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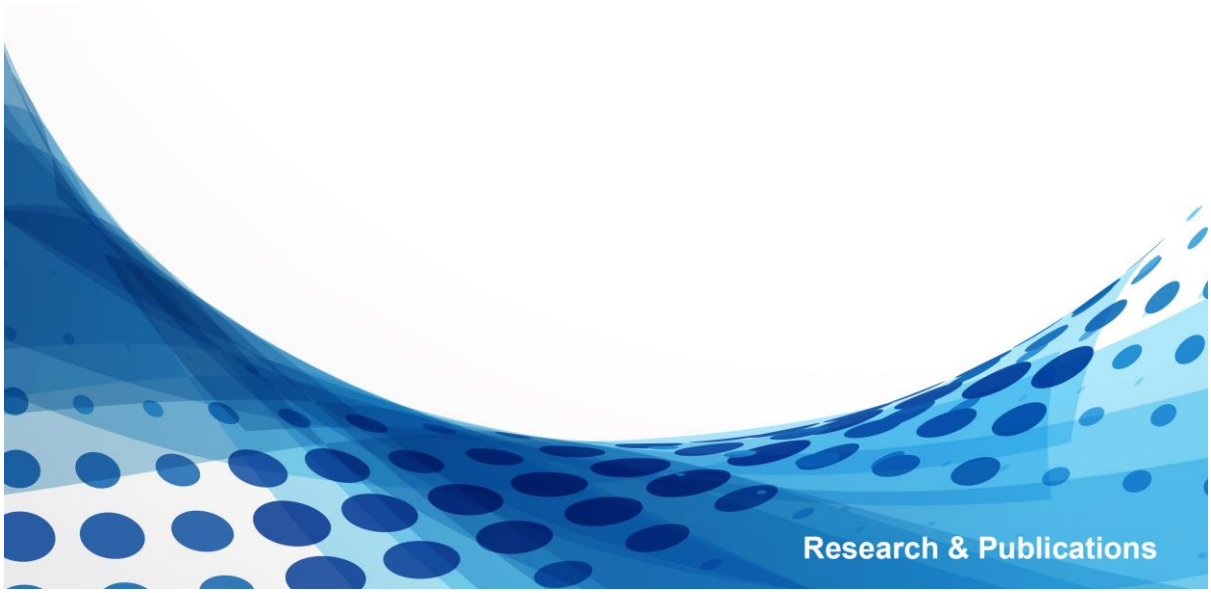
Global Supply Chain Vulnerabilities: Assessing Firm Risk, Environmental Commitments, and Information Channels in the wake of COVID-19

Huzaifa Shamsi



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Global Supply Chain Vulnerabilities: Assessing Firm Risk, Environmental Commitments, and Information Channels in the wake of COVID-19

Huzaifa Shamsi *

January 3, 2024

Abstract

This study investigates the profound impact of the COVID-19 pandemic on firm risk, focusing on supply chain disruptions and their spillover effects on environmental commitments. The research highlights the crucial role of information channels in mitigating these challenges. Employing a Difference-in-Differences (DiD) regression design, the findings reveal a significant increase in default probability among US-incorporated firms with heightened foreign relationships post-COVID-19, particularly those connected to Chinese supply chains. Additionally, firms with foreign relationships show a decline in environmental commitments, suggesting prioritization of survival during adversity. Notably, companies with robust information channels with industry peers exhibit resilience against supply chain disruptions. These results underscore the importance of strategic resilience and diversification in navigating the complexities of the modern global economic landscape.

Keywords: Supply chains, COVID-19, Firm risk, Environmental commitments, China, Information channels

JEL Classification: G32, G33, F23, Q56, L14

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1 Introduction

In the 1980s, advancements in information and communication technology (ICT) empowered developed nations to relocate manufacturing to emerging countries, sparking a surge in trade and foreign direct investment (FDI). The subsequent ICT revolution allowed G7 enterprises to share proprietary expertise with emerging countries while outsourcing production stages. This created an innovative, low-wage manufacturing model, reshaping the competitive landscape (Baldwin, 2016). The outcome was the swift industrialization of specific emerging markets, surpassing the historical development pace of renowned newly industrialized economies like Hong Kong, Singapore, South Korea, and Taiwan (Birdsall et al., 2007). By 2010, the G7's global manufacturing share had decreased from two-thirds in 1990 to less than half, counteracted by the ascent of a few rapid industrializers—most notably China (Baldwin and Freeman, 2022).

Emerging countries experienced significant growth, yet not without complexities. Increased dependence on foreign nations, natural disasters in Malaysia and Thailand, and the rise of populism shifted the narrative towards risk assessment in supply chain systems rather than rewards. This shift influenced national policies in the 2010s, marking a transformation of global supply chains. Once pillars of globalization and industrial competitiveness, they symbolize vulnerability, coercion, and the amplification of micro shocks into macro shocks. The surge of right-wing political ideologies, the growing inclination toward deglobalization, and the intensification of the U.S.-China trade conflict exacerbated apprehensions in financial markets. To illustrate, Huang et al. (2018) discerned that American enterprises reliant on both exports to and imports from China encountered diminished stock and bond returns, coupled with elevated default risks surrounding the announcement date. Han et al. (2021), in their investigation, established that U.S. sanctions detrimentally affected innovation and stock performance among Chinese firms operating in the sanctioned sectors. However, the culminating blow was delivered by the onset of the COVID-19 crisis.

The lockdowns in countries pushed them to the brink of economic failure. The global economy entered a recession in 2020 due to the COVID-19 pandemic. Stock markets

worldwide faced their most severe decline since 1987, and the G20 economies collectively contracted by 3.4% in the first quarter of 2020. During the second quarter of that year, the International Labour Organization reported a staggering loss of approximately 400 million full-time jobs globally. Additionally, global worker income plummeted by 10% in the first nine months of 2020, amounting to a substantial loss exceeding US$3.5 trillion [1]. The firms exposed to the Covid faced substantial constraints to pass through it. The impact of the pandemic was heterogeneous based on firms' characteristics and exposures. Bretscher et al. (2020) found that companies based in a county affected by an event generally encounter a 27-basis-point reduction in returns during the ten days following the event. It found the adverse impact doubled for companies in counties with a higher infection rate, reaching -50 basis points. Companies in labor-intensive industries and those situated in counties experiencing significant declines in mobility exhibit poorer stock performance. Carletti et al. (2020) analyzed a large sample of Italian firms. It found that a 3-month lockdown results in an overall annual profit decline equivalent to approximately 10% of the Gross Domestic Product (GDP).It also found that smaller and medium-sized enterprises, those with high pre-COVID-19 leverage, and companies in the Manufacturing and Wholesale Trading sectors are more prone to financial difficulties.

The pandemic and subsequent recession caused a substantial supply chain disruption, particularly due to the closure of businesses in China, the world's leading exporter. My analysis revealed that nearly two-thirds of the firms were reliant on sources outside the U.S., with China accounting for approximately 25% of these firms. The considerable dependence on international supply chains exposed these companies to significant risks, potentially prompting them to explore alternatives and reduce expenditures for future endeavors. The disruptions have exposed the fragilities of the global supply chain system and highlighted the costs associated with non-diversification in entities. This lack of diversification subjected them to idiosyncratic risks.

This study focuses on the impact of supply chain disruption on firm risk and other endeavors during COVID-19. In this study, I employ a Difference-in-Differences (DiD) regression design to examine whether firms exposed to foreign relationships experience an increase in

[1] https://en.wikipedia.org/wiki/Economic_impact_of_the_COVID-19_pandemic

firm risk after COVID-19. The treatment group in this case consists of US-incorporated firms with non-domestic relationships. The post-period commences from the 1st quarter of 2020, and a relationship variable, serving as a count variable proxying the number of foreign relationships, is incorporated. Empirical analysis indicates that an increase in the relationship with one foreign firm raises the firm's default probability after COVID-19 by 0.018 percentage points over sixty months. The increase in risk is 0.9% of the mean of the dependent variable. The findings suggest that the heightened risk diminishes after the fading out of the COVID-19 impact. Notably, firms exposed to Chinese supply chains exhibit a more pronounced impact compared to those with non-Chinese suppliers or customers.

Additionally, foreign relationship firms are observed to reduce their commitments to environmental endeavors, resulting in a decline in their environmental proxy scores. This reduction in environmental commitment may be attributed to the increased survival risk, prompting firms to prioritize essential activities during adverse times. Furthermore, firms with better information channels with other same industry firms demonstrate an ability to mitigate the impact of supply chain disruptions on firm risk. These results remain robust across various specifications.

I conducted three robustness tests for my main hypothesis. Firstly, I employed Propensity Score Matching (PSM) based on firms' characteristics just before the shock, and the results remained robust to this approach. Secondly, I implemented a placebo test by considering the first quarter of 2014 as the start of the post-period. The findings did not hold in that specification, indicating that the observed effect is specifically associated with the impact of COVID-19. For the final robustness check, I excluded firms that had a relationship with China, the most critical supplier severely affected by COVID-19. The results remained robust to this exclusion, suggesting that the observed effects are not driven solely by one country in the sample.

My study contributes to the literature in several significant ways. Firstly, to the best of my knowledge, it is the first study to comprehensively examine the impact of COVID-19 on firm risk, encompassing relationships with all countries. While previous studies have focused on the one-to-one relationship between the US and China, this study expands the

scope to include all non-domestic relationships, providing a more holistic understanding of the global impact. Secondly, the study delves into the subsequent effects of supply chain risk spillovers on the environmental commitments of firms. This aspect has not been explored in previous research, revealing the spillover effects that firms may have on non-essential endeavors during times of adversity. This adds a nuanced perspective to the understanding of how external shocks can influence firms' broader commitments. Thirdly, the findings related to the information channel contribute substantially, offering insights into the role of common ownership during times of adversity. This aspect provides a valuable direction for the literature on how interconnected ownership structures among firms can influence risk mitigation strategies. In summary, this study makes a threefold contribution by connecting supply chain dynamics with firm risk, analyzing the spillover effects on environmental commitments, and exploring the role of information channels in risk mitigation during challenging times.

In this paper, I conduct a literature review and articulate the research hypotheses in Section 2. Section 3 explains the data description and research methodology. Moving on to Section 4, I present the results and analyses for various hypotheses, accompanied by robustness tests. Finally, Section 5 offers the conclusion to this paper.

2 Literature review and Hypothesis development

Global supply chains have played a crucial role in shaping the world's economic landscape throughout the 21st century. Research indicates that disturbances to the cross-border movement of goods can exert significant economic impacts. The past decade witnessed various disruptions, including the US-China trade war, Brexit, and the Thailand floods. Hoontrakul (2017) demonstrated that the 2011 floods in Thailand had a substantial impact on global electronic and automotive industries, resulting in an estimated 2.5 percentage point decline in the growth rate of global industrial production. Carvalho et al. (2021) illustrated that the Great East Japanese earthquakes led to a 2-3 percentage point decline in firm-level annual sales growth for companies exposed to supply chain disruptions. Fajgelbaum and Khandelwal (2022) found that US consumers of imported goods

bore the brunt of tariffs through higher prices, with the trade war reducing aggregate real income in both the US and China.

Among these disruptions, the COVID-19 pandemic emerged as the most formidable, exposing firms to substantial risks due to the blockade of global supply chains. Companies exposed to it faced increased disruptions and encountered various constraints. Meier et al. (2020); Lafrogne-Joussier et al. (2023) demonstrated that industries heavily reliant on imports from China experienced significant contraction in March and April 2020 compared to less dependent sectors. These highly exposed sectors exhibited lower production, higher workforce layoffs, reduced export and import activities, and more pronounced increases in both import and output prices. Hupka (2022) revealed that firms historically responded to global supply pressures by reducing the total debt ratio. However, during the COVID-19 pandemic, companies sharply increased short-term debt values while also reducing long-term debt. Zhang et al. (2022) showed that COVID-19 altered the one-direction causality from the US oil market to the Chinese market in the pre-COVID period to a bidirectional causal relation between the two markets during the COVID period. Agca et al. (2020) found that abnormal CDS spreads for firms with Chinese supply chain partners increased by 12-13 percent relative to the average raw CDS spreads due to supply chain disruptions during the economic shutdown in China.

Following these studies, I conjecture that firms that are exposed to supply chain disruptions during COVID-19 would have seen an increase in their risk of default. The increase in risk should subside with time as firms start adjusting towards alternative sources, and the fading out of COVID-19. The effect depends on the extent of the relationships a firm has with foreign companies. China is the largest exporter to the US and was highly impacted by COVID. The spillover effects would be higher for the firms having a relationship with China compared to others. This leads us to propose our first hypothesis:-

Hypothesis 1 - Firms with international supplier or customer relationships are exposed to heightened risks as a result of the impact of COVID-19.

Having outlined the impact of supply chain shocks on exposed firms' risk, the subsequent analysis delves into its implications. Existing research reveals that firms tend to curtail

investments, leverage, and payouts during crises. For instance,Bliss et al. (2015) identified significant reductions in corporate payouts during the 2008-2009 financial crisis, particularly in firms with higher leverage, valuable growth options, and lower cash balances. Similarly, Kariya (2022) observed that firms constrained by earnings-based borrowing curtailed investments, debt issues, and corporate payouts during the 2008 financial crisis. These studies underscore the tendency of shocks to compel firms to minimize cash outflows.

In the 21st century, the imperative for investment escalated with the emergence of climate shocks and transition risks. The 2010s witnessed a growing acknowledgment of climate change, with governments setting net-zero targets, institutional investors incorporating environmental considerations, and firms exploring renewable energy transitions. Over the past two decades, investments aligned with Environmental, Social, and Governance (ESG) goals have surged, reaching $35.3 trillion globally by the beginning of 2020, a 15% increase from 2018, constituting almost 36% of total assets under management ((Bialkowski and Starks, 2016)

The COVID-19 pandemic compelled firms to trim spending, leverage, investments, and corporate payouts (Krieger et al., 2021; Jiang et al., 2021; Haque and Varghese, 2021). Such shocks may prompt firms to reconsider future commitments, especially in plans for future endeavors like transitioning to renewable resources. Firms previously committed to renewable energy may face delays or cancellations due to the pandemic's impact on their survival strategies. This reduction in commitments is expected to be more pronounced for firms highly exposed to the shocks, as indicated by our first hypothesis stating that firms with non-domestic relationships are more susceptible to supply chain disruptions, leading to heightened risk. This rationale forms the basis for our second hypothesis, positing that exposed firms are deferring their commitments to climate risks.

Hypothesis 2 - Firms with international supplier or customer relationships reduce their commitment to environmental goals as a consequence of the impact of COVID-19.

This hypothesis investigates whether enhanced information exchange between firms can

contribute to their resilience during economic downturns. In my previous propositions, I posited that US firms with non-domestic relationships faced heightened default risk during COVID-19 due to supply chain disruptions. Additionally, the spillover effect of these disruptions prompted firms to prioritize survival over their ESG commitments. Now, I posit that companies with more robust information channels, particularly those sharing owners within the same industry, may act as moderators, alleviating the impact of supply chain disruptions on firm risk during the pandemic. This information exchange could facilitate optimal collective solutions. This channel is called common ownership.

Common ownership in the US has evolved with time, particularly with the rise of mutual funds. Studies have demonstrated improved information transfer when firms share stockholders within their industry. This overlapping ownership has fostered collaboration and enhanced governance, offering insights into potential mechanisms for mitigating adverse shocks. Kang et al. (2018) showed that common owners, possessing industry-specific experience and knowledge, can monitor managers at a lower cost. Gompers et al. (2008) observed that startup companies benefit from more industry information and experience, enabling them to identify investment opportunities more effectively. The monitoring experience in one company can also reduce supervision costs for other companies in the same industry, as found by (Boyson and Mooradian, 2012). Jiang et al. (2022) demonstrated that common ownership leads to lower stock price crash risk, attributed to the monitoring effect of Common Ownership Concentration (CoC). Additionally, it reduces earnings management and increases accounting conservatism. Common ownership enhances price informativeness through increased disclosure, improved information production and diffusion, and active trading by common owners (Jang et al., 2022).

Common owners can play a crucial role in times of adversity. Collusion among firms with common ownership can facilitate the formation of cartels, increasing their market power and ensuring diversification in certain endeavors. In the context of supply chain relationships, firms facing shocks from suppliers can swiftly shift to other firms' suppliers through better information transfer if they share a common owner. For instance, if a company imports products from China and a trade war disrupts its supply chain, having a common owner with another firm in the same industry that procures materials from

a different country allows for quick identification of alternative suppliers. This channel facilitates shock mitigation and serves as a shock absorber during times of adversity. This leads us to propose our third hypothesis. China is the most important contributor to the US supply chain. This hypothesis uses relationship data of Chinese companies only as it was the most important source of supply chains during COVID-19.

Hypothesis 3 - Firms engaged in supplier or customer relationships with China exhibit lower risk levels when they share a common owner in the same industry, as compared to those without such common ownership

3 Data and Methodology

This section will explore the sample collection, data sources, variable construction, and methodology used in the study. I will also show the summary statistics and coefficient plots used in this study.

3.1 Data

This study utilizes quarterly data from publicly listed US firms, excluding financial firms (SIC codes 6000-6999) and utility firms (SIC codes 4900-4999). The dataset covers the period from the first quarter of 2017 to the second quarter of 2022, comprising 22 quarters of data. All data points have been winsorized at the 1% and 99% levels.

The dataset for relationships is sourced from the Factset revere of WRDS, extensively utilized in firm-level relationship studies (Fruehling et al., 2023; Hand et al., 2022). It encompasses customer, supplier, competitor, and partner relationships. For supplier-customer relationships, reporting is based on both suppliers and customers, with an example being if Walmart reports certain firms as suppliers, and those supplier firms report Walmart as a customer. All suppliers and customers may not be reporting the relationships. Hence, to enhance granularity, reports from both sides are combined to obtain more comprehensive data. Variables for firms that have not reported any relationships are marked with zero.

This study focuses on the non-domestic supplier, partner, and customer relationships of US firms and doesn't use competitor relationships as this doesn't align with our hypoth-

esis. A count variable has been created based on the number of reported relationships at the end of each quarter. For example, if the relationship variable is 10, this means the firm has supplier, partner, or customer relationships with ten companies outside the US. Emphasis is placed on all non-domestic relationships as well as those with China, a significant contributor to the US supply chain adversely affected by COVID-19. The analysis reveals heterogeneity in effects between China and all other countries.

My main dependent variable for the first hypothesis is the risk of the firm. The Probability of Default (PD) and Distance to Default (DTD) measures serve as proxies for risk. Data for these measures is sourced from the National University of Singapore website, providing estimates at the daily level. This database has been widely utilized in various studies (Nguyen et al., 2022; Hsu and Chen, 2021). The PD measure in this study is derived from the forward intensity model proposed by (Duan et al., 2012). This model utilizes both Macro-financial factors and Firm-specific factors as attributes to estimate the Probability of Default (PD). Five duration measures of PD are employed, encompassing sixty months, thirty-six months, twenty-four months, twelve months, and six months probability of default. The Distance to Default (DTD) measure is based on (Merton, 1974)'s structural model, with the National University of Singapore (NUS) utilizing a modified version. Additional proxies are incorporated into the analysis to enhance robustness. These variables are available at the quarterly level.

Institutional ownership data is extracted from the 13F filings data of WRDS. This dataset is widely used in common ownership literature. It can be extracted either through WRDS or direct scraping from filings. It focuses on block holders with a minimum of 5 percent ownership of a firm's outstanding shares. These blockholders have incentives to influence firm decisions, aligning with prior studies He and Huang (2017). Two proxies for common ownership at the firm-quarter level are utilized. The "Presence" variable is a dummy variable indicating whether a company's owner has block holding in another firm within the same industry. Another variable, "Extent," measures the number of firm owners holding another firm in the same industry. The natural logarithm of extent is employed to estimate the percentage effect of the extent of common ownership. Proxies related to Environment and Emissions are derived from Refinitiv Eikon. The environmental score

considers resource use, emissions, and innovation toward renewable sources in relation to the company's sector. The emission category score assesses a company's dedication and effectiveness in reducing environmental emissions during its production and operational processes. Additionally, the ESG Combined Score offers a comprehensive evaluation of a company's Environmental, Social, and Governance (ESG) performance based on reported information in these pillars. The ESG score may not be properly interpretable as it has confounders in the form of social and governance factors. This dataset, extensively used in prior studies, acts as a proxy for firms' environmental commitments. This variable is available at the yearly level.

Several firm-level control variables are employed, including the natural logarithm of total assets (Firm size), Debt/Assets (Leverage), Institutional ownership percentage, Net Profit Margin (NPM), Price-to-Book Ratio (PTB), firm beta relative to the market (B-Mkt), and Return on Assets (ROA). Fixed effects will be used to control for other characteristics. **??** provides the definition of each of the variables. These variables are available at a quarterly level from Compustat other components of WRDS.

The pre-variable spans from the 1st quarter of 2017 to the 4th quarter of 2019, with the post-period commencing in the 1st quarter of 2020, coinciding with the onset of the COVID-19 pandemic. It is crucial to acknowledge that the matching of data from various sources may result in some loss of population data, but this limitation is unavoidable.

Table 2 presents the summary statistics for each variable used in the analysis. `Relationship` is the variable for having a count of all non-domestic relationships during the quarter. `Relationship_CN` is the count of relationships with Chinese firms. `PD` measures the probability of default in the next sixty, thirty-six, twenty-four, twelve, and six months. `DTD` is a distance to default measure of risk. `Institute_own` is the percentage of ownership by institutions out of total shares outstanding. `Extent` and `Presence` are proxies for common ownership. Others are control variables.

The summary statistics indicate that the average number of non-domestic relationships for US firms is approximately 4.5, a substantial figure. China constitutes a significant portion of these relationships. About 66% of firms have reported at least one non-domestic

relationship, while approximately 15% of firms have reported at least one relationship with China. This implies that 25% of firms with relationships outside the country have China as a foreign supplier. The Probability of Default measures have been multiplied by 100 to express them as a percentage chance of default, as their original values were very low in probability terms. The scores from Refinitiv are on a scale of 0 to 100, where a higher score indicates a better commitment or measures towards environmental-related goals.

3.2 Methodology

3.2.1 For hypothesis 1 and 2

I use a Difference-in-Difference (DiD) methodology to estimate the impact of non-domestic relationships on firm risk during and after COVID-19. The baseline specification is as follows:-

$$Y_{i,(t+1),j} = \beta_0 + \beta_1 Z_{i,t,j} + \beta_2 Z_{i,t,j} \times \text{COVID-19} + \beta_3 X_{i,t,j} + \alpha_i + \gamma_t + \lambda_{t,j} + \varepsilon_{i,t,j} \qquad (1)$$

In Equation 1, the dependent variable, denoted as Y, represents firm risk in our baseline specification. The main explanatory variable, denoted as Z, represents a firm's non-domestic relationships at the end of the quarter. The subscript j indicates the industry of the firm for the inclusion of industry fixed effects. The dummy variable COVID-19 equals one from the first quarter of 2020. β_1 captures the effect of non-domestic relationship with firm risk. The β_2 captures the hypothesized main effect of how COVID-19 impacts the risks of the firms that have business relationships outside the country. It is expected to be positive for the probability of default and negative for distance to default proxies as the dependent variable.

Firm-level control variables, including size, leverage, institutional ownership, NPM, PTB, beta, and ROA, collectively denoted as Z in the study, are lagged by a quarter to address potential endogeneity concerns. Unobserved heterogeneity at the firm level is controlled using α as firm fixed effects.

Time-fixed effects, denoted as γ, are employed to control for unobserved heterogeneity at the quarter-year level. λ serves as an Industry $\times$ Year fixed effect variable to control for industry-level unobserved characteristics that vary throughout the quarter-year. It might be possible that whole industries were severely affected by COVID-19, and they or the government are taking industry-level measures. This robust fixed effect model helps in mitigating the omitted variable bias in the study.

For Hypothesis 2, the dependent variable Y represents the environmental, emissions, and ESG scores of the firm. All other variables and fixed effects remain unchanged for this hypothesis.

I also investigate the moderating effect of common ownership firms on firm risk after COVID-19. This hypothesis explores non-domestic relationships with China, considering its pivotal role in the US supply chain, particularly affected during COVID-19. Employing a DiD methodology with triple interaction, it evaluates the influence of common ownership on firms' risk within the same industry, comparing those with common owners to those without.

$$\begin{aligned} Y_{i,(t+1),j} = \beta_0 &+ \beta_1 Z_{i,t,j} + \beta_2 A_{i,t,j} + \beta_3 Z_{i,t,j} \times \text{COVID-19} \\ &+ \beta_4 A_{i,t,j} \times \text{COVID-19} + \beta_5 Z_{i,t,j} \times A_{i,t,j} \times \text{COVID-19} \\ &+ \beta_6 X_{i,t,j} + \alpha_i + \gamma_t + \lambda_{t,j} + \varepsilon_{i,t,j} \end{aligned} \tag{2}$$

In Equation 2, the dependent variable, denoted as Y, represents a firm risk in this specification as well. The main variable for our estimation is β_5, which represents the effect of common ownership for the firms that have non-domestic relationships with China during COVID-19. I hypothesize it to be negative for the probability of default and positive for distance to default as it is weakening the effect induced by COVID-19 on relationship firms. All other variables are variables, and specifications are the same as in the last equation.

For robustness, Three robustness tests are used. I employ propensity score matching

(PSM), placebo testing, and exclusion of China from the sample.

First, PSM matching utilizes firm controls from the last quarter of 2019, the final point in the pre-period, including variables such as relationship, size, leverage, institutional ownership, NPM, PTB, beta, and ROA. The matching results are presented for hypotheses 1 and 2.

Second, The placebo analysis uses data from the 1st quarter of 2011 to the 4th quarter of 2016. The pre-treatment period spans twelve quarters until the end of 2013, with the 1st quarter of 2014 serving as the initial post-treatment period for both first and second hypotheses. For hypothesis 2, Environmental coverage is notably low during the placebo and especially in its pre-period, which weakens the robustness of the second hypothesis. The coverage also decreases for Hypothesis 1, but a significant portion of the sample remains intact. Third, China has a substantial role to play in the world's supply chains, and it was most impacted during COVID-19. To substantiate the findings. I dropped firms that have a relationship with China during the sample. The results, after excluding these firms, will help validate the findings.

4 Findings and discussion

This section delves into the outcomes of the proposed hypotheses. Initially, it examines the influence of non-domestic relationships on firm risk post-COVID-19. The presentation commences with coefficient plots, highlighting the significance of the results, and concludes by showcasing robustness tests. Subsequently, the discussion shifts to the second hypothesis, investigating the impact of these relationships on the firm's environmental scores. Lastly, the third hypothesis explores and discusses the relationships in the context of China, elucidating how common ownership mitigates supply chain disruptions arising from the region.

4.1 Impact of non-domestic relationship with firm risk

Figure 1, Figure 2, and Figure 3 present coefficient plots for various risk proxies. The positive significance for the probability of default and the negative significance of distance

to default after COVID-19 indicate an increase in the risk of firms with non-domestic relationships. This effect diminishes after 4-5 quarters of the post-period, potentially due to firm-level adjustments, government rescue packages, and the easing of lockdowns in various countries. The "t" point in the x-line marks the last quarter of 2019. All risk proxies consistently exhibit an uptick for firms with relationships during COVID-19. However, the effects for twenty-four months PD, twelve months PD, and six months PD are comparatively weak. Long-term PD measures are deemed more robust due to the calculation methodology.

The Distance to Default measure significantly differs from 0 after COVID-19, but it also exhibits declines in some quarters in the pre-treatment period. This could be influenced by the wave of deglobalization and the trade war with China. In an unreported analysis, I explore a coefficient plot after excluding China from the sample, but the prior significance of DTD persists. Hence, this effect is not solely driven by China and may be attributed to the spillover of the trade war or the wave of deglobalization.

Table 3 presents the regression results utilizing two specifications of fixed effects. In Columns 1, 3, and 5, industry and year fixed effects are applied, while Columns 2, 4, and 6 utilize firm and industry fixed effects, representing the most robust model in this study. The consistent findings indicate that firms with non-domestic relationships experience an increase in their default risk after COVID-19. Significance holds across all specifications and proxies used for firm risk, with results significant at the 1% level. The standard deviation of the relationship variable is 9.441. For Column 2, a one standard deviation increase in non-domestic relationships results in a (0.018×9.441) 0.16 percentage point increase in sixty-month PD. The size of the effect diminishes as the PD term reduces from sixty months to 24 months. Table 4 displays results for twelve-month PD, six-month PD, and DTD, showing consistent results although the coefficient or economic significance has markedly decreased for PD measures. For column 2 in Table 4, a one standard deviation increase in a relationship leads to an increase in twelve months PD by 0.02 percentage points. Control variables also exhibit consistent results. The negative coefficient for institutional ownership and the positive coefficient for leverage align with existing literature.

In Table 5, I conducted regressions replacing the relationship variable with a variable that specifically calculates the Chinese relationships of US firms. The coefficients obtained were significant and around ten times higher than those reported for all non-domestic relationships. This underscores the considerable importance of China for US firms.

4.1.1 Robustness

In this section, three robustness checks are conducted to validate the results of the baseline. Firstly, a Propensity Score Matching (PSM) is performed based on the matching of control variables in the pre-treatment period. Secondly, a placebo test is executed using data from 2011-2016, with the first quarter of 2014 designated as the start of the post-treatment period. As indicated in the preceding section, the significance for Chinese firms is notably higher compared to the overall sample. To validate the findings, Firms with Chinese relationships are dropped from the sample to estimate the results to make results robust.

Table 6 presents the results for Propensity Score Matching (PSM) estimates. The sample size is reduced due to matching, but the results remain significant across regression specifications. Only firm and Industry-year fixed effects specification results are displayed for all risk proxies, and the findings consistently hold, albeit showing some weakening in certain specifications.

Table 7 displays the results for the placebo test, where a fabricated treatment is introduced in the first quarter of 2014. The coefficients are weak and almost significant, with an opposite sign to the main results. This suggests that the findings in Table 3 and Table 4 are driven by COVID-19 and not by any other event in the pre-treatment period. Table 8 presents the results after excluding firms with relationships with China. The findings, while somewhat weakened, remain significant for four of the six proxies in the sample. This underscores the substantial role China plays in the US supply chains and its impact during the COVID-19 pandemic. It's important to note that this subsample would also exclude firms with relationships with other countries, not just China, but this limitation cannot be avoided.

The three robustness checks employed in the study validate the results, and the causal effect can be interpreted accordingly. The significance of China during this disruption, as

indicated in the literature, cannot be discounted. The second hypothesis illustrates the spillover of firm risk onto the environmental goals of the firms, emphasizing the heightened focus on survival during times of adversity.

4.2 Spillover of supply chain disruptions on Environmental commitments

Figure 4 displays coefficient plots for Environment and Emissions scores. ESG score plots are omitted, as they encompass social and governance scores not pertinent to our hypothesis. Scores are calculated annually, resulting in quarterly clustering as other variables are at quarter-year level, but this does not hinder result interpretation. Negative significance in both environmental and emissions scores post-COVID-19 suggests a decline in firms' environmental commitments with international relationships, attributable to supply chain disruptions during the pandemic. The "t" point on the x-axis marks the last quarter of 2019, and all environment proxies consistently show a downturn for firms with non-domestic relationships during COVID-19. However we don't see any recovery as being shown in our main hypothesis. The recovery can be hindered by the anti-ESG wave and ambiguity towards ESG commitments and investments from firms. In 2023, around 25 states of the US has passed anti-ESG laws in some form or the other [2]. BlackRock's support for shareholder proposals on environmental and social issues are also falling sharply [3]. This is the reason that firms have not recovered towards Environment-related commitments after economic recovery.

Table 9 exhibits regression results with two fixed effects specifications. Columns 1, 3, and 5 include firm and year fixed effects, while columns 2, 4, and 6 add firm and industry-year fixed effects. Consistent findings indicate that firms with non-domestic relationships witness decreased environmental commitments post-COVID-19. Significance persists across all specifications and risk proxies, with results significant at the 1% level. The standard deviation of the relationship variable is 10.67. For column 2, a one standard deviation increase in non-domestic relationships results in a (-0.134 $\times$ 10.67) 1.42 units decrease

[2] https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/states-anti-esg-push-leaves-patchwork-of-policies-unclear-mandates-77133331

[3] https://www.ft.com/content/06fb1b85-56ba-48cd-b6f6-75f8b8eee7e1

in the Environmental score. Similar results hold for other specifications. Caution is advised in interpreting ESG scores, as they include commitments to social and governance categories. Control variables contrast with our first hypothesis, showing no significant results.

The environmental score reflects a company's management practices to navigate environmental risks and capitalize on opportunities for long-term shareholder value. Increased survival risk may divert management focus to immediate concerns, such as supply chain disruptions, leading to a decline in efforts and commitments towards climate change. The Emission category score gauges a company's commitment and effectiveness in reducing environmental emissions in production and operations, indicating a withdrawal of efforts in climate change commitment.

4.2.1 Robustness

This hypothesis undergoes validation through three robustness checks. First, propensity score matching (PSM) is conducted based on control variables, similar to the first hypothesis. Second, a placebo is employed with pre and post-period definitions as before. The third robustness check excludes Chinese relationships from regressions.

Table 10 presents PSM estimates with a reduced sample size due to matching. The coefficients in the main specification, featuring firm and industry-year fixed effects, have significantly increased compared to baseline results, rising by almost 50

Table 11 displays placebo results, cautioning interpretation due to low environmental scores coverage in the early 2010s. The limited 23-quarter data, representing 6,000 observations compared to the original 24,000, upholds results, but the joint f-statistic null is not rejected for all three specifications, indicating a cautious interpretation of placebo results. The significance in the placebo results can be the spillover of climate risks on customer firms after Paris agreement 2015.

Table 12 reveals results after excluding China from the sample. These specifications yield non-significant results, except weakly for ESG scores, challenging proper interpretation. This underscores the significant impact China has on supply chain relationships with

the US during the COVID-19 pandemic, with the 5,000 Chinese firm sample potentially influencing outcomes. Note that this subsample also excludes firms with relationships with other countries, an unavoidable limitation.

Table 13 demonstrates PSM estimates, with the independent variable being the number of relationships with China. The substantial size of coefficients, almost ten times compared to baseline results, highlights the pronounced impact of China in this context.

The three robustness checks weaken the results, emphasizing the need for a cautious interpretation of the causal effect. The undeniable significance of China during this disruption, as supported in the literature, leads to the last hypothesis, which specifically considers relationships with China.

5 Additional analysis

In this section, I investigate the moderation effect of common ownership during COVID-19 disruptions. The results for the impact of common ownership on various proxies of firm risk are presented in Table 14. The variable "Extent" represents the logarithm of the count of the firm's owners who own other firms in the same industry. Columns include six proxies of risk with firm and industry-year fixed effects. All columns employ the triple interaction specification. Our main variable of interest is Cov. $\times$ Relat_CN $\times$ Extent. I hypothesize that common ownership negatively moderates the effect of the supply chain on firm risk during COVID-19. The results must be interpreted in conjunction with the variable (Covid $\times$ Relat_CN), which presents the results for our first hypothesis: that firm risk increases during Covid-19 if the firm has a relationship with foreign companies.

The results for the triple interaction indicate that the effect of the first hypothesis is mitigated if the firm shares a common owner in the same industry. In column 1, the Hypothesis 1 variable exhibits a positive coefficient of 0.218. The triple interaction shows a negative value of -0.143. This implies that the firm risk for relationship firms that have common owners increases by only 0.75 percentage points in the case of a one-unit increase in a relationship or common ownership during COVID-19, whereas firms without a common owner experience an increase in risk by 0.218 percentage points in a similar

scenario.

In the untabulated analysis, I regressed the increase in non-China relationships after COVID-19 but found it insignificant. This implies that firms are not substituting relationships with China.

Table 15 presents the results using a dummy variable indicating the presence of common ownership. This accounts for non-linearities associated with common ownership. All the results hold in this specification as well and the coefficients become stronger. This suggests that the common ownership effect is concave in nature; the effect diminishes with the rise in the number of shared owners.

This hypothesis suggests improved information channels can help mitigate risk during challenging times. In the untabulated analysis, I conducted a regression using relationships excluding China as a variable instead of considering all relationships. However, the results did not hold. I further tested these results using only Mexico's supply relationships data, but the results did not hold there either. This implies that common owners are facilitating a shift away from the largest risk source, which is China, and there might be a movement towards the domestic market for the supply chain.

6 Conclusion

The drive for cost reduction, tax incentives, and gaining a competitive edge compelled firms to cultivate numerous foreign relationships. However, the global disruption in supply chains resulting from the COVID-19 crisis laid bare the vulnerabilities and risks inherent in such global connections. This paper presents evidence concerning the impact of foreign relationships on a firm's default risk when supply chains are disrupted due to lockdowns.

My findings reveal that as firms increase the number of non-domestic relationships leading into the COVID-19 pandemic, their default risk proportionally rises. This effect is notably driven by Chinese relationships and, to a lesser extent, relationships with firms outside of China. The significance of Chinese relationships is underscored by its status as the world's largest exporter and a major contributor to global supply chains. This underscores the limitations of over-reliance on a single country. My study employs a com-

prehensive dataset, demonstrating the broader implications that firm risks can have on various aspects of a firm's endeavors.

Furthermore, I demonstrate that firms more exposed to supply chain risks experience a decrease in their environmental proxies after COVID-19. This decline may be attributed to these firms delaying their commitments to addressing climate risks. Firms that had previously committed to renewable energy initiatives may encounter delays or cancellations due to the pandemic's impact on their survival strategies. The heightened risk of survival may redirect management focus toward immediate concerns, such as supply chain disruptions, resulting in a decline in efforts and commitments towards addressing climate change.

Furthermore, my findings reveal that firms with better information channels with other companies in the same industry experience lower increases in firm risk compared to those without such communication channels. I use same-industry firms with a shared owner as a proxy for an information channel. Additionally, I discovered that the impact of common ownership is concave, and the incremental effect diminishes with an increase in the number of common owners.

The findings bear significant implications for both firms and governments. Research has consistently demonstrated that a lack of diversification in supply chains heightens firm risks (Banerjee et al., 2008). Firms should prioritize diversifying their supply chains to minimize idiosyncratic risks associated with their operations. My findings underscore the distinct and substantial impact that relationships with Chinese firms have on overall risk. Firms should actively work towards reducing foreign dependence and consider sourcing products domestically. The shift towards regionalization can be synergized with the adoption of renewable sources, offering a more cost-effective integration, as the separate costs of each transformation would be higher. Alicke et al. (2021), drawing on survey data from firm executives, reported that 90% of respondents anticipate pursuing some level of regionalization post-COVID-19.

Governments, recognizing this trend, can play a pivotal role in supporting domestic setups and encouraging subsidies, especially if these initiatives are aligned with the transition

towards renewable resources. Such measures can contribute to both economic resilience and sustainability.

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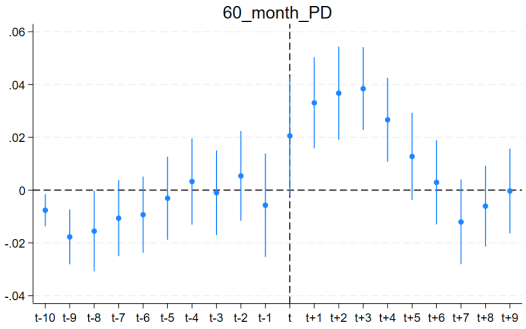
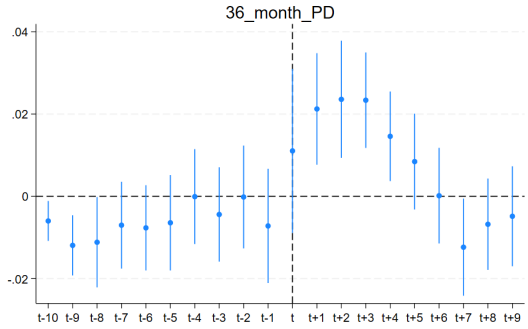
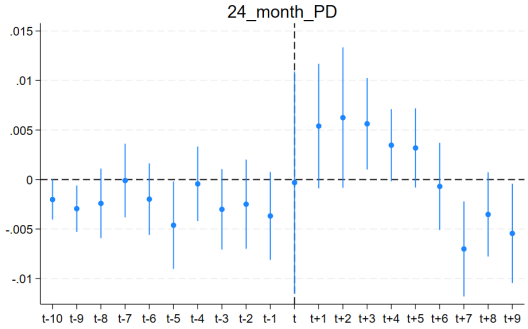


(a) 60 months PD (%)

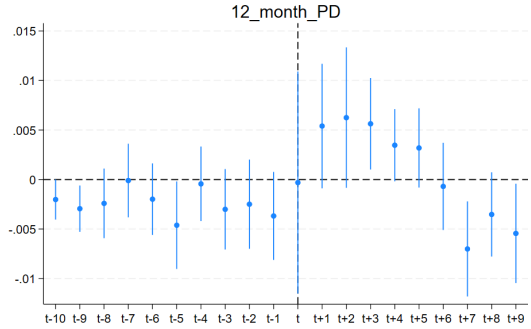


(b) 36 months PD (%)

Figure 1

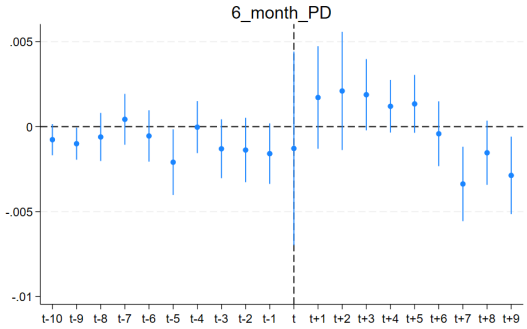


(a) 24 months PD (%)

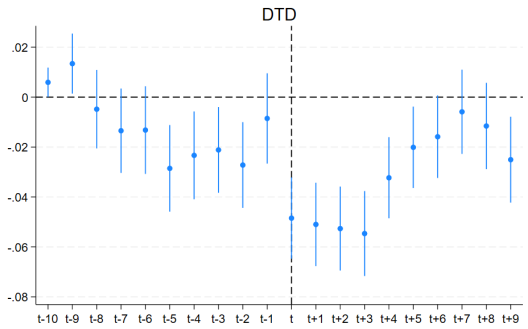


(b) 12 months PD (%)

Figure 2

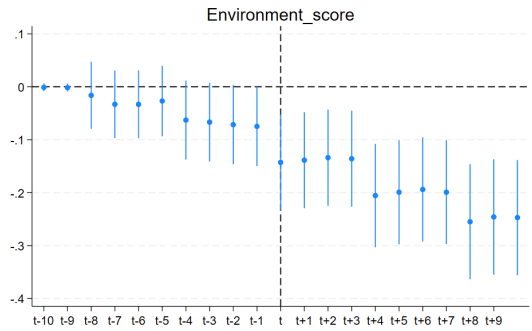


(a) 6 months PD (%)

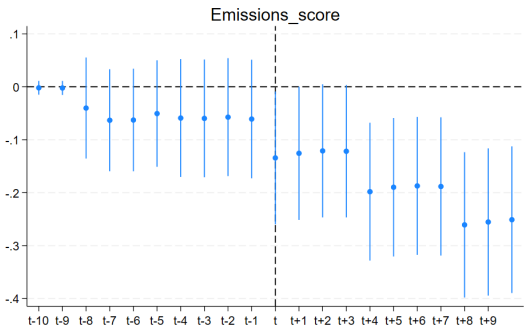


(b) Distance to default

Figure 3



(a) Environment Score



(b) Emissions score

Figure 4: Coefficient plots

Table 1: Variable Definitions

Variable	Definition and Construction	Data Source
Relationship_CN	The number of customer, supplier, and partner relationships of US firms with Chinese firms at the end of the quarter	Factset Revere
Relationship	The number of customer, supplier, and partner relationships of US firms with non-domestic firms at the end of the quarter	Factset Revere
DTD	DTD is the Distance-to-Default Measure of firm default risk. It is calculated using Merton's 1974 model	NUS website
60_month_PD_%	Probability of Default (PD) is the credit measure of the NUS-CRI corporate default prediction system. It is based on Duan et al. (2012)	NUS website
36_month_PD_%	Probability of Default (PD) is the credit measure of the NUS-CRI corporate default prediction system. It is based on Duan et al. (2012)	NUS website
24_month_PD_%	Probability of Default (PD) is the credit measure of the NUS-CRI corporate default prediction system. It is based on Duan et al. (2012)	NUS website
12_month_PD_%	Probability of Default (PD) is the credit measure of the NUS-CRI corporate default prediction system. It is based on Duan et al. (2012)	NUS website
6_month_PD_%	Probability of Default (PD) is the credit measure of the NUS-CRI corporate default prediction system. It is based on Duan et al. (2012)	NUS website
Institute_own.	It is the total ownership by institutional investors out of total shares outstanding for the company	13f WRDS
Log_extent_CO	Logarithm of the number of blockholders who own at least one other firm in the same industry	13f WRDS

Table 1: Variable Definitions

Variable	Definition and Construction	Data Source
Presence_CO	Presence of the owner who owns at least one other firm in the same industry	13f WRDS
Debt_Assets	Total debt scaled by total assets. Proxied for Leverage	Compustat
Log_Assets	Logarithm of the total assets of the company. Proxied for size	Compustat
NPM	Net profit margin is a measure of cost and sales dynamics of the firm	Compustat
PTB	Price to book ratio is used to estimate the future growth options of the company	Compustat
B_Mkt	Beta of the stock in the last six months given the riskiness of the stock	Compustat
ROA	Return on assets gives the profitability dynamics of the company	Compustat
ESG_w	The ESG Combined Score provides a rounded and comprehensive evaluation of a company's ESG performance based on the reported information in the ESG pillars	Refinitiv Eikon
Environ_score	Environment score takes into account resource use, emissions, and innovation towards renewable sources of the firm relative to the company's sector.	Refinitiv Eikon
Emissions_Score	Emission score takes into account emissions, waste, biodiversity, and environmental management systems of the firm relative to the company's sector.	Refinitiv Eikon

Table 2: Summary Statistics

Variable	Mean	SD	p25	p50	p75	N
Relationship_CN	0.311	1.011	0.000	0.000	0.000	48604
Relationship	4.588	9.441	0.000	1.000	4.000	48604
DTD	4.634	5.941	2.270	3.776	5.906	43413
60_month_PD_%	3.079	3.419	0.823	2.003	4.039	43417
36_month_PD_%	1.854	2.775	0.239	0.852	2.242	43417
24_month_PD_%	1.205	2.222	0.075	0.382	1.279	43417
12_month_PD_%	0.524	1.278	0.009	0.080	0.404	43417
6_month_PD_%	0.203	0.594	0.001	0.016	0.115	43417
Institute_own.	0.634	0.324	0.369	0.729	0.903	48205
Log_extent_CO	0.854	0.613	0.000	1.099	1.386	48604
Presence_CO	0.711	0.453	0.000	1.000	1.000	48604
Debt_Assets	0.516	0.297	0.289	0.507	0.691	48040
Log_Assets	6.528	2.121	4.985	6.552	7.979	48310
NPM	-3.163	14.142	-0.220	0.015	0.080	44413
PTB	4.937	6.954	1.372	2.595	5.211	45705
B_Mkt	0.948	1.830	0.212	0.960	1.713	48590
ROA	-0.051	0.331	-0.144	0.074	0.139	47652
ESG_w	38.098	17.698	24.123	35.179	50.001	31698
Environ_score	22.643	26.515	0.000	10.440	40.855	31698
Emissions_Score	24.352	30.058	0.000	9.300	43.400	32606

Table 3: Impact of covid-19 for US firms having non-domestic relationships

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	60_PD_%	60_PD_%	36_PD_%	36_PD_%	24_PD_%	24_PD_%
Relationship	-0.001	0.009	-0.001	0.007	-0.001	0.005
	[0.010]	[0.010]	[0.008]	[0.008]	[0.006]	[0.006]
Covid × Relationship	**0.018*** **	**0.017*** **	**0.012*** **	**0.012*** **	**0.008*** **	**0.008*** **
	[0.004]	[0.004]	[0.003]	[0.003]	[0.002]	[0.002]
Institute_own.	-0.841***	-0.607**	-0.662***	-0.505*	-0.534***	-0.422**
	[0.286]	[0.309]	[0.244]	[0.261]	[0.201]	[0.213]
Debt_Assets	5.041***	5.198***	3.809***	3.976***	2.829***	2.985***
	[0.280]	[0.283]	[0.238]	[0.241]	[0.196]	[0.199]
Log_Assets	1.588***	1.507***	1.121***	1.045***	0.782***	0.719***
	[0.108]	[0.116]	[0.091]	[0.098]	[0.074]	[0.080]
NPM	0.004	0.001	0.003	0.001	0.003	0.001
	[0.003]	[0.003]	[0.003]	[0.003]	[0.002]	[0.002]
PTB	-0.085***	-0.078***	-0.071***	-0.066***	-0.056***	-0.052***
	[0.006]	[0.006]	[0.005]	[0.005]	[0.004]	[0.004]
B_Mkt	0.003	0.004	0.001	0.002	0	0.001
	[0.008]	[0.009]	[0.008]	[0.008]	[0.007]	[0.007]
ROA	-2.229***	-1.581***	-1.676***	-1.187***	-1.246***	-0.882***
	[0.261]	[0.255]	[0.223]	[0.219]	[0.187]	[0.183]
Observations	35,175	33,431	35,175	33,431	35,175	33,431
R-squared	0.629	0.703	0.574	0.659	0.53	0.625
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	N	Y	N	Y	N
Ind-Year FE	N	Y	N	Y	N	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4: Impact of covid-19 for US firms having non-domestic relationships: Alternate proxies for risk

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	12_PD_%	12_PD_%	6_PD_%	6_PD_%	DTD	DTD
Relationship	0	0.003	0	0.001	0.006	0.005
	[0.003]	[0.003]	[0.001]	[0.002]	[0.007]	[0.008]
Covid × Relationship	**0.003*** **	**0.003** **	**0.001** **	**0.001***	**-0.012*** **	**-0.014*** **
	[0.001]	[0.001]	[0.000]	[0.001]	[0.003]	[0.004]
Institute_own.	-0.332***	-0.273**	-0.165***	-0.139**	0.501***	0.330**
	[0.119]	[0.124]	[0.056]	[0.058]	[0.143]	[0.159]
Debt_Assets	1.437***	1.543***	0.612***	0.665***	-3.654***	-3.678***
	[0.117]	[0.119]	[0.055]	[0.057]	[0.170]	[0.174]
Log_Assets	0.354***	0.319***	0.136***	0.120***	-0.935***	-0.883***
	[0.044]	[0.047]	[0.020]	[0.022]	[0.063]	[0.066]
NPM	0.001	0	0.001	0	-0.003	-0.002
	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]	[0.002]
PTB	-0.030***	-0.028***	-0.013***	-0.012***	0.051***	0.047***
	[0.003]	[0.003]	[0.001]	[0.001]	[0.004]	[0.004]
B_Mkt	-0.001	0	-0.001	0	-0.013***	-0.012***
	[0.004]	[0.004]	[0.002]	[0.002]	[0.004]	[0.004]
ROA	-0.637***	-0.450***	-0.273***	-0.192***	1.503***	1.201***
	[0.115]	[0.112]	[0.056]	[0.054]	[0.155]	[0.157]
Observations	35,175	33,431	35,175	33,431	35,182	33,438
R-squared	0.464	0.574	0.42	0.542	0.811	0.851
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	N	Y	N	Y	N
Ind-Year FE	N	Y	N	Y	N	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 5: Impact of covid-19 for US firms having relationship with China

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	60_PD_%	36_PD_%	24_PD_%	12_PD_%	6_PD_%	DTD
Relationship_CN	-0.026	-0.008	0	0.006	0.004	0.041
	[0.057]	[0.042]	[0.031]	[0.016]	[0.007]	[0.056]
Covid × Relationship	**0.104*** **	**0.065** **	**0.040** **	**0.013**	**0.004**	**-0.089** **
	[0.034]	[0.026]	[0.020]	[0.011]	[0.005]	[0.037]
Institute_own.	-0.637**	-0.526**	-0.436**	-0.279**	-0.141**	0.346**
	[0.309]	[0.261]	[0.213]	[0.124]	[0.058]	[0.160]
Debt_Assets	5.195***	3.974***	2.983***	1.542***	0.665***	-3.676***
	[0.283]	[0.242]	[0.200]	[0.119]	[0.057]	[0.174]
Log_Assets	1.505***	1.044***	0.719***	0.318***	0.120***	-0.878***
	[0.116]	[0.098]	[0.080]	[0.047]	[0.022]	[0.066]
NPM	0.001	0.001	0.001	0	0	-0.002
	[0.003]	[0.003]	[0.002]	[0.001]	[0.001]	[0.002]
PTB	-0.078***	-0.066***	-0.052***	-0.028***	-0.012***	0.046***
	[0.006]	[0.005]	[0.004]	[0.003]	[0.001]	[0.004]
B_Mkt	0.003	0.002	0.001	0	0	-0.012***
	[0.009]	[0.008]	[0.007]	[0.004]	[0.002]	[0.004]
ROA	-1.588***	-1.192***	-0.886***	-0.452***	-0.193***	1.199***
	[0.255]	[0.219]	[0.183]	[0.112]	[0.054]	[0.157]
Observations	33,431	33,431	33,431	33,431	33,431	33,438
R-squared	0.702	0.659	0.624	0.574	0.542	0.851
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	N	N	N	N	N	N
Ind-Year FE	Y	Y	Y	Y	Y	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 6: Impact of covid-19 for US firms having non-domestic relationships: Propensity score matched estimates

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	60_PD_%	36_PD_%	24_PD_%	12_PD_%	6_PD_%	DTD
Relationship	0.031**	0.023**	0.016**	0.008*	0.003*	-0.006
	[0.015]	[0.011]	[0.008]	[0.004]	[0.002]	[0.011]
Covid × Relationship	**0.016*** **	**0.009*** **	**0.006****	**0.002***	**0.001**	**-0.017*** **
	[0.005]	[0.003]	[0.002]	[0.001]	[0.000]	[0.005]
Institute_own.	-1.441**	-1.272***	-1.064***	-0.638***	-0.299***	0.432
	[0.600]	[0.490]	[0.391]	[0.223]	[0.103]	[0.298]
Debt_Assets	6.044***	4.289***	3.039***	1.460***	0.607***	-4.972***
	[0.554]	[0.403]	[0.302]	[0.166]	[0.077]	[0.452]
Log_Assets	1.696***	1.207***	0.862***	0.409***	0.163***	-1.065***
	[0.274]	[0.218]	[0.173]	[0.098]	[0.045]	[0.136]
NPM	-0.005	-0.004	-0.004	-0.002	-0.001	-0.001
	[0.008]	[0.007]	[0.006]	[0.003]	[0.002]	[0.004]
PTB	-0.070***	-0.052***	-0.037***	-0.017***	-0.007***	0.057***
	[0.012]	[0.008]	[0.006]	[0.003]	[0.001]	[0.008]
B_Mkt	0.011	0.008	0.007	0.005	0.003	-0.023**
	[0.017]	[0.014]	[0.011]	[0.007]	[0.003]	[0.011]
ROA	-1.370***	-0.949***	-0.673**	-0.333**	-0.143**	1.282***
	[0.450]	[0.342]	[0.263]	[0.147]	[0.068]	[0.380]
Observations	23,665	23,665	23,665	23,665	23,665	23,683
R-squared	0.793	0.757	0.725	0.673	0.638	0.892
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	N	N	N	N	N	N
Ind-Year FE	Y	Y	Y	Y	Y	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 7: Impact of covid-19 for US firms having non-domestic relationships: Placebo test

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	60_PD_%	36_PD_%	24_PD_%	12_PD_%	6_PD_%	DTD
Relationship	0.013	0.01	0.007	0.003	0.001	-0.002
	[0.012]	[0.009]	[0.007]	[0.003]	[0.001]	[0.012]
Placebo × Relationship	**-0.009**	**-0.008***	**-0.006***	**-0.003***	**-0.001***	**-0.004**
	[0.006]	[0.004]	[0.003]	[0.002]	[0.001]	[0.006]
Institute_own.	-1.010**	-0.788**	-0.585**	-0.287*	-0.116*	0.386
	[0.434]	[0.347]	[0.272]	[0.148]	[0.066]	[0.339]
Debt_Assets	6.167***	4.267***	2.957***	1.363***	0.545***	-6.415***
	[0.467]	[0.397]	[0.327]	[0.195]	[0.092]	[0.342]
Log_Assets	1.189***	0.773***	0.495***	0.189***	0.061**	-0.815***
	[0.198]	[0.153]	[0.115]	[0.059]	[0.025]	[0.145]
NPM	0.007	0.004	0.002	0	0	-0.010*
	[0.007]	[0.005]	[0.004]	[0.002]	[0.001]	[0.006]
PTB	-0.078***	-0.058***	-0.042***	-0.020***	-0.008***	0.083***
	[0.011]	[0.009]	[0.007]	[0.004]	[0.002]	[0.008]
B_Mkt	0.025**	0.012	0.005	-0.001	-0.001	-0.034***
	[0.011]	[0.010]	[0.008]	[0.005]	[0.002]	[0.007]
ROA	-3.278***	-2.483***	-1.855***	-0.954***	-0.407***	2.569***
	[0.532]	[0.448]	[0.365]	[0.214]	[0.099]	[0.358]
Observations	25,805	25,805	25,805	25,805	25,805	25,806
R-squared	0.702	0.653	0.614	0.561	0.531	0.842
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	N	N	N	N	N	N
Ind-Year FE	Y	Y	Y	Y	Y	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 8: Impact of covid-19 for US firms having non-domestic relationships: Results after excluding China

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	60_PD_%	36_PD_%	24_PD_%	12_PD_%	6_PD_%	DTD
Relationship	0.008	0.005	0.004	0.002	-0.001	0
	[0.020]	[0.017]	[0.014]	[0.008]	[0.001]	[0.013]
Covid × Relationship	**0.030****	**0.024****	**0.018****	**0.009****	**0.003**	**-0.012**
	[0.014]	[0.011]	[0.009]	[0.005]	[0.002]	[0.010]
Institute_own.	-0.338	-0.27	-0.231	-0.169	-0.127***	0.323*
	[0.321]	[0.275]	[0.227]	[0.135]	[0.043]	[0.165]
Debt_Assets	5.021***	3.880***	2.935***	1.529***	0.644***	-3.509***
	[0.305]	[0.263]	[0.218]	[0.131]	[0.047]	[0.181]
Log_Assets	1.483***	1.020***	0.696***	0.304***	0.078***	-0.867***
	[0.129]	[0.109]	[0.090]	[0.053]	[0.013]	[0.071]
NPM	0.001	0	0	0	0	-0.002
	[0.004]	[0.003]	[0.003]	[0.002]	[0.001]	[0.002]
PTB	-0.077***	-0.066***	-0.052***	-0.028***	-0.012***	0.048***
	[0.007]	[0.006]	[0.005]	[0.003]	[0.001]	[0.004]
B_Mkt	0.004	0.002	0.001	0	0	-0.011**
	[0.010]	[0.009]	[0.007]	[0.005]	[0.002]	[0.004]
ROA	-1.588***	-1.177***	-0.867***	-0.439***	-0.226***	1.227***
	[0.269]	[0.232]	[0.194]	[0.119]	[0.045]	[0.166]
Observations	27,794	27,794	27,794	27,794	56,944	27,802
R-squared	0.704	0.659	0.623	0.572	0.509	0.854
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	N	N	N	N	N	N
Ind-Year FE	Y	Y	Y	Y	Y	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 9: Impact of foreign relationships with Environmental commitments of the firms

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Env_sco.	Env_sco.	Emis_sco	Emis_sco	ESG	ESG
Relationship	0.206***	0.201**	0.164**	0.09	0.137**	0.104
	[0.067]	[0.079]	[0.074]	[0.090]	[0.067]	[0.067]
Covid × Relationship	**-0.124*** **	**-0.134*** **	**-0.111*** **	**-0.125*** **	**-0.228*** **	**-0.224*** **
	[0.023]	[0.029]	[0.034]	[0.037]	[0.022]	[0.027]
Institute_own.	-3.489***	-3.667***	-5.460***	-6.643***	-0.556	-0.924
	[1.271]	[1.416]	[1.694]	[1.927]	[1.028]	[1.178]
Debt_Assets	0.104	0.996	0.03	0.177	-0.856	-0.437
	[1.563]	[1.718]	[2.113]	[2.303]	[1.154]	[1.234]
Log_Assets	0.959	1.171*	2.739***	2.764***	0.457	0.776
	[0.583]	[0.628]	[0.781]	[0.809]	[0.441]	[0.486]
NPM	0.019	0.016	0.008	0.008	0.003	0
	[0.015]	[0.015]	[0.014]	[0.012]	[0.009]	[0.010]
PTB	0.041	0.017	0.109**	0.075*	0.017	-0.001
	[0.030]	[0.033]	[0.045]	[0.043]	[0.021]	[0.023]
B_Mkt	-0.018	-0.046	-0.022	-0.053	0.007	-0.012
	[0.029]	[0.034]	[0.040]	[0.046]	[0.023]	[0.026]
ROA	-1.64	-0.651	-0.857	0.061	-0.265	-0.709
	[1.284]	[1.394]	[1.685]	[1.774]	[0.950]	[1.042]
Observations	26,341	24,508	27,132	25,294	26,341	24,508
R-squared	0.921	0.936	0.884	0.907	0.876	0.9
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	Y	N	Y	N	Y	N
Ind-Year FE	N	Y	N	Y	N	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 10: Impact of foreign relationships with Environmental commitments of the firms Propensity score matched estimates

	(1)	(2)	(3)
VARIABLES	Env_sco.	Emis_sco	ESG
Relationship	0.073	-0.073	0.07
	[0.088]	[0.102]	[0.073]
Covid × Relationship	**-0.191*** **	**-0.230*** **	**-0.218*** **
	[0.026]	[0.037]	[0.035]
Institute_own.	-2.818	-4.743*	2.535
	[2.011]	[2.760]	[2.347]
Debt_Assets	0.682	-2.914	-5.439*
	[3.246]	[4.037]	[3.010]
Log_Assets	3.404***	6.728***	0.129
	[1.158]	[1.570]	[1.069]
NPM	0.021	0.006	0.001
	[0.023]	[0.023]	[0.021]
PTB	0.104*	0.203**	-0.005
	[0.060]	[0.088]	[0.067]
B_Mkt	0.081	0.122	0.017
	[0.064]	[0.101]	[0.088]
ROA	-2.72	-2.815	2.765
	[2.582]	[3.253]	[2.593]
Observations	17,737	18,220	17,737
R-squared	0.965	0.941	0.881
Firm FE	Y	Y	Y
Year FE	N	N	N
Ind-Year FE	Y	Y	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 11: Impact of foreign relationships with Environmental commitments of the firms Placebo tests

	(1)	(2)	(3)
VARIABLES	Env_sco.	Emis_sco	ESG
Relationship	-0.051	-0.073	-0.146
	[0.095]	[0.137]	[0.092]
Covid × Relationship	-0.079**	-0.127**	0.045
	[0.032]	[0.059]	[0.056]
Institute_own.	-4.706	2.744	2.055
	[4.838]	[4.620]	[3.395]
Debt_Assets	-4.059	0.514	-0.532
	[4.126]	[5.649]	[4.313]
Log_Assets	2.332	2.847	-0.271
	[2.144]	[2.360]	[1.238]
NPM	-0.059	-0.064	-0.007
	[0.037]	[0.058]	[0.029]
PTB	0.035	0.059	0.071
	[0.067]	[0.100]	[0.064]
B_Mkt	-0.054	-0.053	-0.046
	[0.076]	[0.101]	[0.089]
ROA	3.521	6.948	9.105**
	[4.105]	[6.140]	[3.783]
Observations	6,022	7,357	6,022
R-squared	0.977	0.964	0.943
Firm FE	Y	Y	Y
Year FE	N	N	N
Ind-Year FE	Y	Y	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 12: Impact of foreign relationships with Environmental commitments of the firms: Dropping China from the sample

	(1)	(2)	(3)
VARIABLES	Env_sco.	Emis_sco	ESG
Relationship	0.191	0.005	0.093
	[0.140]	[0.169]	[0.090]
Covid × Relationship	**0.117**	**0.109**	**-0.136***
	[0.106]	[0.121]	[0.073]
Institute_own.	-2.889**	-5.910***	-0.243
	[1.346]	[1.961]	[0.984]
Debt_Assets	1.586	1.573	0.554
	[1.849]	[2.420]	[1.320]
Log_Assets	0.359	1.668*	0.651
	[0.674]	[0.861]	[0.517]
NPM	0.016	0.005	0
	[0.018]	[0.014]	[0.011]
PTB	0.003	0.052	-0.007
	[0.037]	[0.044]	[0.024]
B_Mkt	-0.054	-0.077*	-0.016
	[0.035]	[0.046]	[0.026]
ROA	0.084	1.055	-0.79
	[1.407]	[1.728]	[1.118]
Observations	19,598	20,250	19,598
R-squared	0.923	0.898	0.906
Firm FE	Y	Y	Y
Year FE	N	N	N
Ind-Year FE	Y	Y	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 13: Impact of Chinese Relationships on Environmental Commitments of the firms - PSM estimates

	(1)	(2)	(3)
VARIABLES	Env_sco.	Emis_sco	ESG
Relationship	-0.017	-0.424	0.235
	[0.384]	[0.495]	[0.524]
Covid × Relationship	**-1.412*** **	**-1.525*** **	**-1.850*** **
	[0.348]	[0.441]	[0.394]
Institute_own.	-2.334	-2.554	2.367
	[3.625]	[4.222]	[4.362]
Debt_Assets	-11.248**	-8.27	-8.043*
	[5.249]	[6.049]	[4.156]
Log_Assets	4.105**	7.634***	0.036
	[1.680]	[2.026]	[1.699]
NPM	0.001	0.025	-0.07
	[0.034]	[0.038]	[0.049]
PTB	0.210***	0.336***	0.079
	[0.074]	[0.117]	[0.077]
B_Mkt	-0.013	-0.013	-0.154
	[0.106]	[0.183]	[0.145]
ROA	-5.973	-7.299	7.832
	[5.390]	[6.568]	[5.477]
Observations	4,416	4,599	4,416
R-squared	0.971	0.946	0.884
Firm FE	Y	Y	Y
Year FE	N	N	N
Ind-Year FE	Y	Y	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 14: Moderation of common owners in firm risk

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	60_PD_%	36_PD_%	24_PD_%	12_PD_%	6_PD_%	DTD
Relat_CN	-0.091	-0.049	-0.026	-0.004	0.001	0.181***
	[0.086]	[0.064]	[0.048]	[0.026]	[0.012]	[0.069]
Covid × Relat_CN	0.218***	0.150***	0.106***	0.049***	0.019**	-0.264***
	[0.053]	[0.042]	[0.033]	[0.018]	[0.008]	[0.061]
Extent	-0.193*	-0.121	-0.073	-0.02	-0.002	0.355***
	[0.112]	[0.093]	[0.075]	[0.043]	[0.020]	[0.069]
Covid × Extent	0.462***	0.386***	0.299***	0.150***	0.059***	-0.298***
	[0.091]	[0.077]	[0.062]	[0.036]	[0.017]	[0.061]
Relat_CN × Extent	0.08	0.05	0.033	0.014	0.005	-0.184***
	[0.096]	[0.070]	[0.051]	[0.026]	[0.011]	[0.061]
Cov. × Relat_CN × Extent	**-0.143****	**-0.107****	**-0.082****	**-0.044****	**-0.019****	**0.232*****
	[0.068]	[0.052]	[0.040]	[0.021]	[0.009]	[0.059]
Institute_own.	-0.607*	-0.540**	-0.466**	-0.311**	-0.159***	0.11
	[0.328]	[0.274]	[0.222]	[0.129]	[0.060]	[0.166]
Debt_Assets	5.118***	3.912***	2.937***	1.520***	0.657***	-3.615***
	[0.283]	[0.241]	[0.199]	[0.119]	[0.057]	[0.174]
Log_Assets	1.504***	1.039***	0.714***	0.315***	0.118***	-0.900***
	[0.117]	[0.098]	[0.080]	[0.047]	[0.022]	[0.065]
NPM	0.001	0.001	0	0	0	-0.002
	[0.003]	[0.003]	[0.002]	[0.001]	[0.001]	[0.002]
PTB	-0.077***	-0.065***	-0.051***	-0.027***	-0.012***	0.046***
	[0.006]	[0.005]	[0.004]	[0.003]	[0.001]	[0.004]
B_Mkt	0.006	0.004	0.003	0.001	0	-0.014***
	[0.009]	[0.008]	[0.007]	[0.004]	[0.002]	[0.004]
ROA	-1.546***	-1.155***	-0.857***	-0.436***	-0.186***	1.182***
	[0.254]	[0.218]	[0.183]	[0.112]	[0.054]	[0.155]
Observations	33,431	33,431	33,431	33,431	33,431	33,438
R-squared	0.703	0.66	0.625	0.574	0.542	0.852
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	N	N	N	N	N	N
Ind-Year FE	Y	Y	Y	Y	Y	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 15: Moderation of common owners in firm risk: Alternative proxy for common owner

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	60_PD_%	36_PD_%	24_PD_%	12_PD_%	6_PD_%	DTD
Relat_CN	-0.097	-0.061	-0.041	-0.017	-0.006	0.169**
	[0.099]	[0.071]	[0.051]	[0.026]	[0.011]	[0.073]
Covid × Relat_CN	0.258***	0.179***	0.126***	0.059***	0.023***	-0.304***
	[0.054]	[0.044]	[0.035]	[0.020]	[0.009]	[0.061]
Presence	-0.281**	-0.195*	-0.131	-0.048	-0.013	0.412***
	[0.119]	[0.102]	[0.084]	[0.049]	[0.023]	[0.075]
Covid × Presence	0.626***	0.521***	0.402***	0.201***	0.079***	-0.414***
	[0.124]	[0.105]	[0.086]	[0.051]	[0.024]	[0.081]
Relat_CN × Presence	0.11	0.08	0.062	0.035	0.016	-0.213***
	[0.130]	[0.095]	[0.068]	[0.033]	[0.014]	[0.073]
Cov. × Relat_CN × Presence	**-0.227*** **	**-0.167*** **	**-0.127*** **	**-0.068** **	**-0.030** **	**0.331*** **
	[0.082]	[0.063]	[0.049]	[0.026]	[0.012]	[0.071]
Institute_own.	-0.600*	-0.518*	-0.442**	-0.292**	-0.150**	0.198
	[0.316]	[0.266]	[0.217]	[0.127]	[0.059]	[0.160]
Debt_Assets	5.125***	3.918***	2.941***	1.523***	0.658***	-3.618***
	[0.283]	[0.241]	[0.199]	[0.119]	[0.056]	[0.174]
Log_Assets	1.507***	1.043***	0.717***	0.317***	0.119***	-0.896***
	[0.118]	[0.099]	[0.081]	[0.047]	[0.022]	[0.065]
NPM	0.001	0.001	0.001	0	0	-0.002
	[0.003]	[0.003]	[0.002]	[0.001]	[0.001]	[0.002]
PTB	-0.077***	-0.065***	-0.051***	-0.027***	-0.012***	0.046***
	[0.006]	[0.005]	[0.004]	[0.003]	[0.001]	[0.004]
B_Mkt	0.006	0.004	0.003	0.001	0	-0.014***
	[0.009]	[0.008]	[0.007]	[0.004]	[0.002]	[0.004]
ROA	-1.548***	-1.160***	-0.861***	-0.440***	-0.188***	1.169***
	[0.255]	[0.219]	[0.183]	[0.112]	[0.054]	[0.156]
Observations	33,431	33,431	33,431	33,431	33,431	33,438
R-squared	0.703	0.66	0.625	0.574	0.542	0.852
Firm FE	Y	Y	Y	Y	Y	Y
Year FE	N	N	N	N	N	N
Ind-Year FE	Y	Y	Y	Y	Y	Y

Clustered standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$