\lambda} - 1}{\lambda}$, where $\lambda$ is set at 0.119 to minimize skewness and achieve the best approximation of a normal distribution. In Section 4.3, we present consistent results using $ForeignUncertainty3$ as the indicator of foreign demand uncertainty.

Our indicator of foreign demand uncertainty presents both advantages and disadvantages, particularly when compared to some prior measures of trade policy uncertainty. First, numerous studies (e.g., Pierce and Schott (2016), Feng et al. (2017), Facchini et al. (2019), Bao et al. (2022), Alessandria et al. (2024), and Rodrigue et al. (2024)) have utilized the Normal Trade Relations (NTR) gap—the gap between the worst-case tariff and the applied

[19]We use the sample average values of $\frac{\bar{X}_{ipnt}}{X_{ipt}}$ and $\frac{\bar{X_{it}}}{R_{it}}$ for the weights in Eq.(5), unlike some previous studies (e.g., Bricongne and Gigout (2019) and Barrows and Ollivier (2021)) that use values from a year before the sample period. This approach is justified for several reasons: First, our sample period begins in 2001, the year China joined the WTO, and covers a range up to 2016. Trade patterns of Chinese firms significantly changed after 2001, so values prior to the sample period may not accurately indicate firms' foreign market shares and export dependency. Second, it is necessary for the weights in Eq.(5) to remain constant, ensuring that variation in the measured foreign demand uncertainty (i.e., $ForeignUncertainty1$) is attributable solely to changes in the uncertainty of idiosyncratic demand shocks (i.e., $Dispersion$). Using the sample average values for these weights fulfills this requirement.

tariff—as a proxy for the severity of trade policy uncertainty. Due to data limitations, this approach is mostly applied in research focusing on the trade policy uncertainty faced by Chinese exporters vis-a-vis the United Sates.[20] Our approach diverges from these studies by leveraging detailed data on firms' exports to all foreign markets, with varying shares of foreign markets in their export portfolios, thereby creating a comprehensive measure of uncertainty stemming from demand in all external markets relevant to individual firms. Second, some research adopted a textual approach to gauge trade policy uncertainty faced by Chinese firms by counting the frequency of specific trade-policy-related keywords in major Chinese newspapers (Davis et al., 2019; Huang and Luk, 2020). This type of indicators is recognized for not imposing "any prior view on whether the source of policy uncertainty is domestic or foreign" (Huang and Luk, 2020). Caldara et al. (2020) constructed a firm-level indicator of trade policy uncertainty by applying text analysis to firms' earnings calls. However, measurements based on text analysis are often influenced by firms' subjective sentiment, which may not accurately reflect the underlying economic reality. In contrast, our indicator, which utilizes trade-flow data in real world, offers an objective measure of foreign demand uncertainty which is less susceptible to subjective biases. Lastly, while our indicator captures the complex and multifaceted nature of uncertainty in cross-country trade, we recognize that it is unable to explicitly identify the sources from which foreign demand uncertainty arises, unlike indicators specifically focused on uncertainty originating from trade policy.

#### *3.3.3. Other variables*

In line with existing literature on the determinants of corporate risk-taking, we incorporate a series of firm-specific characteristics (i.e., $CV$ in Eq.(1)) that are potentially correlated with foreign demand uncertainty and may influence firms' risk-taking behavior. Specifically, these characteristics include:

***Size:*** Firm size is measured by the natural logarithm of total assets. Large firms typically benefit from greater market power, economies of scale, and favorable political connections, possibly weakening their prudence towards excessive risk. However, as noted by Hadlock and Pierce (2010) and Garcia-Appendini and Montoriol-Garriga (2013), large firms often face fewer financial constraints, which may diminish their risk-taking incentives.

***Age:*** Firm age is defined as (the logarithm of) the number of years since the firm's

[20]These studies largely employed a DID approach, assuming a significant decrease in trade policy uncertainty after 2001 compared to prior years, but not quantifying its variation over time.

founding. Firms with longer operating history may possess a more established reputation and richer market information, which could influence their appetite for risky ventures.

***Leverage:*** A firm's leverage is measured as the ratio of total liabilities to total assets. Traditional corporate finance views suggest that equity holders in highly leveraged firms have an incentive to increase asset risk, as they benefit from the upside of risky activities while debt holders bear the downside losses (Jensen and Meckling, 1976). Seta et al. (2020) and Chen and Duchin (2022) find consistent evidence that highly leveraged firms significantly increase their investments in risky financial assets.

***Book-to-market ratio:*** The book-to-market ratio, defined as the ratio of a firm's book value to its market value, serves as an indicator of market expectations regarding future growth. Prior research, such as Hovakimian et al. (2004), suggests that firms with lower book-to-market ratios are generally more inclined to avoid risks.

***ROA:*** Return on assets (ROA) is employed to measure a firm's profitability. Higher ROA values may reflect firms' superior ability to achieve higher profits with a given amount of assets, thereby potentially discouraging speculative investments in risky projects.

***Production costs:*** Production costs are measured as the growth rate of a firm's manufacturing costs, including expenses related to raw materials, labor, and overhead. Controlling for firms' production costs mitigates the impact of supply shocks on our estimates. If firms perceive rising production costs as another source of uncertainty, they may adopt a more conservative risk-taking stance (Gupta and Krishnamurti, 2018).

***Tax burden:*** The tax burden is proxied by the ratio of total tax paid to revenue. Hanlon and Heitzman (2010) reviewed research on the impact of taxes on various corporate decisions, including investment, financing, and mergers and acquisitions. Shevlin et al. (2019) documented that firms may alter their business activities to minimize tax liabilities in response to changes in government tax policy.

***Tangibility:*** Tangibility is defined as the proportion of a firm's assets that are tangible, such as property, plant, and equipment. Since tangible assets can be more accurately valued and easily recaptured by creditors in the event of default, a higher proportion of such assets may facilitate easier access to financing (Almeida and Campello, 2007), which in turn can affect a firm's risk-taking incentives.

***State ownership:*** State ownership is captured by a binary variable equal to 1 if a firm

is ultimately state-owned, and 0 otherwise. Boubakri et al. (2013a) find state ownership is negatively associated with corporate risk-taking, probably due to government interventions aimed at maximizing social stability or employment, which may constrain state-owned firms' ability to engage in risky investments. On the other hand, Borisova et al. (2015) observe that state-owned firms experience higher credit spreads in tranquil periods but lower spreads during crises.

***Board Size:*** Board size is measured by (the natural logarithm of) the number of board directors in the current year. While larger boards may offer a more diverse range of expertise, they may also face challenges in reaching consensus, leading to ambiguous effects on corporate risk-taking. For example, Cheng (2008) find that firms with larger boards exhibit lower performance volatility, while Coles et al. (2008) identify a U-shaped relationship between Tobin's $Q$ and board size.

***Director age:*** We also control for the average age of board directors in the current year. Older directors might bring more experiential wisdom but a tendency towards conservatism in corporate decision-making, whereas younger directors may bring a more adventurous spirit and a higher tolerance for risks.

***CEO tenure:*** Simsek (2007) points out that CEO tenure can affect corporate performance by shaping the top management team's risk-taking propensity. We measure CEO tenure using the number of years the current CEO has held the position. Longer-tenured CEOs may exert greater influence over the firm's strategies and encounter less opposition when pursuing risky projects.

***CEO duality:*** Lastly, we control for CEOs' power by using the indicator of CEO duality, a binary variable equal to 1 if a CEO also serves as the board chair, and 0 otherwise. Based on the premise that firm risk arising from the CEO's judgment errors cannot be adequately diversified when the CEO wields excessive power, Adams et al. (2005) find consistent evidence that stock returns are more volatile in firms run by powerful CEOs.

### *3.4. Descriptive statistics*

We present the major descriptive statistics of our main variables in Table 1.

[Table 1 about here.]

When measuring the level of corporate risk-taking by using the four-year earnings volatility

metric, $Risk1$, we observe a mean (median) value of 0.036 (0.022). The range of $Risk1$ spans from the minimum 0.002 to the maximum 0.231, with a standard deviation of 0.039, indicating noticeable variation in firms' risk-taking behaviors. Although not explicitly reported, the within-firm standard deviation is 0.038, while the between-firm standard deviation is 0.024. These results highlight significant variability in risk-taking behaviors both across firms and within individual firms over time. Similar distributional patterns are observed for the alternative indicators of corporate risk-taking (i.e., $Risk2$–$Risk4$).

Our primary measure of foreign demand uncertainty, $ForeignUncertainty1$, has a mean value of 0.027 and a standard deviation of 0.069. The within-firm standard deviation is 0.068, while the between-firm standard deviation is 0.024. These findings align with our expectations regarding the pattern of foreign demand uncertainty, which tends to be modest for most firms most of the time but may surge considerably during specific periods for certain firms. As mentioned before, the distribution of $ForeignUncertainty1$ exhibits notable skewness, as indicated by the mean value substantially exceeding the median (0.002) and an (unreported) Fisher-Pearson skewness coefficient of 4.505. A similar pattern is observed for $ForeignUncertainty2$, even though it employs an alternative method to measure the variability in idiosyncratic demand shocks. To mitigate concerns about the skewness in $ForeignUncertainty1$, we applied the Box-Cox transformation, resulting in $ForeignUncertainty3$, a measure with minimized skewness and approximate normality. The transformation significantly narrows the gap between the mean and median values, with the Fisher-Pearson skewness coefficient decreasing to -0.148.

Before conducting multivariate regression analyses, we perform a univariate examination comparing the means of our corporate risk-taking indices (and other variables) between subsamples with above- and below-mean (i.e., high and low) levels of foreign demand uncertainty. As presented in Table 2, we find that the mean values of our corporate risk-taking indicators are consistently higher in the subsample of firms exposed to greater foreign demand uncertainty. For example, the mean of $Risk1$ is equal to 0.039 for firms exposed to high foreign demand uncertainty, compared to 0.035 for firms under lower uncertainty, with the difference being statistically significant at 1% level. While these univariate tests provide preliminary support for our hypothesis regarding the impact of foreign demand uncertainty on corporate risk-taking, these results need to be interpreted with caution. Note that the means of corporate risk-taking indicators in different subsamples are quantitatively close yet statistically different, likely due to the sensitivity of $t$-test statistic to our large sample size.

Moreover, the minute difference in subsample means may suggest that the practical impact of foreign demand uncertainty on corporate risk-taking might be minimal.[21]

[Table 2 about here.]

In Table 3, we present a correlation matrix for our indicators of corporate risk-taking and foreign demand uncertainty. The correlation coefficient between $Risk1$ and $ForeignUncertainty1$ is significantly positive but quantitatively modest at 0.026. Even when we substitute other corporate risk-taking indicators, the correlation with $ForeignUncertainty1$ remains significant but similarly modest. This pattern also persists across different indices of foreign demand uncertainty. Notably, when using the transformed indicator, $ForeignUncertainty3$, we observe even negative and insignificant correlation coefficients with some measures of firm risk-taking. These findings highlight the importance of controlling for other potentially confounding variables to accurately assess the impact of foreign demand uncertainty on corporate risk-taking behaviors.

[Table 3 about here.]

## 4. Empirical results

### *4.1. Baseline results*

We present our baseline estimation results in Table 4, where the dependent variable is $Risk1$. In column (1), we include only our primary indicator of foreign demand uncertainty, $ForeignUncertainty1$, alongside firm-specific time-invariant effects and year-specific effects.[22] In column (2), we refine our estimation by adding firm characteristics to examine whether the estimated relationship between $Risk1$ and $ForeignUncertainty1$ is altered. Finally, in

[21] Most of the other variables also display different means across the high and low foreign demand uncertainty subsamples. In general, these mean differences are quantitatively small but statistically significant. These findings seemingly imply potential linkages between foreign demand uncertainty and these variables, underscoring the necessity of including them as covariates in our analysis.

[22] Year-specific fixed effects control for macroeconomic shocks or events that impact all firms simultaneously. We also experiment with replacing these year-specific fixed effects with various macroeconomic variables, such as real GDP growth rate, inflation rate, currency depreciation rate, and interest rates. Our main results remain qualitatively unchanged.

column (3), we further incorporate industry-year-specific fixed effects and province-year-specific fixed effects, which help to capture industry-wide demand shocks, regional economic policies, industry-specific technological changes, and other factors that might influence both foreign demand uncertainty and corporate risk-taking.

The results across all estimations provide supportive evidence that corporate risk-taking and foreign demand uncertainty are positively and significantly related. These findings are consistent with Hypothesis *H1.a*, suggesting that firms may increase risk-taking behaviors in response to heightened demand uncertainty in external markets. Even after controlling for numerous firm characteristics, which could potentially influence their risk-taking propensity, and multiple fixed effects to account for unobserved impacts, the positive relationship between corporate risk-taking and foreign demand uncertainty remains consistent and statistically significant. The impact of foreign demand uncertainty on corporate risk-taking is also economically significant. Using the estimates from column (3), the coefficient on $ForeignUncertainty1$ is 0.023, indicating that a one standard deviation increase in foreign demand uncertainty raises the level of our corporate risk-taking indicator, $Risk1$, by approximately $(0.069 \times 0.023 =)0.0016$, which corresponds to about 4.408% of its mean level (0.036).[23]

In synthesizing our findings with the diverse perspectives in the existing literature, our results suggest that foreign demand uncertainty exerts a net positive influence on corporate risk-taking behavior. While the "real option" theory posits that firms facing increased uncertainty tend to postpone or reduce investments to avoid irreversible commitments, our research adds nuance to this theory by indicating that such a response does not necessarily preclude firms from increasing their overall risk profiles. Additionally, our results imply that the managerial conservatism predicted by "agency theory" is seemingly overshadowed by firms' incentive to prioritize risky ventures in the face of heightened foreign demand uncertainty. Although not entirely negating these risk-reduction arguments, our results

[23]Our results suggest that certain firm characteristics are significantly associated with their risk-taking behaviors. For instance, larger firms and those with a longer operating history tend to exhibit a greater propensity to engage in risky activities. This could be attributed to their advantageous market positions or greater familiarity with the market, leading to a higher tolerance for risk. Highly-leveraged firms are also more inclined to take on higher risks, aligning with traditional corporate risk-taking theories suggesting that equity holders might prefer high-risk projects since the costs of failure would primarily be borne by debt holders. Conversely, firms with higher book-to-market ratios and greater profitability appear to have lower incentives to undertake risky activities. Additionally, state-owned firms demonstrate greater risk aversion, while firms led by long-tenured CEOs are more likely to engage in risky ventures.

underscore the risk-increasing effects that may outbalance them. On one hand, uncertainty in external markets may create an imperative compelling firms to engage in more "higher-risk, higher-return" activities to compensate for potential revenue shortfalls. On the other hand, to exploit potential opportunities arising from uncertainty shocks, some adventurous firms may adopt a preemptive risk-taking approach to seize first-mover advantages. Outweighing the potential benefits of conservative responses, these two effects may enable firms to meet either shareholders' expectations or enhance their chances of success in the future, but increase their risk at the present.

[Table 4 about here.]

### *4.2. Endogeneity issues*

While our measure of foreign demand uncertainty, based on import data from non-Chinese exporters, is arguably exogenous to Chinese firms (as supported by Bricongne and Gigout (2019) and Garin and Silvério (2023)), it does not entirely rule out endogeneity concerns. For instance, importers may shift to alternative suppliers if they perceive increased risks with their current exporters, thereby introducing reversal causality. Additionally, despite controlling for a broad range of firm-specific characteristics, there remains the possibility of omitted variables. These unobserved factors could be simultaneously correlated with both foreign demand uncertainty and firms' risk-taking behaviors, potentially biasing our estimates. To address these concerns, we employ a variety of approaches, with the results presented in Table 5. Although no single approach can fully resolve all endogeneity issues, each method contributes to addressing specific aspects of endogeneity, collectively enhancing the robustness and credibility of our findings in the context of potential endogeneity.

[Table 5 about here.]

Firstly, we adopt a "blunt" approach by using the one-year lagged measure of foreign demand uncertainty, i.e., $ForeignUncertainty_{i,t-1}$ as a replacement of our initial indicator. This experiment is based on the premise that foreign demand uncertainty in year $t-1$ might exert a lagged effect on firms' risk-taking in year $t$, while it is less likely that a firm's risk-taking behavior in $t$ would influence foreign demand uncertainty in $t-1$. As shown in

Panel A, the estimated coefficients on the lagged indicator remain positive and statistically significant.[24]

Secondly, we introduce an alternative variable—foreign demand uncertainty faced by a firm's *competitors*—to mitigate potential endogeneity concerns. The competitors of firm $i$ are defined as Chinese firms exporting the same product $p$ to the same destination market $n$.[25] This approach assumes that while the uncertainty faced by a firm's competitors is correlated with its own uncertainty exposure, it does not directly influence the firm's risk-taking decisions. We gauge the foreign demand uncertainty faced by firm $i$'s competitors as follows in Eq.(6):

$$CompetitorUncertainty_{it} = \frac{1}{n} \sum_{h \in (n,p), h \neq i}^{n} ForeignUncertainty_{ht} \tag{6}$$

We then replace the initial $ForeignUncertainty_{it}$ with $CompetitorUncertainty_{it}$, and present the estimation results in Panel B, Table 5. The coefficients on $CompetitorUncertainty$ are still significantly positive, further supporting the hypothesis that increased foreign demand uncertainty leads to greater corporate risk-taking.[26]

Thirdly, we reconstruct the foreign demand uncertainty indicator using the trade uncertainty index from Ahir et al. (2022). Unlike our initial measure, which is based on actual trade flow data, this index is derived from textual analysis, counting mentions of uncertainty in proximity to trade-related terms in EIU country reports. In contrast to our initial indicator using product-firm-level information, Ahir et al. (2022)'s trade uncertainty indices are essentially country-level information. Similar to our prior practice, we weight these indices based on each firm's dependence on foreign sales and the relevance of each

[24]While not explicitly reported, we also experimented with incorporating both the contemporaneous $ForeignUncertainty_{i,t}$ and the lagged $ForeignUncertainty_{i,t-1}$. Including both indicators did not significantly alter our baseline results: the coefficient on $ForeignUncertainty_{i,t}$ remained positive and statistically significant, suggesting a pronounced contemporaneous effect on firms' risk-taking even after controlling for the lagged effect. Nonetheless, the coefficient on $ForeignUncertainty_{i,t-1}$ weakened in magnitude and statistical significance.

[25]Products are identified as same by using the 6-digit HS code.

[26]A limitation of this approach is that the exogeneity of $CompetitorUncertainty$ hinges on the assumption that it cannot *directly* affect firm $i$'s risk-taking. That is, $CompetitorUncertainty$ should only affect firm $i$'s risk-taking through its correlation with the foreign demand uncertainty that firm $i$ faces. However, this premise may not hold in all cases. For instance, competitors might change their risk-taking preferences amid increased uncertainty, which could in turn prompt firm $i$ to adjust its risk-taking behaviors as well.

destination market in their trade portfolio.[27] This approach helps mitigate reversal causality concerns, as firm-specific risk-taking is less likely to affect country-level trade uncertainty. As shown in Panel C of Table 5, the coefficients on this new indicator of foreign demand uncertainty remain qualitatively consistent and statistically significant.

Another source of reversal causality may arise from the weights used to construct the foreign demand uncertainty indicator, specifically, $\left(\frac{\bar{X_{it}}}{R_{it}}\right)$ and $\left(\frac{\bar{X}_{ipnt}}{X_{ipt}}\right)$ in Eq.(5). These terms reflect firm $i$'s reliance on foreign markets and the importance of each destination market $n$ in its export portfolio. To prevent the variation of these weights from influencing our results, we fix them at their sample average values. However, this could introduce bias if these averages are affected by firms' risk-taking during the sample period. To address this concern, we alternatively use *pre-sample* values for these weights, assuming that firms' foreign sales dependencies and market linkages during the pre-sample period are unaffected by subsequent risk-taking.[28] Panel D of Table 5 presents our results, which still align with our baseline findings. Nonetheless, it is important to note that a limitation of this approach is that pre-sample values may not accurately capture firms' current foreign reliance and market linkages, leading to potential measurement errors in our indicator of foreign demand uncertainty.

Next, we address potential persistence in corporate risk-taking by adding the one-year lagged level of risk-taking as an extra explanatory variable. Given that corporate risk-taking behaviors often exhibit temporal persistence, failure to control for past risk-taking may lead to omitted variable bias. However, including this lagged term introduces another layer of endogeneity, as it may be correlated with the error term due to the persistence of unobserved firm-specific factors. To overcome this issue, we employ the estimator of system Generalized Method of Moments (GMM), treating both lagged corporate risk-taking and foreign demand uncertainty as endogenous.[29] Panel E of Table 5 shows that our results continue to support the hypothesis that heightened foreign demand uncertainty leads to increased corporate

[27]Specifically, we compute this indicator as: $\left(\frac{\bar{X_{it}}}{R_{it}}\right)\left(\frac{1}{N^i}\right)\sum_{n=1}^{N^i}\left(\frac{\bar{X}_{int}}{X_{it}} \times TradeUncertainty_{nt}\right)$, where $\frac{\bar{X_{it}}}{R_{it}}$ represents the sample average value of firm $i$'s foreign sales as a share of total revenue, and $\frac{\bar{X}_{int}}{X_{it}}$ is the sample average value of firm $i$'s export value to country $n$ as a share of aggregate foreign sales.

[28]For firms with data starting from year $t0$, we use the values from that year as weights in Eq.(5), and truncate the sample from $t1$ onwards for estimation.

[29]The system GMM estimator uses moment conditions where lagged differences serve as instruments for the level equation, along with lagged levels as instruments for the differenced equation. We use the two-step estimator, which is efficient and robust to various patterns of heteroskedasticity and serial correlation. We also conduct the Arellano-Bond test for serial correlation in the first-differenced errors to detect if there is

risk-taking.

Finally, we employ the latent factor model proposed by Bai (2009), assuming that unobserved factors affecting both corporate risk-taking and foreign demand uncertainty can be represented by a time-varying latent factor ($F_t$), with firms exhibiting heterogeneous responses to these factors. We extend our model by interacting $F_t$ with a firm-specific loading $\lambda_i$ to capture each firm's differential exposure to the latent factor:

$$Risk_{it} = \alpha + \beta ForeignUncertainty_{it} + \sum_{n} \mu_n CV_{it} + \gamma_i + \delta_t + \theta_{jt} + \vartheta_{pt} + \lambda_i F_t + \varepsilon_{it} \quad (7)$$

where $\lambda_i F_t$ is interpreted as the heterogeneous effects of omitted factors across firms. We adopt Bai (2009)'s approach, which utilizes iterative Principal Component Analysis, to estimate Eq.(7). As presented in Panel F of Table 5, the estimated coefficients on foreign demand uncertainty are consistently positive and statistically significant. These results further provide favorable evidence that corporate risk-taking tends to increase under heightened foreign demand uncertainty, even after controlling for the effects of unobservable omitted factors.

### *4.3. Alternative indicators*

To mitigate concerns that our results might be driven by specific proxies for corporate risk-taking or foreign demand uncertainty, we assess the robustness of our baseline findings by using alternative measures for these variables. First, we replace our initial indicator of corporate risk-taking with an alternative measure, $Risk2_{it}$, defined as the maximum minus the minimum of a firm's industry-adjusted earnings ($E_{it}$) over four overlapping years (Boubakri et al., 2013a,b). This measure indicates the range of a firm's returns, highlighting the extreme values that they can attain within a given time frame:

$$Risk2_{it} = Max\left(E_{it}\right) - Min\left(E_{it}\right) \quad (8)$$

Next, we turn to stock market data to construct metrics reflecting the level of corporate risk-taking. In line with common practice, we use the volatility of stock returns as a gauge of a firm's risk-taking, based on the premise that it reflects the market's perception of risk.

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any evidence for model misspecification, and the Hansen J test of over-identifying restrictions to assess the overall validity of our instruments.

Given that stock prices are influenced by investors' assessments of firms' risk profiles, greater risk-taking is expected to manifest as increased volatility in stock returns. We denote this measure as $Risk3_{it}$, which is represented by the annualized standard deviation of weekly stock returns.

However, the volatility of stock returns may be affected by investor sentiment or market noise, instead the intrinsic risk of firms. To address this concern, we decompose stock returns into systemic and idiosyncratic components and use the volatility of the latter as another measure of corporate risk-taking. Specifically, we model stock returns using the Fama-French Three-Factor Model:

$$R_{it} = \alpha + \beta_1(R_t^{Market} - R_t^{Free}) + \beta_2 R_t^{HML} + \beta_3 R_t^{SMB} + \epsilon_{it} \tag{9}$$

where $R_{it}$ represents the weekly stock returns of firm $i$. $R_t^{Market}$ denotes the overall return of the Chinese stock market, and $R_t^{Free}$ represents the risk-free rate (measured by the 3-month policy saving rate set by the Chinese central bank). $R_t^{HML}$ is the difference in returns between high and low book-to-market stocks, reflecting the excess return from investing in value stocks over growth stocks. $R_t^{SMB}$ indicates the size premium, representing the return difference between small- and large-cap stocks. The idiosyncratic error term $\epsilon_{it}$ is interpreted as the deviation of stock returns from the level explained by these three factors. We then use the annualized standard deviation of $\epsilon_{it}$ as our final indicator of corporate risk-taking, denoted as $Risk4_{it}$.[30]

Using $ForeignUnncertainty1$ as the proxy of foreign demand uncertainty, we present the results based on $Risk_{it}$ – $Risk4_{it}$ in Panel A to C of Table 6. The estimated coefficients for $ForeignUnncertainty1$ remain positive and highly significant, consistently indicating an increase (decrease) in corporate risk-taking amid heightened (reduced) foreign demand uncertainty, even when employing different measures of corporate risk-taking.

[Table 6 about here.]

We further examine whether our results withstand different indicators of foreign demand uncertainty. As introduced in Section 3.3.3, we use $ForeignUncertainty2$, which uses the

[30]Although not reported here, our results remain qualitatively unchanged and statistically significant when using daily or monthly stock returns to measure $Risk3_{it}$ and $Risk4_{it}$.

spread between the $75^{th}$ and $25^{th}$ percentiles (i.e., $\mu^{75}_{psnt}-\mu^{25}_{psnt}$) in distribution to capture the volatility range of $\mu_{pmnt}$ (i.e., idiosyncratic shocks in the demand growth of product $p$ exported by country $m$ to country $n$ in year $t$). Alternatively, we employ $ForeignUncertainty3$, which applies the Box-Cox transformation to our original indicator $ForeignUncertainty1$ to reduce non-normality and heteroskedasticity. As reported in Panel D and E of Table 6, our findings are qualitatively unchanged with these varied indicators of foreign demand uncertainty.

### *4.4. Other robustness checks*

In this section, we perform additional robustness checks to examine the consistency of our results. First, although we use the data of country $n$'s import of product $p$ from all exporting countries except China to measure this country's demand for the product, which is expected to exclude Chinese firms' influence, country $n$'s demand might be still affected by a Chinese exporter if it occupies a dominant position in the market. To address this concern, we define firm $i$ as having a dominant market status in country $n$ if its export value of product $p$ constitutes more than 10% for this country's total import of product $p$. Excluding such firms from our sample, we replicate our regressions and present the results in Panel A of Table 7. Our findings remain qualitatively unchanged.

[Table 7 about here.]

Next, we consider the impact of the Global Financial Crisis, which significantly increased firms' risk and likely caused a spike in demand uncertainty across various countries. Including this crisis period in our sample might lead to overstated estimates. To investigate this, we exclude observations during the period from 2008 to 2010 and report the results in Panel B of Table 7. The results are consistent with our previous findings, showing no significant changes in estimates.

Lastly, we truncated our sample period at 2016 due to the cessation of detailed firm-product-destination-specific trade flow data by the Chinese customs authority after this year. This data gap prevents the construction of *firm*-specific time-varying indicators of foreign demand uncertainty for the post-2016 period. However, the significant changes in the international trade environment in recent years raises concerns about the robustness of our findings beyond the sample period. To address this, we instead develop an *industry*-level indicator, capturing the foreign demand uncertainty affecting the industry in which each firm

operates. Specifically, we match the sector category of each product, as classified by its HS code, with the corresponding industry in the *Chinese Industry Classification*.[31] Each firm $i$ in our sample is linked to a specific industry $k$, based on its disclosed industrial category. The industry-level foreign demand uncertainty faced by firm $i$ within industry $k$ is computed as follows:

$$ForeignUncertainty_{kt} = \frac{Export_{kt}}{Output_{kt}} \times \frac{1}{N^k} \sum_{p \in s \in k} Dispersion_{psnt} \tag{10}$$

where $p$, $s$, and $k$ represent product, sector, and industry, respectively. As before, $Dispersion_{psnt}$ denotes the demand uncertainty for product $p$ (within sector $s$) in importing country $n$ in year $t$. $N^k$ denotes the number of products within industry $k$. $Export_{kt}$ represents the value of industry $k$'s export, while $Output_{kt}$ denotes this industry's output. Using this industry-level indicator, we extend our sample period to 2022. Due to the unavailability of firm-level export data post-2016, we include only firms that had export data in the previous sample period, assuming continued export activities beyond 2016. As shown in Panel C of Table 7, our results remain qualitatively consistent with previous findings.[32]

### *4.5. Dynamic effects*

While our earlier findings indicate a risk-increasing effect of foreign demand uncertainty, it offers limited insights into the nuanced dynamics of this impact. In this section, we employ the local projection method, as advocated by Jordà (2005), to assess the over-time variation of firm risk-taking in reaction to shocks in foreign demand uncertainty. Compared to traditional approaches such as vector autoregressions (VAR), the local projection method is preferred due to its robustness against model misspecifications and its ability to avoid unnecessary imposition of dynamic restrictions on variables. Furthermore, this method estimates separate regressions for different time horizons using simple least squares, obviating the need for delta-method approximation in inference.

[31] A single industry in the *Chinese Industry Classification* may encompass multiple HS-coded sectors.

[32] The use of this industry-level indicator excludes industry-year-specific fixed effects in this estimation. While the industry-level indicator provides results broadly consistent with our baseline findings, it has notable limitations compared to our initial measure of foreign demand uncertainty. Specifically, it does not incorporate information on the relevance of individual products within a firm's export portfolio nor the relative importance of each destination market to the firm. These limitations, arising from the absence of detailed data on the $(firm, product, destination)$ triad, imply that this industry-specific indicator may not fully capture the idiosyncratic uncertainty shocks experienced by individual firms.

For each period $h$, we estimate the cumulative response in corporate risk-taking using the following equation:

$$Risk_{it+h} = \alpha^h + \beta^h ForeignUncertainty_{it} + \sum_n \mu_n^h CV_{it} + \gamma_i^h + \delta_t^h + \theta_{jt}^h + \vartheta_{pt}^h + \varepsilon_{it+h} \quad (11)$$

where $h$=0, 1, 2,...5. $Risk_{it+h}$ represents firm risk-taking in year $t$+$h$, and $ForeignUncertainty_{it}$ remains to be the indicator of foreign demand uncertainty in year $t$. The coefficient to be estimated, $\beta^h$, represents the cumulative effect of external demand uncertainty on a firm's risk-taking behaviors $h$ years subsequent to the emergence of foreign demand uncertainty in year $t$. We present the estimates of $\beta^h$ in Figure 3. In Panel A, our covariates only include the indicator of foreign demand uncertainty, along with firm- and year-specific fixed effects. Panel B incorporates other control variables, while Panel C further includes industry-year- and province-year-specific fixed effects.

[Figure 3 about here.]

The key findings from our local projection approach are summarized as follows. Firstly, in line with our baseline results, foreign demand uncertainty exerts a stimulatory impact on firms' risk-taking behavior and this effect remains conspicuous over several years. Notably, the influence of foreign demand uncertainty seems to slightly augment and then peak one year after the uncertainty shock emerges.[33] Secondly, the variation in corporate risk-taking in response to foreign demand uncertainty shocks exhibits a transient pattern, rather than a persistent alteration. We observe that the impact of foreign demand uncertainty diminishes after reaching its maximum and subsequently becomes statistically insignificant approximately one to two years later. These results suggest that, although uncertainty stemming from external markets may trigger adaptive responses in firms' risk-taking behavior, such responses are transitory, representing a short-term adjustment in firms' risk-taking approaches rather than a permanent shift.

[33]However, the difference between the impact of foreign demand uncertainty on firm risk-taking in period $t+1$ and the impact in period $t$ is not significantly different from zero. Thus, we treat the seemingly augmented effects of foreign demand uncertainty one year after its emergence cautiously.

## 5. How foreign demand uncertainty affect corporate risk-taking?

Despite our previous investigation providing consistent and robust evidence for a positive relationship between foreign demand uncertainty and corporate risk-taking, the underlying mechanisms remain unclear. Drawing upon the existing literature, we explore two potential conduits: firms' incentives to seek substitute profits and heightened financing constraints, and examine their roles in linking foreign demand uncertainty and corporate risk-taking.

### *5.1. Profit substitution*

We first investigate whether firms' incentive to seek substitute profits have an explanatory power to the effects of foreign demand uncertainty on corporate risk-taking. Given the significance of foreign markets as firms' critical revenue sources, when demand uncertainty arising from these markets reduces earnings from core business operations, firms may be incentivized to search for alternative profit avenues, which consequently increases their risk exposure. Chong and Gradstein (2009) note that firms in volatile economic environments experience slower sales growth. In a recent study, Feng et al. (2023) also provide consistent evidence that Chinese firms suffer lower revenues amid heightened economic policy uncertainty.

To assess the role of profit substitution in the relationship between foreign demand uncertainty and corporate risk-taking, we unfold our analysis in two steps. First, we examine the impact of foreign demand uncertainty shocks on firms' core business earnings, with a negative relationship indicating a detrimental effect. Second, we incorporate core business returns as an additional determinant of corporate risk-taking. A negative relationship between these returns and risk-taking implies that declining core earnings drive firms toward higher risk-taking. The combined results are viewed as supportive evidence for Hypothesis 2: foreign demand uncertainty affects corporate risk-taking by reducing core business returns, thereby compelling firms to seek alternative profits at higher risk.

We measure firms' core business profits as revenue from primary production and sales, net of incurred costs, taxes, and surcharges, then scaled by firm assets. We regress this measure on the indicator of foreign demand uncertainty ($ForeignUncertainty1$) and control variables as in Eq. (1). With varied specifications in our model, the results are reported in columns (1) - (3) of Panel A, Table 8. As expected, the estimated coefficients on $ForeignUncertainty1$ are negative and statistically significant, suggesting that foreign demand uncertainty significantly reduces firms' core business profits. Incorporating this measure into the corporate risk-taking

($Risk1$) model, as shown in columns (4) - (6) of Panel A, Table 8, yields negative and significant coefficients, suggesting that declining core profits prompt firms to seek alternative profit sources, leading to increased risk-taking. Note that the estimated coefficients on foreign demand uncertainty remain significantly positive, suggesting the existence of other mechanisms that also translate an increase of such uncertainty into higher corporate risk-taking.

[Table 8 about here.]

In search for alternative profits, firms often turn to financial assets, which may yield higher returns (Krippner, 2005; Demir, 2009; Tori and Onaran, 2018; Jin et al., 2022). Compared to fixed asset investments, financial assets have notable advantages in reversibility as investors can promptly trade these assets when needed. Moreover, wise (or speculative) financial transactions can create considerably higher returns than traditional manufacturing and commerce, which may also lure firms away from traditional productions. However, the fickleness in financial asset values may expose firms to higher risk during financial market disorders.

We next assess whether foreign demand uncertainty drives firms to rely more heavily on financial assets for profits and whether this reliance increases corporate risk. The contribution of financial assets to a firm's profits is gauged by the proportion of total profits from financial investments, fair value changes, and other financial incomes.[34] In cases of negative total or financial profits, we use absolute values to prevent distortion. Higher values of this measure imply greater engagement in financial transactions to create profits.

Similar to our prior examination, we regress firms' reliance on financial profits against foreign demand uncertainty and other covariates as before. Results in columns (1) - (3) of Panel B, Table 8 show a positive and significant association between foreign demand uncertainty and firms' financial profit dependence, indicating firms increasingly leverage financial assets when demand uncertainty arises in external markets. Furthermore, after incorporating financial profit reliance as an extra covariate in the corporate risk-taking model, the results show that increased reliance on financial profits is positively associated with risk-taking, suggesting that heightened financial engagement in response to foreign demand uncertainty contributes to higher corporate risk.

[34]We exclude financial income from the firm's joint ventures to avoid overstating reliance on financial profits.

To summarize, our findings provide consistent evidence for Hypothesis 2: increased foreign demand uncertainty reduces firms' core business profits, prompting them to seek alternative profit sources, such as financial transactions, which in turn increases their risk profiles.

### *5.2. Financing constraints*

Another mechanism through which foreign demand uncertainty influences corporate risk-taking could be increased financing constraints. Heightened demand uncertainty in key foreign markets may lead creditors (such as banks and other financial intermediaries) to reassess firms' future prospects negatively. This often results in stricter lending standards or higher risk premiums applied to loans, thus effectively increasing firms' borrowing costs. Firms reliant on external credit may be compelled into "high risk, high return" projects in an attempt to gain more returns to cover increased borrowing expenses. This creates a pathway where foreign demand uncertainty indirectly drives corporate risk-taking through elevated financing costs.

We measure financing costs as the ratio of interest payments to outstanding loans. Similar to our previous analysis, we first estimate the impact of foreign demand uncertainty on financing costs, followed by incorporating the latter as an extra determinant of corporate risk-taking. Results in Panel A of Table 9 show that financing costs significantly increase with foreign demand uncertainty, implying that firms face higher borrowing costs as access to credit becomes more constrained due to unfavorable return outlook. In subsequent regressions, we find that financing costs are positively and significantly associated with corporate risk-taking. These results suggest that firms adaptively assume higher risk in response to tightened credit constraints, probably an attempt to generate more earnings to offset rising borrowing expenses.

[Table 9 about here.]

However, higher interest expenses to pay outstanding loans may not fully capture firms' financing constraints. When access to bank loans or other traditional financing becomes constrained or too costly, firms often shift to trade credit to maintain liquidity or cash flow. If firms can effectively substitute bank loans with trade credit, using the costs of bank loans as the proxy of financing constraints might be biased. To address this, we examine the role of trade credit as a mediator in the "foreign demand uncertainty - corporate risk-taking"

relationship. Trade credit here refers to the credit extended by a firm's suppliers, allowing the firm to postpone payments for goods or services received. Specifically, we employ the sum of accounts payable, notes payable, and advance from customers, scaled by total assets as the measure of trade credit. To mitigate the discrepancy of trade credit across industries, we adjust this measure by using the industrial average. A decline in trade credit with foreign demand uncertainty suggests broader concerns about a firm's future prospects as even non-financial creditors are less willing to extend credit to the firm. Along with our previous findings that foreign demand uncertainty drives up firms' costs for bank loans, the reduction of trade credit can reflect firms' increased financial distress as both formal and informal financing channels are closing off.

We first regress trade credit on foreign demand uncertainty and other control variables, with the results being presented in columns (1) - (3) of Panel B, Table 9. The estimated coefficients on foreign demand uncertainty are negative and significant, suggesting reduced trade credit availability under higher foreign demand uncertainty. This supports our initial finding that foreign demand uncertainty tightens firms' financing constraints, not only raising the costs of bank loans but also limiting their access to business partners' credit. Subsequently, incorporating trade credit as an extra covariate into the corporate risk-taking model, our results in columns (4) - (6) of Panel B, Table 9 reveal that reduced trade credit is associated with increased corporate risk-taking, as firms seek to compensate for heightened financing constraints through higher returns from riskier ventures.

In conclusion, using different but supplementary proxies of financing constraints, we find consistent results with Hypothesis 3: foreign demand uncertainty imposes constraints on both formal and informal financing channels, driving firms to assume greater risk in pursuit of higher returns. Nonetheless, it is important to note that while our analysis focuses on firms' profit substitution and financing constraints, we acknowledge the potential multiplicity of mechanisms for the "foreign demand uncertainty - corporate risk-taking" relationship, where other mediators may also play potentially significant roles. We leave the exploration for additional mediators in this relationship in our future research agenda.[35]

[35]Although not reported, we have investigated the potential mediating effects of risk aversion on the "foreign demand uncertainty - corporate risk-taking" linkage. Despite using varied indicators of risk aversion, we find no significant evidence that firms' risk aversion is noticeably altered by foreign demand uncertainty. These results probably reflect the outcome of competing agency problem theories, or the need of more refined measures for risk aversion. The results are available upon request.

## 6. Extended analysis: some heterogeneities

To gain more nuanced understanding on the impacts of foreign demand uncertainty, we further investigate whether these impacts vary across different firm characteristics, specifically, firms' managerial capacity and technological intensity.

### *6.1. Managerial capacity*

Managerial capacity has been widely agreed as playing a pivotal role in determining firm behavior (Hambrick and Mason, 1984; Hambrick, 2007). A body of studies have explored the relationship between management capacity and various corporate performance, such as earnings (Demerjian et al., 2007), investment (Chen et al., 2021), innovations (Chen et al., 2015), and market entry (Goldfarb and Xiao, 2011). In contrast, the contribution of managerial capacity to corporate risk-taking remains unclear yet. Some works use educational background, particularly whether they graduated with MBA degrees, to capture managers' ability. Many of these studies suggest that managers holding MBAs tend to be more risk averse than their non-MBA counterparts (Miller and Xu, 2019), probably because MBA programs emphasize the skills aiming to reduce losses and avoid mistakes, rather than encouraging risky and innovative activities.[36] While not assessing the influence of broad management ability, these findings imply a potentially negative force yielded by managerial capacity to weaken the effects of foreign demand uncertainty.

In contrast, some other competing views provide arguments for an increase of corporate risk-taking with management capacity. Aligning with the theory of "growth option", managers with richer expertise in coping with operational risks may treat unanticipated shocks, such as demand uncertainty in foreign markets, as a potential of opportunities to achieve higher growth. This may lead them to proactively assume calculated risks, seeking higher returns or greater market shares to offset the adverse effects from economic disturbances. Furthermore, firms with greater managerial capacity are likely to have higher agility in adjusting business strategies or reallocating resources, which hence allows them to adopt riskier but potentially

[36]Some works propose that managers may lean towards a "quiet life", instead of aggressively taking risks in pursuit of firm value. For example, Bertrand and Mullainathan (2003) note that, rather than actively expanding business (which might increase risk but could also increase profits), managers exhibit stronger preference for less risk-taking even if they have been given more autonomy. Gormley and Matsa (2016) also find evidence that managers without the threat of being replaced still prioritize stability and lower risk-taking, even if their conservative managerial decisions could hurt firm value in the long-term.

more rewarding approaches in order to gain the "first-mover" advantages. Consistent with these theoretical perspectives, Chemmanur et al. (2009) find that managers with higher ability more effectively overcome the problems of asymmetric information and implement more investments than their peers. Chen et al. (2015) find that managerial ability is positively associated with more radical innovations that are outside the firm's knowledge base. Andreou et al. (2016) also suggest that more capable bank managers prefer for higher risk. In this section, We examine whether firms' managerial capacity contributes to potentially heterogeneous impacts of foreign demand uncertainty across different firms' risk-taking decisions. We first measure managerial capacity using overhead costs related to management and administration, including salaries and wages paid to top executives, office rents, utilities, administrative supplies, fees for legal, audit, and other professional services, management travel expenses, costs for management training and development, as well as depreciation on management-related assets. Scaled by firm revenue and then adjusted by the industrial average, higher (lower) values of these overhead expenses indicate higher (lower) managerial input per unit of firm income, hence representing lower (higher) managerial quality. Accordingly, we classify firms into high and low managerial quality groups using the mean value of this measure.

Alternatively, following the approach of Qiu and Yu (2020), we proxy a firm's managerial capacity using managerial efficiency, which refers to the ability of management to achieve certain outcomes while minimizing managerial input. Specifically, we estimate Eq. (12)

$$GA_{it} = \alpha_1 L_{it} + \alpha_2 Exp_{it} + \alpha_3 Markup_{it} + \lambda_i + \eta_t + \epsilon_{it} \tag{12}$$

where $GA$ represents the natural logarithm of firm $i$'s general and administrative expenses.[37] $L$ denotes the the log value of labor costs, $Exp$ is the log value of exports, and $Markup$ represents the firm's markup (calculated as revenue divided by the difference between revenue and profit).[38] Managerial efficiency is gauged as the sum of the firm-specific factor ($\lambda_i$), time

[37]We exclude selling expenses per Qiu and Yu (2020), as these expenses can be used as intermediate input to enhance firms' productive efficiency, but may be less relevant for managerial efficiency.

[38]Earlier studies (e.g., Eisfeldt and Papanikolaou (2013)) used SG&A (selling, general, and administrative) expenses to measure organizational capital, suggesting that firms with higher SG&A expenses are more managerial efficient. However, Bloom and Van Reenen (2007) argued that higher SG&A expenses may reflect firm size, higher exporter revenues, or higher markups, without necessarily indicating greater managerial efficiency. In line with this argument, Qiu and Yu (2020) controlled for labor, export value, and markup to identify the level of managerial efficiency in firms.

trend ($\eta_t$), and residuals ($\epsilon_{it}$), which represents the G&A expenses not explained by firm size, export value, and profitability. Adjusted by the industrial average, a higher (lower) value indicates lower (higher) managerial efficiency. Similarly, we classify firms into high and low managerial efficiency groups using the mean value of this measure.

Using these two alternative measures, we estimate the impact of foreign demand uncertainty, proxied by $ForeignUncertainty1$, on corporate risk-taking, indicated by $Risk1$, for firms with high and low managerial capacity, respectively. The results, presented in Figure 4, show in Panel A the estimated coefficients on foreign demand uncertainty across firms with high or low managerial quality, and in Panel B, the estimated coefficients across firms with high or low managerial efficiency. The dashed lines represent the 90% confidence intervals surrounding these estimates.

[Figure 4 about here.]

We find that the estimated coefficients on foreign demand uncertainty shocks are consistently positive for both types of firms, seemingly suggesting that these shocks may commonly induce higher risk-taking in firms regardless of their managerial capacity. However, these impacts are only statistically significant for more capable firms. We interpret these findings as supportive evidence for the view that superior managerial ability may embolden firms to address the adverse effects of foreign demand uncertainty by engaging in riskier activities. In line with the theory of "growth option", firms with higher managerial capacity more likely perceive demand shocks as growth opportunities, thereby assuming higher risk to pursue advantageous positions in the future. In comparison, firms with inferior managerial capacity may be constrained by their inability to effectively deal with potential risks if they similarly alter operational strategies, hence opting to maintain the status quo rather than engage in extra risks.

### *6.2. Technological intensity*

Lastly, we investigate whether firms' technological intensity influences their risk-taking responses to foreign demand uncertainty. There are several reasons why firms with higher technological intensity, referred to as high-tech firms hereinafter, may exhibit more sensitive changes in risk-taking behaviors in response to such uncertainty. Firstly, compared to markets of traditional manufactured goods, high-tech markets are often more competitive due to the

lack of monopolistic firms with dominant market power. According to the "growth option" theory, firms in competitive environments are more likely to view looming uncertainty as an opportunity to outperform their counterparts, which hence spurs them to adopt riskier approaches to gain "first-mover" advantages. Tsai et al. (2009) suggest that high-tech firms may interpret volatile market conditions as increasing demand for novelty, thereby encouraging greater investment in R&D to upgrade their technology. However, increased R&D expenditure with unpredictable outcomes can also exacerbate the riskiness of these firms. Additionally, the continuous emergence of new start-ups, which typically carry new technological know-how, can also incentivize incumbent firms to expand product lines, even if this approach amplifies their risk profiles.[39]

Secondly, high-tech firms inherently have a greater risk preference because their survival and sustainability decisively hinge on the systematic application of scientific and technical knowledge to develop innovations with advanced and novel technological content, which however has high odds of failure compared to traditional manufacturing firms. Thus, firms with higher technological intensity are naturally more risk-tolerant than those less technologically inclined counterparts (Hsu et al., 2014), driving them to respond to foreign demand uncertainty shocks by pursuing riskier ventures.

Thirdly, many high-tech firms in China are largely export-oriented, making them heavily reliant on overseas markets for revenue generation. A surge of foreign demand uncertainty can negatively impact their sales and income, subsequently fuelling their incentive to seek alternative profit avenues even if it means higher risk-taking. Furthermore, high-tech firms, often younger and more dependent on external credit, may face higher financing costs and limited access to funding when demand uncertainty rises, which may also prompt riskier activities in pursuit of higher returns.[40] Given the evolution of Chinese exports up the value ladder, examining whether high-tech firms are more affected by external demand uncertainty provides insights into the implications of the increasingly intensified frictions between China and some main trade counterparts in the realm of high-tech goods.

We identify high-tech industries based on the *Classification of High-tech Industries* by

[39]However, Benguria et al. (2022) find some evidence that Chinese firms tend to reduce their R&D expenditure when trade policy uncertainty becomes sour.

[40]Note that the possibility of less pronounced impact of foreign demand uncertainty on the risk-taking of high-tech firms cannot be simply ruled out due to the Chinese government's industrial policies, including fiscal subsidies and tax credits, to support these industries.

the Chinese government.[41] Using two samples of firms from high-tech and other industries, respectively, we re-examine their risk-taking variation in reaction to foreign demand uncertainty. The results, presented in Panel A of Figure 5, show a significant increase of risk-taking among firms from high-tech industries. In contrast, the impact on firms from other industries, while positive, is statistically insignificant. These results suggest that heightened foreign demand uncertainty creates more pronounced repercussions on firms in high-tech industries by fueling their inclination towards greater risk-taking, likely due to their stronger impetus to seize growth opportunities, inherent risk preference, and greater reliance on foreign markets for earnings.

[Figure 5 about here.]

To ensure the robustness of our findings, we also define high-tech firms based on the nature of their main products (i.e., the products with the largest shares in a firm's sales revenue). Using Shirotori et al. (2010)'s indices of "revealed factor intensity" for traded goods, we identify high-tech firms if their primary exported goods are technology intensive products. Note that unlike our previous approach which differentiates high-tech vis-a-vis other industries, this approach allows us to identify high-tech enterprises even if they do not belong to high-tech industries. Re-estimating the effects of foreign demand uncertainty, as shown in Panel B of Figure 5, we consistently observe that foreign demand uncertainty exerts a compelling force that drives high-tech firms to engage in significantly higher risk-taking, while this effect is statistically insignificant in non-high-tech firms.

## 7. Conclusion

Increasing uncertainty in cross-country trade has become a primary source of macroeconomic uncertainty. Despite the rich size of existing literature studying the real impacts of uncertainty, how demand uncertainty arising from external markets affects exporting firms' behavior, particularly risk-taking, still lacks sufficient investigation. As firms likely face

[41] In 2017, the National Bureau of Statistics in China classified eight high-tech industries, including electronic information and communication, biotechnology and new medicine, aerospace, new materials, high-tech services, new energy and energy-saving, resource and environmental technology, and high-tech transformation of traditional industries. Refer to the website https://www.stats.gov.cn/sj/tjbz/gjtjbz/202302/t20230213_1902772.html for details.

greater earning and financing predicament or attempt to seize potential growth opportunities when foreign demand uncertainty emerges, we hypothesize that firms may engage in higher risk-taking in response to such uncertainty. Employing panel data from over 1,700 Chinese listed firms from 2001 to 2016, we find consistent and robust evidence for this hypothesis, showing that firms assume higher risk with increased foreign demand uncertainty. Furthermore, reduced returns from firms' core business and heightened financing costs amid foreign demand uncertainty play significant roles in compelling firms to take on higher risk. When we delve into the heterogeneous effects of foreign demand uncertainty, we find such uncertainty generates more conspicuous effects among firms with superior managerial capacity and higher technological intensity.

One question related to but beyond the scope of this paper is the implications of higher corporate risk-taking when faced with foreign demand uncertainty: does increased risk-taking benefit or harm firms? We believe that the answer hinges on whether firms assume risks wisely. A potentially positive outcome of heightened risk-taking is that it may drive firms to commit more to R&D and product innovation, which consequently enhances their productivity and propels them up the value ladder in the future. However, greater risk-taking also carries potential downsides if firms recklessly engage in hazardous investments, diverge into unfamiliar business areas, or participate in speculative financial transactions. Rather than contributing to higher productivity, these activities might destabilize firms and even the broader economic landscape if not carefully managed. Policymakers can help firms navigate complex uncertain environments by establishing regulatory frameworks that balance the encouragement of productive risk-taking with safeguards against imprudent ventures.

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**Figure 1 Foreign demand uncertainty and corporate risk-taking**
This figure presents the median values of foreign demand uncertainty and corporate risk-taking.

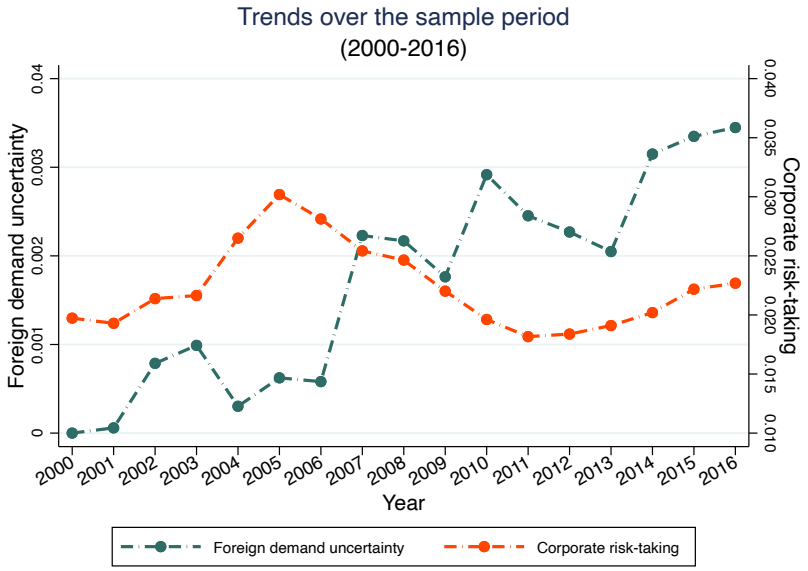

**Figure 2 Distribution of idiosyncratic demand shocks**
This figure presents the distribution of the idiosyncratic demand shocks captured by $\mu_{pmnt}$ in Eq.(3). Panel (A) exhibits the cumulative distribution of $\mu_{pmnt}$. In Panel (B), we further exclude the product-specific and the industry-year-specific fixed effects from $\mu_{pmnt}$ and present the cumulative distribution of the outcome.

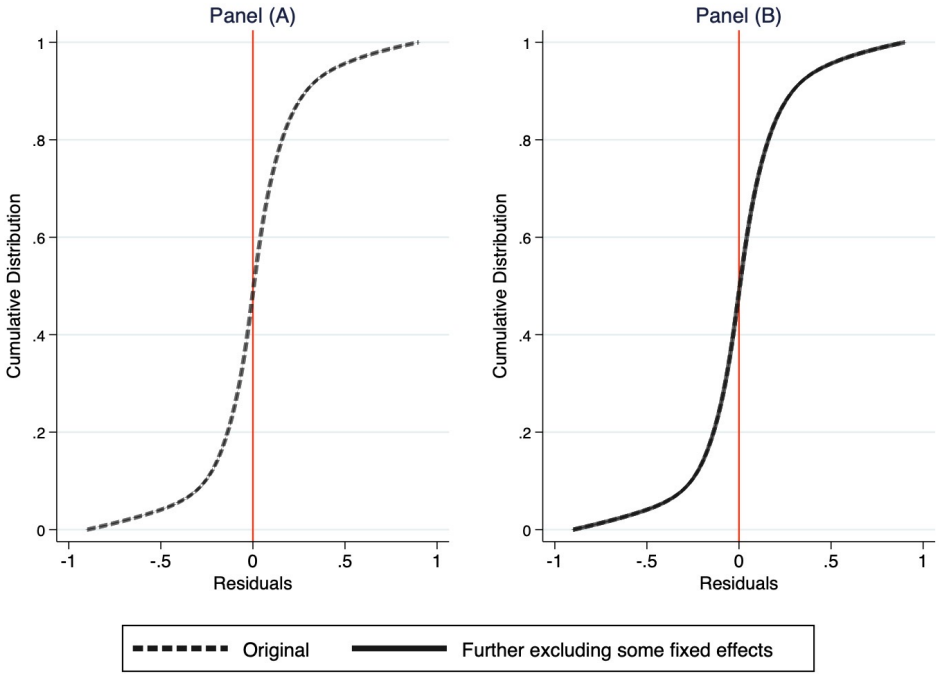

**Figure 3 Dynamic effects of foreign demand uncertainty on corporate risk-taking**
This figure illustrates the dynamic impacts of foreign demand uncertainty on corporate risk-taking behavior. Employing the local projection method proposed by Jordà (2005), we estimated the cumulative effects of foreign demand uncertainty on corporate risk-taking. We use $Risk1$ to measure the level of corporate risk-taking and $ForeignUncertainty1$ to proxy the severity of uncertainty arising from foreign demand. In Panel A, the covariates include only $ForeignUncertainty1$, along with firm- and year-specific fixed effects. Panel B incorporates other control variables, while Panel C further includes industry-year- and province-year-specific fixed effects. The shaded areas represent the 95% confidence intervals.

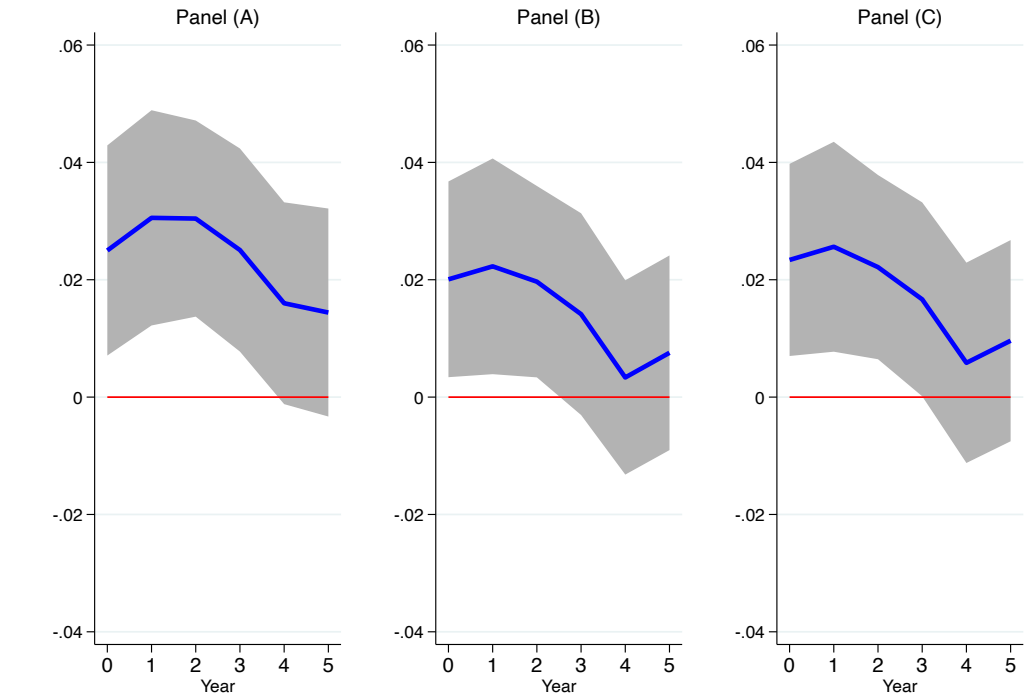

**Figure 4 Managerial capacity**

This figure presents the heterogeneous effects of foreign demand uncertainty on corporate risk-taking in firms with high and low managerial capacity. In Panel A, we measure firms' managerial capacity using overhead costs related to management and administration scaled by revenue, while in Panel B we use managerial efficiency estimated by the approach of Qiu and Yu (2020). We classify firms into those with high and low managerial capacity according to the mean value of the above two proxies. The level of corporate risk-taking is indicated by $Risk1$, while foreign demand uncertainty is measured by $ForeignUncertainty1$. All regressions are estimated using a fixed-effects estimator. We employ heteroskedasticity and within-panel serial correlation robust standard errors, and cluster standard errors at the industry-level. The dots represent the estimates for the coefficient on our foreign demand uncertainty, and the dashed lines indicate the 90% confidence interval around these estimates.

**Figure 5 Technological intensity**
This figure presents the heterogeneous effects of foreign demand uncertainty on corporate risk-taking in firms with different technological intensity. In Panel A, we identify firms from high-tech industries and their counterparts from other industries. Then we estimate the effects of foreign demand uncertainty on the risk-taking behavior of these two groups of firms, respectively. In Panel B, we alternatively define a firm as a high-tech firm if its main exported goods are technology intensive goods according to Shirotori et al. (2010)'s indices of "revealed factor intensity". The level of corporate risk-taking is indicated by $Risk1$, while foreign demand uncertainty is measured by $ForeignUncertainty1$. All regressions are estimated using a fixed-effects estimator. We employ heteroskedasticity and within-panel serial correlation robust standard errors, and cluster standard errors at the industry-level. The dots represent the estimates for the coefficient on our foreign demand uncertainty, and the dashed lines indicate the 90% confidence interval around these estimates.

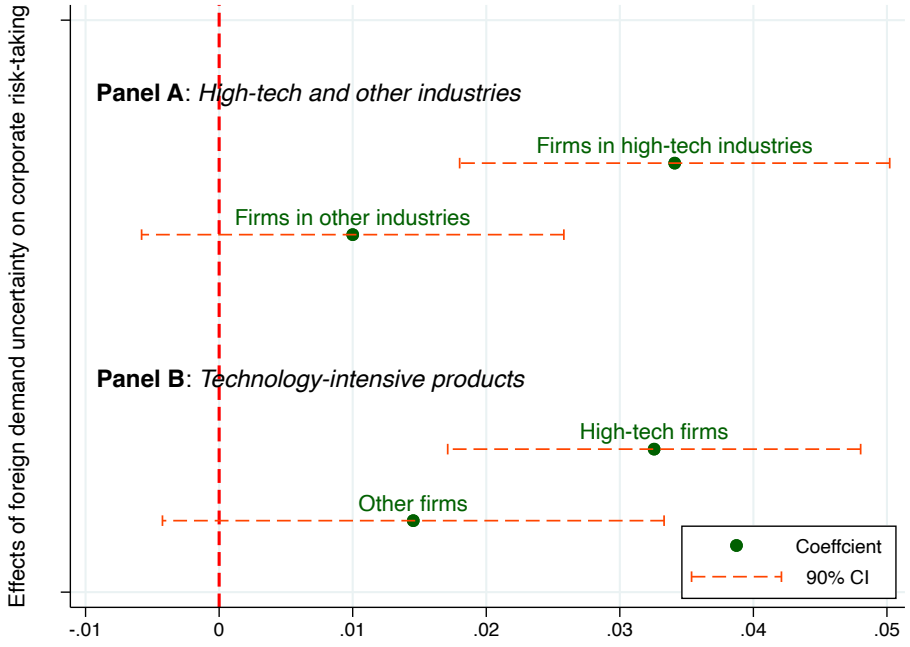

**Table 1 Descriptive statistics**
This table presents the main descriptive statistics of our variables.

| Variable | Obs. | Mean | Std.Dev. | Median | Min | Max |
|---|---|---|---|---|---|---|
| ***Corporate risk-taking:*** | | | | | | |
| Risk1 | 19,981 | 0.036 | 0.039 | 0.022 | 0.002 | 0.231 |
| Risk2 | 19,981 | 0.078 | 0.084 | 0.048 | 0 | 0.48 |
| Risk3 | 19,865 | 0.483 | 0.206 | 0.433 | 0.164 | 1.458 |
| Risk4 | 19,792 | 0.271 | 0.178 | 0.232 | 0.029 | 0.833 |
| ***Foreign demand uncertainty:*** | | | | | | |
| ForeignUncertainty1 | 19,981 | 0.027 | 0.069 | 0.002 | 0 | 0.584 |
| ForeignUncertainty2 | 19,981 | 0.018 | 0.052 | 0.001 | 0 | 0.909 |
| ForeignUncertainty3 | 19,981 | -5.269 | 2.543 | -4.394 | -8.357 | -0.521 |
| ***Control variables:*** | | | | | | |
| Size | 19,981 | 21.738 | 1.242 | 21.579 | 19.14 | 25.966 |
| Age | 19,981 | 2.628 | 0.433 | 2.708 | 0.693 | 3.932 |
| Leverage | 19,981 | 0.464 | 0.208 | 0.464 | 0.058 | 0.977 |
| Book-to-market ratio | 19,492 | 0.529 | 0.247 | 0.502 | 0.089 | 1.177 |
| ROA | 19,838 | 0.039 | 0.065 | 0.037 | -0.269 | 0.232 |
| Production costs | 19,824 | 0.206 | 0.425 | 0.133 | -0.588 | 2.569 |
| Tax burden | 19,981 | 0.012 | 0.02 | 0.006 | 0 | 0.133 |
| Tangibility | 19,981 | 0.258 | 0.168 | 0.227 | 0.002 | 0.744 |
| Sate ownership | 19,896 | 0.352 | 0.478 | 0 | 0 | 1 |
| Board size | 19,979 | 2.286 | 0.211 | 2.303 | 0 | 3.219 |
| Director age | 19,981 | 3.867 | 0.071 | 3.871 | 3.546 | 4.1 |
| CEO tenure | 19,388 | 1.426 | 0.557 | 1.386 | 0 | 2.944 |
| CEO duality | 19,470 | 0.198 | 0.398 | 0 | 0 | 1 |
| ***Other variables:*** | | | | | | |
| Trade uncertainty | 19,981 | 0.116 | 0.408 | 0.005 | 0 | 8.14 |
| Firm industry type | 19,981 | 0.424 | 0.494 | 0 | 0 | 1 |
| Firm factor type | 19,471 | 1.488 | 0.5 | 1 | 1 | 2 |
| Managerial costs | 19,981 | 0.1 | 0.098 | 0.077 | 0.006 | 0.673 |
| Managerial efficiency | 19,988 | -0.004 | 0.526 | 0 | -1.227 | 1.354 |
| Trade credit | 19,981 | 0.005 | 0.104 | -0.014 | -0.174 | 0.321 |
| Financing costs | 17,854 | 0.021 | 0.021 | 0.017 | 0 | 0.111 |
| Main business revenue | 19,926 | 0.073 | 0.128 | 0.062 | -0.365 | 0.569 |
| Financial profit reliance | 19,981 | 0.206 | 0.663 | 0.015 | -1.09 | 4.38 |

**Table 2 The comparison between the mean values in the subsamples of high and low foreign demand uncertainty**

This table compares the mean values of our corporate risk-taking indicators and other variables in the subsamples of high and low foreign demand uncertainty. The first two columns present the mean values of various variables in the group with above- and below-mean foreign demand uncertainty. The column with the label $Mean-diff$ reports the differences between the mean values of variables in theses two subsamples. The last column reports the $t$-test statistics for the comparisons.

| **Variables** | **Higher Foreign Uncertainty** | **Lower Foreign Uncertainty** | | |
|---|---|---|---|---|
| | **Mean(1)** | **Mean(0)** | **Mean-diff** | **T-stats** |
| ***Corporate risk-taking:*** | | | | |
| Risk1 | 0.039 | 0.035 | 0.004*** | 5.182 |
| Risk2 | 0.084 | 0.077 | 0.008*** | 5.124 |
| Risk3 | 0.501 | 0.479 | 0.022*** | 6.194 |
| Risk4 | 0.282 | 0.268 | 0.014*** | 4.345 |
| ***Foreign demand uncertainty:*** | | | | |
| ForeignUncertainty1 | 0.114 | 0.004 | 0.110*** | 118.379 |
| ForeignUncertainty2 | 0.076 | 0.003 | 0.073*** | 99.42 |
| ForeignUncertainty3 | -2.169 | -6.067 | 3.898*** | 111.227 |
| ***Control variables:*** | | | | |
| Size | 21.572 | 21.776 | -0.204*** | -9.411 |
| Age | 2.655 | 2.622 | 0.033*** | 4.344 |
| Leverage | 0.458 | 0.466 | -0.008** | -2.165 |
| Book-to-market Ratio | 0.512 | 0.533 | -0.021*** | -4.733 |
| ROA | 0.032 | 0.04 | -0.009*** | -7.644 |
| Production costs | 0.188 | 0.21 | -0.022*** | -2.913 |
| Tax burden | 0.008 | 0.013 | -0.005*** | -14.293 |
| Tangibility | 0.24 | 0.262 | -0.022*** | -7.439 |
| State ownership | 0.306 | 0.363 | -0.057*** | -6.796 |
| Board size | 2.275 | 2.289 | -0.014*** | -3.702 |
| Director age | 3.867 | 3.866 | 0.001 | 0.609 |
| CEO tenure | 1.446 | 1.421 | 0.025** | 2.53 |
| CEO duality | 0.211 | 0.195 | 0.016** | 2.295 |
| ***Other variables:*** | | | | |
| Trade uncertainty | 0.170 | 0.102 | 0.067*** | 1.353 |
| Firm industry type | 0.463 | 0.413 | 0.050*** | 5.76 |
| Firm factor type | 1.458 | 1.496 | -0.038*** | -4.329 |
| Managerial costs | 0.103 | 0.100 | -0.003 | 1.488 |
| Managerial efficiency | -0.026 | 0.002 | -0.029*** | -3.094 |
| Trade credit | 0 | 0.007 | -0.007*** | -3.593 |
| Financing costs | 0.021 | 0.022 | -0.001 | -1.521 |
| Main business revenue | 0.044 | 0.078 | -0.034*** | -11.128 |
| Financial profit reliance | 0.263 | 0.191 | 0.072*** | 6.195 |

**Table 3 Pairwise correlation**

This table reports the pairwise correlation coefficients between our indicators of corporate risk-taking and foreign demand uncertainty. The figures in the bold and italic font denote the correlation coefficients with a $p$-value lower than 0.1.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| (1) Risk1 | 1.000 | | | | | |
| (2) Risk2 | ***0.997*** | ***1.000*** | | | | |
| (3) Risk3 | ***0.117*** | ***0.118*** | ***1.000*** | | | |
| (4) Risk4 | ***0.067*** | ***0.068*** | ***0.758*** | ***1.000*** | | |
| (5) ForeignUncertainty1 | ***0.026*** | ***0.026*** | ***0.016*** | ***0.016*** | ***1.000*** | |
| (6) ForeignUncertainty2 | ***0.014*** | ***0.014*** | 0.011 | 0.012 | ***0.912*** | ***1.000*** |
| (7) ForeignUncertainty3 | -0.007 | -0.007 | ***0.043*** | ***0.027*** | ***0.526*** | ***0.4726*** |

**Table 4 Baseline results**

This table presents the results of our baseline estimations. The dependence variables that indicates the level of corporate risk-taking is *Risk*1. Foreign demand uncertainty is measured by *ForeignUncertainty*1. Among control variables, *Size* represents firm size, measured by the natural logarithm of total assets. *Age* denotes the number of years since a firm's founding. *Leverage* is the ratio of a firm's total liabilities to total assets. *Book-to-market Ratio* is the ratio of a firm's book value to its market value. *ROA* represents a firm's return to assets. *Production costs* denotes the growth rate of a firm's manufacturing costs. *Tax burden* is proxied by the ratio of total tax paid to revenue. *Tangibility* is the proportion of a firm's tangible assets in its total assets. *State ownership* is a binary equal to 1 if a firm is ultimately sate-owned, and 0 otherwise. *Board size* is measured by the natural logarithm of the number of board directors. *Director age* denotes the average age of board directors. *CEO tenure* refers to the number of years the current CEO has held the position. *CEO duality* is a binary variable equal to 1 if a CEO also serves as the board chair. All regressions are estimated using a fixed-effects estimator. We employ heteroskedasticity and within-panel serial correlation robust standard errors, and cluster standard errors at the industry-level. *t*-statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

| | Corporate risk-taking | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| Foreign demand uncertainty | 0.025*** | 0.020*** | 0.023*** |
| | (3.553) | (3.064) | (3.635) |
| Size | | 0.002*** | 0.003*** |
| | | (3.334) | (3.822) |
| Age | | 0.009*** | 0.006** |
| | | (3.426) | (2.150) |
| Leverage | | 0.023*** | 0.022*** |
| | | (7.593) | (7.297) |
| Book-to-market ratio | | -0.030*** | -0.027*** |
| | | (-13.892) | (-12.433) |
| ROA | | -0.177*** | -0.173*** |
| | | (-23.572) | (-23.342) |
| Production costs | | 0.000 | 0.000 |
| | | (0.016) | (0.480) |
| Tax burden | | -0.062** | 0.053* |
| | | (-2.297) | (1.838) |
| Tangibility | | -0.002 | -0.000 |
| | | (-0.633) | (-0.082) |
| State ownership | | -0.006*** | -0.006*** |
| | | (-7.427) | (-7.827) |
| Board size | | 0.001 | 0.001 |
| | | (0.260) | (0.484) |
| Director age | | -0.002 | -0.011 |
| | | (-0.293) | (-1.396) |
| CEO tenure | | 0.001** | 0.001* |
| | | (2.282) | (1.953) |
| CEO duality | | 0.001 | -0.000 |
| | | (0.621) | (-0.136) |
| Observations | 19,926 | 18,634 | 18,610 |
| Adjusted R-squared | 0.347 | 0.429 | 0.455 |
| Firm FE | YES | YES | YES |
| Year FE | YES | YES | YES |
| Industry×Year | | | YES |
| Province×Year | | | YES |

**Table 5 Endogeneity examinations**

This table presents the results of our endogeneity examinations. In Panel A, we replace the initial foreign demand uncertainty indicator with its one-year lagged counterpart. In Panel B, we substitute the firm-specific foreign demand uncertainty indicator with one that reflects the uncertainty faced by firms' competitors. Additionally, we construct an alternative firm-specific indicator for foreign market uncertainty using country-level trade uncertainty indices. We employ this indicator in Panel C. In Panel D, we use the pre-sample values of firms' dependence on foreign sales and linkages to foreign markets as the weights to calculate the foreign demand uncertainty indicator. Panel E employs the system Generalized Method of Moments (GMM), while Panel F uses the approach proposed by Bai (2009). Throughout, we use standard errors robust against heteroskedasticity and within-panel serial correlation, and cluster them at the industry-level. *t*-statistics in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

| | Firm Risk | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Panel A: Lagged foreign demand uncertainty** | | | |
| Lagged foreign demand uncertainty | 0.031*** | 0.020*** | 0.023*** |
| | (4.241) | (3.177) | (3.549) |
| Observations | 18,114 | 17,083 | 17,060 |
| Adjusted R-squared | 0.366 | 0.445 | 0.472 |
| **Panel B: Competitors' foreign demand uncertainty** | | | |
| Foreign demand uncertainty faced by competitors | 0.018*** | 0.015*** | 0.017*** |
| | (3.426) | (3.108) | (3.603) |
| Observations | 19,926 | 18,634 | 18,610 |
| Adjusted R-squared | 0.347 | 0.429 | 0.455 |
| **Panel C: Trade policy uncertainty** | | | |
| Trade policy uncertainty | 0.006*** | 0.005*** | 0.004*** |
| | (7.204) | (6.250) | (6.076) |
| Observations | 19,959 | 18,649 | 18,649 |
| Adjusted R-squared | 0.384 | 0.464 | 0.476 |
| **Panel D: Pre-sample weights** | | | |
| Foreign demand uncertainty | 0.018** | 0.016** | 0.020*** |
| | (2.186) | (2.052) | (2.580) |
| Observations | 18,149 | 17,104 | 17,081 |
| Adjusted R-squared | 0.423 | 0.498 | 0.546 |
| **Panel E: System GMM** | | | |
| Foreign demand uncertainty | 0.051** | 0.050* | 0.026* |
| | (2.458) | (1.945) | (1.682) |
| Observations | 15,508 | 15,508 | 15,508 |
| Number of firms | 1,641 | 1,641 | 1,641 |
| AR(1)/AR(2) | 0/0.711 | 0/0.695 | 0/0.524 |
| Hansen J | 0.399 | 0.309 | 0.367 |
| **Panel F: Latent factor** | | | |
| Foreign demand uncertainty | 0.018*** | 0.020*** | 0.023*** |
| | (4.089) | (3.054) | (3.631) |
| Observations | 19,981 | 18,634 | 18,610 |
| Control variables | | YES | YES |
| Firm FE | YES | YES | YES |
| Year FE | YES | YES | YES |
| Industry × Year | | | YES |
| Province × Year | | | YES |

**Table 6 Alternative indicators**

This table reports our results using alternative indicators for corporate risk-taking and foreign demand uncertainty. In Panel A, we utilize an alternative indicator for firm risk-taking, denoted as $Risk2_{it}$. This term is calculated as the range between the maximum and minimum earnings across a four-year overlapping time period. Panel B, measuring corporate risk-taking from the perspective of stock return volatility, uses the annualized standard deviation of weekly stock returns, denoted as $Risk3_{it}$. Panel C adopts the indicator of $Risk4_{it}$, which is calculated as the annualized standard deviation of weekly excess stock returns. Additionally, we use $ForeignUncertainty2$ and $ForeignUncertainty3$, respectively, as measures for foreign demand uncertainty. All regressions are estimated using a fixed-effects estimator. We employ heteroskedasticity and within-panel serial correlation robust standard errors, and cluster standard errors at the industry-level. $t$-statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

| | Firm Risk | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Panel A: Firm Risk2** | | | |
| Foreign demand uncertainty | 0.056*** | 0.045*** | 0.052*** |
| | (3.640) | (3.147) | (3.722) |
| Observations | 19,926 | 18,634 | 18,610 |
| Adjusted R-squared | 0.351 | 0.430 | 0.457 |
| **Panel B: Firm Risk3** | | | |
| Foreign demand uncertainty | 0.043*** | 0.029*** | 0.034*** |
| | (4.389) | (2.867) | (3.351) |
| Observations | 19,792 | 18,584 | 18,559 |
| Adjusted R-squared | 0.713 | 0.728 | 0.736 |
| **Panel C: Firm Risk4** | | | |
| Foreign demand uncertainty | 0.075*** | 0.054*** | 0.058*** |
| | (5.170) | (3.767) | (3.894) |
| Observations | 19,865 | 18,643 | 18,618 |
| Adjusted R-squared | 0.490 | 0.556 | 0.568 |
| **Panel D: Demand Uncertainty2** | | | |
| Foreign demand uncertainty | 0.026*** | 0.020*** | 0.023*** |
| | (3.230) | (2.827) | (3.254) |
| Observations | 19,926 | 18,634 | 18,610 |
| Adjusted R-squared | 0.346 | 0.428 | 0.455 |
| **Panel E: Demand Uncertainty3** | | | |
| Foreign demand uncertainty | 0.001*** | 0.001*** | 0.000*** |
| | (7.440) | (3.990) | (3.070) |
| Observations | 19,926 | 18,634 | 18,610 |
| Adjusted R-squared | 0.349 | 0.429 | 0.455 |
| Control variables | | YES | YES |
| Firm FE | YES | YES | YES |
| Year FE | YES | YES | YES |
| Industry × Year | | | YES |
| Province × Year | | | YES |

**Table 7 Other robustness tests**

This table reports the results of our other robustness checks. The dependent variable is our primary corporate risk-taking indicator, $Risk1$. The measure of foreign demand uncertainty is $ForeignUncertainty1$. In Panel A, we exclude those potential dominant firms, defined as those with the export of a good exceeding 10% of a country's import for this good. In Panel B, we exclude the observations during the Global Financial Crisis period. In Panel C, we extend our the end-period of our sample from 2016 to 2022. However, due to data limitations, we replace our initial firm-level foreign demand uncertainty indicator by using an industry-level indicator. With the use of this industry-level indicator, we exclude the industry-year-specific fixed effects. All regressions are estimated using a fixed-effects estimator. We employ heteroskedasticity and within-panel serial correlation robust standard errors, and cluster standard errors at the industry-level. $t$-statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

| | Firm Risk | | |
|---|---|---|---|
| | (1) | (2) | (3) |
| **Panel A: Drop dominant firms** | | | |
| Foreign demand uncertainty | 0.020** | 0.017** | 0.020** |
| | (2.468) | (2.116) | (2.569) |
| Observations | 15,619 | 14,532 | 14,502 |
| Adjusted R-squared | 0.354 | 0.434 | 0.465 |
| **Panel B: Drop observations from 2008 to 2010** | | | |
| Foreign demand uncertainty | 0.029*** | 0.022*** | 0.025*** |
| | (3.603) | (2.950) | (3.376) |
| Observations | 16,418 | 15,245 | 15,222 |
| Adjusted R-squared | 0.344 | 0.426 | 0.453 |
| **Panel C: Industry-level foreign demand uncertainty** | | | |
| Foreign demand uncertainty | 0.004*** | 0.003*** | 0.008* |
| | (3.158) | (2.069) | (1.698) |
| Observations | 28,937 | 27,039 | 27,028 |
| Adjusted R-squared | 0.332 | 0.410 | 0.422 |
| Control variables | | YES | YES |
| Firm FE | YES | YES | YES |
| Year FE | YES | YES | YES |
| Industry × Year | | | YES |
| Province × Year | | | YES |

**Table 8 Foreign demand uncertainty, profit substitution, and firm risk-taking**
This table reports our results on the mediating role of firms' profit substitution incentive in the "foreign demand uncertainty - corporate risk-taking" relationship. Panel A regresses firms' core business profit on foreign demand uncertainty, with results presented in columns (1) - (3), and incorporate core business profits as an additional determinant of corporate risk-taking, with results presented in columns (4) - (6). Panel B regresses firms' reliance on financial assets in generating profits on foreign demand uncertainty in columns (1) - (3), and then regresses corporate risk-taking on firms' reliance on financial profits in columns (4) - (6). Corporate risk-taking is measured by $Risk1$, while foreign demand uncertainty is measured by $ForeignUncertainty1$. All regressions are estimated using a fixed-effects estimator. We employ heteroskedasticity and within-panel serial correlation robust standard errors, and cluster standard errors at the industry-level. $t$-statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

| | Mediator | | | Firm Risk | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Panel A: Main business profits** | | | | | | |
| Foreign demand uncertainty | -0.131*** | -0.063*** | -0.059*** | 0.016** | 0.019*** | 0.022*** |
| | (-5.526) | (-3.244) | (-3.275) | (2.300) | (2.902) | (3.475) |
| Core business profits | | | | -0.071*** | -0.011* | -0.012** |
| | | | | (-17.444) | (-1.882) | (-2.048) |
| Observations | 19,926 | 18,630 | 18,606 | 19,926 | 18,630 | 18,606 |
| Adjusted R-squared | 0.386 | 0.721 | 0.729 | 0.381 | 0.431 | 0.457 |
| **Panel B: Reliance on financial profits** | | | | | | |
| Foreign demand uncertainty | 0.277** | 0.263** | 0.218** | 0.025*** | 0.019*** | 0.023*** |
| | (2.219) | (1.985) | (2.072) | (4.826) | (2.970) | (3.554) |
| Reliance on financial profits | | | | 0.001 | 0.001** | 0.001* |
| | | | | (1.465) | (2.252) | (1.721) |
| Observations | 19,926 | 18,630 | 18,606 | 19,926 | 18,630 | 18,606 |
| Adjusted R-squared | 0.157 | 0.168 | 0.168 | 0.347 | 0.431 | 0.457 |
| Controls | | YES | YES | | YES | YES |
| Firm FE | YES | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES | YES |
| Industry × Year | | | YES | | YES | YES |
| Province × Year | | | YES | | | YES |

**Table 9 Foreign demand uncertainty, financing constraints, and corporate risk-taking**
This table reports the results on the mediating role of financing constraints in the "foreign demand uncertainty - corporate risk-taking" relationship. Panel A uses borrowing costs, defined as interest expenses to outstanding loans, to represent financing constraints. The impacts of foreign demand uncertainty on firms' financing costs are presented in columns (1) - (3), while the effects of financing costs on corporate risk-taking are reported in columns (4) - (6). Panel B uses the availability of trade credit to measure financing constraints. The impacts of foreign demand uncertainty on trade credit are presented in columns (1) - (3), while the effects of trade credit on corporate risk-taking are reported in columns (4) - (6). Corporate risk-taking is measured by $Risk1$, while foreign demand uncertainty is measured by $ForeignUncertainty1$. All regressions are estimated using a fixed-effects estimator. We employ heteroskedasticity and within-panel serial correlation robust standard errors, and cluster standard errors at the industry-level. $t$-statistics are reported in parentheses. ***, ** and * indicate significance at the 1%, 5%, and 10% levels, respectively.

| | Mediator | | | Firm Risk | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Panel A: Financing costs** | | | | | | |
| Foreign demand uncertainty | 0.012*** | 0.007*** | 0.006** | 0.022*** | 0.024*** | 0.031*** |
| | (3.855) | (2.946) | (2.517) | (3.089) | (3.593) | (4.631) |
| Financing costs | | | | 0.364*** | 0.216*** | 0.228*** |
| | | | | (13.750) | (8.607) | (9.042) |
| Observations | 16,746 | 15,896 | 15,875 | 15,987 | 15,052 | 15,035 |
| Adjusted R-squared | 0.483 | 0.665 | 0.680 | 0.405 | 0.471 | 0.495 |
| **Panel B: Trade credit** | | | | | | |
| Foreign demand uncertainty | -0.033** | -0.034** | -0.042*** | 0.025*** | 0.020*** | 0.023*** |
| | (-2.294) | (-2.488) | (-3.052) | (3.583) | (2.975) | (3.525) |
| Trade credit | | | | 0.006 | -0.016*** | -0.015*** |
| | | | | (1.378) | (-3.446) | (-3.200) |
| Observations | 19,926 | 18,634 | 18,610 | 19,926 | 18,634 | 18,610 |
| Adjusted R-squared | 0.590 | 0.671 | 0.695 | 0.347 | 0.429 | 0.456 |
| Controls | | YES | YES | | YES | YES |
| Firm FE | YES | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES | YES |
| Industry×Year | | | YES | | | YES |
| Province×Year | | | YES | | | YES |