The Covid-19 Pandemic: Supply Chain Disruption, Wealth Effects, and Corporate Responses*

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Abstract

How did the Covid-19 pandemic affect firm-supplier-customer relationships? We find that, by the end of 2020q1, U.S. firms lost as many as 10.3% of their Chinese suppliers, suffering market value losses of up to $1.4 trillion. Affected U.S. firms were unable to relocate their supply chains, leading to lower inventory, sales, and operating performance. In response, these firms tapped the debt market, and partly built cash reserves. Employment decreased by 5.2%. Chinese suppliers suffered milder consequences. Sourcing from a single manufacturing hub has drawbacks, but policymakers should avoid trade tensions because firms are unable to quickly relocate their supply chains.

Keywords: Firm-supplier-customer relationships, supply chain disruption, wealth effects, Covid-19, sourcing strategies, inventory, credit, cash reserves, investment, employment.

JEL Classification: G12; G14; G31; G32; G33; L1; L2; L5.

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1 Introduction

China's GDP grew at the formidable rate of 9.3% per year on average over the 30-year period from 1989 to 2018 (Source: World Bank). Studies have attributed this growth to the impressive increase in productivity of China's manufacturing sector associated to global trade liberalization and the accession of China to the World Trade Organization at the end of 2001 (e.g., Brandt, Van Biesebroeck and Zhang, 2012; Khandelwal, Schott and Wei, 2013; Yu, 2015; Brandt et al., 2017). These productivity benefits can help explain why it became common practice for firms worldwide to adopt a China-centric supply chain, as China grew to be known as the 'factory' of the world. However, a geographically concentrated supply chain is subject to disruption risk (see, for example, Ang, Iancu and Swinney, 2017; Bimpikis, Candogan and Ehsani, 2019). Therefore, it is not surprising that, as officials in China started to disclose in late 2019 that dozens of people in Wuhan were infected by a new virus, concern grew that a potential pandemic could severely impact firms worldwide relying on China's suppliers for their sourcing needs.

The media started to report U.S. firms lamenting delays with their product shipments from China from the early stages of the pandemic. On January 29, 2020, CNBC reported a list of 27 firms, including Apple, 3M, United Technologies, Crane & Co., discussing in their earnings calls the Covid-19 pandemic and concerns related to the supply chain disruption. The concerns of U.S. firms with product shipments from China were also discussed by ABC News (February 12, 2020) and the Washington Post (February 25, 2020, and March 11, 2020). An updated version of the early CNBC's analysis, dated March 11, 2020, reports 150 companies concerned with Covid-19 and the supply chain disruption. Our own analysis reveals that by March 31, 2020, 195 earnings calls of U.S. firms with Chinese suppliers discussed concerns due to the Covid-19 supply chain disruption.

These concerns mirror macroeconomic data showing that China's industrial production dropped by 13.5% year-on-year in both January and February, 2020, and an additional 1.1% in March 2020, before starting to grown again in April 2020 (Source: National Bureau of Statistics of China). Container traffic from China's top eight ports dropped by 19.8% year-on-year in February 2020, and another 5.6% in March 2020 (Source: China Ports and Harbors Association – China Ministry of Transport),[1] while U.S. imports from China dropped by 19.9%, 31.3%, and 36.5% year-on-year

[1]The China Ports and Harbors Association suspended the release of container traffic statistics for the month of

in January, February, and March 2020 (Source: U.S. Census Bureau), respectively.

Since Coase (1937) and Jensen and Meckling (1976), theory recognizes that firms are an intricate network of economic relationships, involving shareholders and financial (i.e., debtholders) and non-financial (e.g., employees, customers, suppliers) stakeholders. In the context of supply chain relationships, theory shows that firms avoid excessive debt because the risk of financial distress could discourage critical suppliers from making relation specific investments (e.g., Titman, 1984; Maksimovic and Titman, 1991; Chemla and Faure-Grimaud, 2001; Hennessy and Livdan, 2009; Chu, 2012). In line with this prediction, empirical studies find that supply chain relationships affect capital structure (e.g., Kale and Shahrur, 2007; Banerjee, Dasgupta and Kim, 2008) and other corporate policies of the related firms (e.g., Allen and Phillips, 2000; Cen, Van Biesebroeck and Zhang, 2017; Chu, Tian and Wang, 2019; Dai, Liang and Ng, 2020).

Surprisingly, however, existing evidence suggests that supply chain information is incorporated slowly into equity prices. For instance, Cohen and Frazzini (2008) find that stock prices can take up to 12 months to account for news concerning firms in a buyer-supplier relation, leading the authors to conclude that investors display limited attention by neglecting "... publicly available information and often longstanding relationships between firms..." In a related study, Menzly and Ozbas (2010) find similar effects for the case of customers/suppliers in a firm's industry,[2] while Hertzel et al. (2008) find mixed evidence of price responsiveness, documenting that a firm's financial distress has a negative wealth effect on its suppliers, but no consequences for the firm's customers. Similarly, Madsen (2017) shows that stock price responsiveness improves, but remains imperfect, for the case of earnings news concerning firms in a supply chain relationship.

We contribute to this literature by studying the effect of the Covid-19 pandemic – a major supply chain event – on firm-supplier-customer relationships. We ask the following questions. To what extent did U.S. firms lose Chinese suppliers amid the pandemic? Were the affected U.S. firms able to relocate their supply chains domestically or elsewhere? What was the wealth impact of the supply chain disruption on the shareholders and bondholders of the affected U.S. firms? How did the supply chain disruption affect inventory holdings, sales, and operating performance of affected

January 2020.

[2]In a replication study of 452 anomalies, Hou, Xue and Zhang (2020) find that the price anomalies in Cohen and Frazzini (2008) and Menzly and Ozbas (2010) are among a few anomalies robust to currently acceptable empirical standards, although the replicated economic effects are smaller than those in the original studies.

U.S. firms? What actions did these firms put in place to mitigate the effect of the disruption? How were the Chinese firm counterparts of the U.S. firms affected?

The headline results of our papers are that U.S. firms lost a significant number of Chinese suppliers in the first quarter of 2020, with the stock prices of the affected U.S. firms incorporating relatively quickly the effect of the supply chain disruption in reflection of the difficulties that these firms faced to relocate their supply chain. To partly mitigate the effect of the supply chain disruption, these firms tapped the long-term debt market and partly used the fund to build their cash reserves.

To perform our tests, we rely on a novel granular data source to identify material Chinese suppliers of U.S. firms at the onset of the Covid-19 pandemic. We start by analyzing the extent to which U.S. firms lost Chinese suppliers in 2020q1. We then combine the supply chain data with a standard event study framework that allows us to control for domestic and global factor exposures in the period preceding the pandemic outbreak. Using the event study methodology, we estimate cumulative average abnormal returns (CAARs) for U.S. firms with material exposure to Chinese suppliers in the period from January 6, 2020 (trading day 0) to February 19, 2020 (trading day +30).

We consider January 6, 2020 as the first day of our event window because U.S. media coverage of a "mysterious" virus in China started to increase around that date, perhaps as a result of China President Xi Jinping's announcement of his direct involvement in the efforts to contain the virus (e.g., "China Grapples With Mystery Pneumonia-Like Illness," New York Times, January 6, 2020).[3] We end our event window on February 19, 2020 to circumvent the effects of monetary policy, fiscal stimulus, and other interventions on U.S. capital markets, which started with the Fed's sweeping reduction of the fed funds rate to a range of 0%-0.25% with a combined 150 basis points (bps) cut on March 3 (10 trading days prior to February 19) and March 16, 2020, the announcement that the Fed would start a massive Quantitative Easing (QE) program and directly provide credit to companies, the Federal government's $2 trillion fiscal stimulus package, and the "shelter in

[3]To our knowledge, Fox News was the first media outlet in the U.S. to discuss a mysterious respiratory illness in China on Friday, January 3, 2020 ("Mysterious Respiratory Illness Linked to China Food Market Sickens At Least 44, Officials Say"). On January 6, 2020, the news was covered by Bloomberg, CNN, New York Times, and Wall Street Journal. From January 7, 2020 to January 11, 2020, the pandemic was covered by most of the major media outlets, including Bloomberg (January 8), CNN (January 9), Fox Business News (January 8), NBC News (January 9 and 11), New York Times (January 8 and 10), Wall Street Journal (January 8, 10, and 11), and Washington Post (January 9).

place" order issued by six counties in the San Francisco area on March 17, 2020. Altogether, our micro supply chain data and carefully designed tests provide a suitable setting to measure the wealth effects of the Covid-19 supply chain disruption while limiting the potentially contaminating consequences of monetary policy and fiscal stimulus.

We find that in the first quarter of 2020 U.S. firms lost between 8.4% and 10.3% of their Chinese suppliers. These effects are in excess of what could be explained by the ongoing trade war between the U.S. and China, which peaked in 2018q4 and leveled off during 2019. Turning to the wealth effects, we find that U.S. firms with high, moderate, and low exposure to Chinese suppliers (measured as the number of Chinese suppliers per billion ($) of sales of the U.S. firm) experienced CAARs of -12.1%, -5.1%, and -2.9%, respectively, in the 31 trading days starting on January 6, 2020. A simple back of the envelop calculation suggests that U.S. firms with Chinese suppliers lost between $0.8 trillion to $1.4 trillion of their market value (on a risk-adjusted basis) because of the Covid-19 supply chain disruption.

Notably, we are able to rule out that our results are driven by a stock market trend specific to the U.S. firms with Chinese suppliers that started prior to the Covid-19 pandemic, rather than the consequences of the supply chain disruption that we are interested in. In addition, numerous robustness tests confirm that the wealth effects documented in the paper are the direct consequence of the Covid-19 supply chain disruption, rather than other channels. Our analysis further show risk-adjusted market value losses for U.S. firms with tier 2 and tier 3 Chinese suppliers and for the bondholders of U.S. firms with Chinese suppliers, while the stock prices of the Chinese suppliers of U.S. firms dropped sizably (on a risk-adjusted basis) in the first 20 days of our event window, but quickly rebounded after that.

Because the U.S. is also a major exporter to China, one should expect that U.S. firms are affected by the Covid-19 pandemic also through a 'demand channel.' To analyze this mechanism, we consider a sample of U.S. firms with Chinese customers, but without Chinese suppliers. We find that these U.S. firms lost between 4.6% and 6.6% of their Chinese customers in 2020q1. Turning to the wealth effects, we document CAARs ranging from -11.7% to -4.4% during our 31-day trading window for firms from high to low exposure to Chinese customers, respectively, suggesting that the 'demand shock' caused by the pandemic was also very costly for U.S. firms. The bondholders

of these U.S. firms experienced abnormal returns of -2.7% during our event window. As for the Chinese suppliers of U.S. firms, the Chinese customers of U.S. firms experienced sizable negative CAARs by day 20th of our event window, but CAARs became equal to zero by day 30th.

How did the Covid-19 supply chain disruption affect the sourcing strategies of U.S. firms with Chinese suppliers? In a difference-in-difference framework, we find that during the pandemic U.S. firms were unable to replace their lost Chinese suppliers with domestic suppliers, and further lost some of their global (non-Chinese) suppliers. The inability of the affected U.S. firms to remedy their supply chain disruption led to a decrease in their inventory holdings and accounts payable, with the consequence that their sales and operating performance were also negatively affected in 2020q1 relative to firms without Chinese suppliers.

We further find that U.S. firms with Chinese suppliers issued on average 6.6 percentage points (pp) more debt in 2020q1 than unaffected firms, which they used in part to build up their cash reserves. We do not find that investment decreased for the affected firms in 2020q1 relative to unaffected firms, possibly because of their increased access to credit access credit. Our findings suggest, however, that employment decreased by 5.2% for these firms in 2020q1 relative to unaffected firms. In line with the event study results, we find that Chinese suppliers and customers of U.S. firms suffered milder real and financial consequences in 2020q1 relative to Chinese firms with no exposure to U.S. firms.

In addition to the studies discussed above, our paper is also related to a growing literature on the Covid-19 crisis. This literature finds that firms are more resilient to the economic slowdown caused by the Covid-19 pandemic if they have higher financially flexibility (Fahlenbrach, Rageth and Stulz, 2020; Ding et al., 2020; Ramelli and Wagner 2020; Buchheim et al., 2020; Carletti et al., 2020; Davison, 2020; Lugo, 2020; Begley and Weagley, 2020), better social ratings and corporate culture (Albuquerque et al., 2020; Ding et al., 2020; Li et al., 2020), lower exposure to global trade (Ding et al., 2020; Ramelli and Wagner 2020), less entrenched executives (Ding et al., 2020; Mazur, Dang and Vega, 2020), and a workplace more compatible with social distancing (Buchheim et al., 2020; Pagano, Wagner and Zechner, 2020; Davison, 2020). The unifying theme of these studies is the focus on the characteristics that make firms more resistant to the Covid-19 pandemic.

Our paper is also related to the literature on supply chain disruption (e.g., Hendricks and

Singhal, 2009; Babich et al., 2012; Tang, Gurnani and Gupta, 2014; Ang, Iancu and Swinney, 2017; Bimpikis, Fearing and Tahbaz-Salehi, 2018; Bimpikis, Candogan and Ehsani, 2019; and Hendricks, Jacobs and Singhal, 2020), supplier unreliability (Tomlin and Wang, 2005; Tomlin, 2006; Dada et al., 2007; Tomlin, 2009; Wang et al., 2010; Babich and Tang, 2012; Yang et al., 2012; and Li et al., 2017), and supplier default (e.g., Anupindi and Akella, 1993; and Babich et al., 2007).

We contribute to these two streams of literature by studying how the Covid-19 pandemic affected firm-supplier-customer relationships. We document that U.S. firms lost as many as 10.3% of their Chinese suppliers in the first quarter of 2020. Using novel granular data on U.S. firms' suppliers and customers and a carefully designed event study, we find that the shareholders and bondholders of the U.S. firms with Chinese suppliers and customers suffered major risk-adjusted market value losses because of the supply chain disruption. These losses reflect the difficulties that these firms faced to relocate their supply chain domestically or elsewhere, which increased access to the credit mitigated only in part. The Chinese suppliers and customers of U.S. firms rebounded more quickly than their U.S. firm counterparts, perhaps because of more effective lockdown measures enforced in China.

Our findings offer useful insights to decisionmakers around the world involved in trade discussions amid the pandemic. There is mounting pressure from political analysts, policymakers, and the public to decouple the U.S. supply chain from China. For example, Senator Tom Cotton and Congressman Mike Gallagher introduced a bill on March 19, 2020, called "Protecting our Pharmaceutical Supply Chain from China Act", to end U.S. dependence on China for pharmaceutical manufacturing. However, our findings suggest that U.S. firms exposed to the Covid-19 supply chain disruption suffered substantial market value losses because they were unable to quickly relocate their supply chain domestically, within China, or in other countries. It is possible that over time these firms have made significant relationship specific investments (see, for example, Grossman and Hart, 1986; Aghion and Tirole, 1994) making it very difficult and costly for them to replace their suppliers. The takeaway for the policymakers of the U.S. and China is to avoid escalating trade tensions that would end up inflicting additional damage to U.S. and Chinese firms related through supply chain networks.

The rest of the paper is organized as follows. Section 2 discusses data sources and descriptive

statistics. Section 3 presents evidence on U.S. firms' sourcing activities from China in 2020q1. Section 4 contains the evidence on the wealth effects of the Covid-19 supply chain disruptions for U.S. firms with Chinese suppliers or customers, their bondholders, and their Chinese suppliers and customers. Results on sourcing strategy and other corporate policies are in Section 5. Section 6 concludes. An Appendix provides additional details about our data and presents additional tests.

2 Data Sources and Descriptive Statistics

We obtain granular supply chain relationship data from FactSet Revere Supply Chain Relationships. As discussed on the FactSet website, the dataset contains up-to-date information of material intercompany relationships obtained from supply contracts, purchase obligations, SEC 10-K filings, investor presentations, press releases, and other public sources. The focus on material supply chain relationships indicates that our sample firms might also have relationships with suppliers that are too small to be included in the FactSet database. Using FactSet, we extract information on Chinese suppliers and customers for U.S. publicly listed firms as of December 31, 2019, the onset of the Covid-19 pandemic. For these U.S. firms, we also extract information on Mexican and Canadian suppliers, the second (second) and third (first) import (export) trading partners of the U.S. at the end of 2019, respectively. Figure 1 displays imports, exports, and combined trading between the U.S., China, Mexico, and Canada from 2010 to 2019 (Source: U.S. Census Bureau), the three countries of the North America Free Trade Agreement (NAFTA), replaced by the U.S., Mexico, Canada Agreement (USMCA) on July 1, 2020.

[Figure 1]

We combine the supply chain relationship data with U.S. firms' fundamentals from COMPUSTAT North America Fundamentals (annual and quarterly) using 9-digit CUSIPs. We obtain additional information for the U.S. firms from the following sources: daily stock returns are from COMPUSTAT Security Daily, Fama-French factors from Kenneth French's website (`https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`), U.S. bond transaction prices from the Trade Reporting and Compliance Engine (TRACE) Enhanced database, bond characteristics from the Mergent Fixed Income Securities Database (FISD), and analysts earnings conference

call transcripts from the BAMSec database. We adjust stock prices for dividends and splits using the daily adjustment factor and total return factor provided in the COMPUSTAT North America Security Daily database. U.S. media coverage of the Covid-19 pandemic is obtained from LexisNexis and Factiva. U.S. import and export data are from the U.S. Census Bureau.

Daily stock returns for the U.S. firms' Chinese suppliers and customers are from COMPUSTAT Global Security Daily, while fundamentals for these Chinese suppliers and customers are from COMPUSTAT Global Fundamentals annual and quarterly. We adjust stock prices for dividends and splits using the daily adjustment factor and total return factor provided in the COMPUSTAT Global Security Daily database. Macroeconomic data on China's GDP growth and container traffic are from the World Bank and the China Ports and Harbors Association – China Ministry of Transport, respectively.

Table 1 reports basic descriptive statistics for the universe of U.S. firms in FactSet, except financial firms (SICs 6000-6999), in 2019q4. We report statistics separately for firms with and without at least one Chinese supplier as of December 31, 2019, the onset of the Covid-19 pandemic. Table A.1 in the Appendix provides detailed definitions for all the variables used in the paper. To avoid any undue influence of outliers, we winsorize all ratios at the 1st and 99th percentiles of their distributions. Table 1 shows that U.S. firms with Chinese suppliers are significantly larger than U.S. firms without Chinese suppliers, \$31.074 billion compared to \$5.511 billion, with the difference of \$25.546 billion statistically significant at the 1% percent level. The two groups are very similar in terms of tangibility, and relatively comparable with respect to Tobin's q, 2.227 and 2.478, with the difference of -0.249 statistically significant at the 10% level, for the U.S. firms with and without Chinese firms, respectively. Whenever appropriate we control for relevant firm characteristics in our regressions.

[Table 1]

Table 1 also shows that U.S. firms with Chinese suppliers have on average 10.8% of Chinese suppliers, compared to 44.5% and 44.7% of U.S. suppliers and other global suppliers (excluding Chinese suppliers), respectively. By contrast, U.S. firms without Chinese suppliers rely more on domestic suppliers, with U.S. suppliers being 63.9% of their total suppliers, and the remaining 36.1% being global suppliers from countries other than China. The 19.4% lower exposure to domestic

suppliers of the U.S. firms with Chinese suppliers relative to U.S. firms without Chinese suppliers (44.5% – 63.9%) is statistically significant at the 1% level.

Notably, the U.S. firms with high exposure to Chinese suppliers have on average 25.8% of their suppliers from China, compared to 12.9% and 4.9% for the moderate and low exposure groups, respectively. The 12.9% (25.8% – 12.9%) and 20.9% (25.8% – 4.9%) differences between the percentage of Chinese suppliers of the high exposure group and the moderate and low exposure groups, respectively, are both statistically different at the 1% level. Similarly, the difference of 8.0% (12.9% – 4.9%) between the percentage of Chinese suppliers of the moderate and low exposure groups is statistically significant at the 1% level.

In some of our tests, we separate U.S. firm with Chinese suppliers as of December 31, 2019 into three groups: 1) High Chinese Suppliers' Exposure: firms with one Chinese supplier or more per $1 billion of sales; 2) Moderate Chinese Suppliers' Exposure: firms with one Chinese supplier per $1+ billion to $3 billion of sales; 3) Low Chinese Suppliers' Exposure: firms with one Chinese supplier per $3+ billion of sales. Table A.2 in the Appendix reports the names of the top 10 U.S. firms by 2019q4 sales in each of the three groups, together with firm-level sales and the ratio of Chinese suppliers to total suppliers.

Figure 2 presents a snapshot of General Motors (GM) suppliers as of December 31, 2019. GM had in total 557 suppliers, of which, 148 from the U.S., 66 from China, 16 from Canada, 8 from Mexico, 83 from various European Union countries, and the remaining from various foreign countries including Argentina, Bermuda, Brazil, Chile, Great Britain, Indonesia, Isle of Man, India, Japan, Malaysia, New Zealand, Philippines, Pakistan, Russia, Serbia, Singapore, South Korea, Sri Lanka, Switzerland, Thailand, Turkey, Taiwan, Ukraine, and Vietnam. China with 66 suppliers was the country with the highest number of foreign suppliers for GM.

[Figure 2]

3 The Effect the Covid-19 Supply Chain Disruption on U.S. Firms Sourcing Activities from Chinese Suppliers

How did the Covid-19 supply chain disruption affect U.S. firms sourcing activities from Chinese suppliers? To address this question, we estimate the following regression model:

$$\begin{aligned} Log\ of\ Chinese\ Suppliers_{i,q} = \\ \beta_1 2018q2 + \beta_2 2018q3 + \beta_3 2018q4 + \beta_4 2019q1 + \beta_5 2019q2 + \beta_6 2019q3 + \beta_7 2019q4 \\ + \beta_8 2020q1 + \boldsymbol{Controls}_{i,q}\gamma + y_i + \varepsilon_{i,q}, \end{aligned} \quad (1)$$

Log of Chinese Suppliers is the natural logarithm of the number of Chinese suppliers of U.S. firm i in quarter q. Our main analysis focuses on the sample period from December 8, 2017 to March 31, 2020. This allows us to assess how the trade war affected the sourcing strategies of U.S. firms from Chinese suppliers in the nearly two-year period that preceded the pandemic outbreak. We consider March 8, 2018, the day when President Trump ordered 25% tariffs on steel imports and 10% tariffs on aluminum imports, as the beginning of the 'trade war' between the U.S. and China. Trade tensions started to ease during the weeks that preceded the announcement on December 13, 2019 that new tariffs to be mutually imposed on December 15 would not be implemented, and a follow-up agreement signed on January 15, 2020.

Our sample includes one pre-trade war quarter, the period from December 8, 2018, to March 7, 2018, 2018q1. We also include all quarters from the beginning of the trade war on March 8, 2018, 2018q2, till March 31, 2020, 2020q1. We note that 2018q2 and 2019q4 are a bit longer than a typical quarter, spanning from March 8, 2028 to June 30, 2019, and from October 1, 2019 to January 5, 2020, the day prior to the increased coverage of the Covid-19 pandemic in the U.S. media (see our discussion in the Introduction and Section 3.1 below), respectively. We build indicators for each of these quarters, 2018q1 to 2020q1, with 2018q1 being the omitted case. In these regressions, we consider U.S. firms with Chinese suppliers as of March 7, 2018, the day prior to the beginning of the trade war. Therefore, the coefficients on the quarter indicators measure the percentage change in the number of Chinese suppliers for these firms relative to 2018q1, which we treat as the pre-

trade war quarter. We also estimate Eq. (1) for the 2019q4 and 2020q1 quarters only, with 2019q4 being the omitted case. In these regressions, we consider U.S. firms with Chinese suppliers as of December 31, 2019. These are all the firms with Chinese suppliers at the onset of the Covid-19 pandemic, which we use in our event study analysis discussed below.

Our control variables include the following company characteristics: (1) Log of Assets is the natural logarithm of book assets; (2) Tobin's q is the ratio of the market value of assets to book assets; (3) Tangibility is the ratio of property, plant, and equipment to book assets.

Table 2 reports results from these estimations. The coefficient of -0.044, statistically significant at the 1% level, for the 2018q2 indicator, in Table 2, column 1 suggests that U.S. firms lost 4.4% of their Chinese suppliers in 2018q2 relative to 2018q1, the pre-trade war quarter. They recovered part of their Chinese suppliers in 2018q3, as indicated by the coefficient of -0.010, statistically insignificant, for the 2018q3 indicator, which is smaller (in absolute value) than the coefficient of -0.044 for the 2018q2 indicator. However, the coefficient of -0.084, statistically significant at the 1% level, for the 2018q4 indicator, indicates that by 2018q4 U.S. firms had lost 8.4% of their Chinese suppliers.

After 2018q4, the effect of the trade war seems to have leveled off, as suggested by the coefficients of -0.089, -0.094, -0.104, and -0.088, all statistically significant at the 1% level, for the 2019q1, 2019q2, 2019q3, and 2019q4, respectively. This is further confirmed by the evidence in Table 2, column 2, showing that the changes in the coefficients for the 2019q1, 2019q2, 2019q3, and 2019q4 indicators relative to the coefficients for their respective previous quarter indicators are all economically very close to zero and statistically insignificant. However, importantly, the coefficient of -0.172, statistically significant at the 1% level, for the 2020q1 in Table 2, column 1, suggests that by 2020q1 U.S. firms had lost 17.2% of their Chinese suppliers relative to 2018q1, the pre-trade war quarter. If compared with the coefficient of -0.088 for the 2019q4 indicator, the coefficient of -0.172 for 2020q1 suggests that, during the Covid-19 pandemic, U.S. firms lost 8.4% more of their Chinese suppliers than can be explained by the ongoing trade war between the U.S. and China. As Table 2, column 2 shows the -0.084 change in the coefficients for the 2020q1 indicator relative to the 2019q4 indicator is statistically significant at the 1% level. Refer also to Figure 3, Panels A and B, which plot the coefficients on the quarters and difference in quarter indicators from columns 1

and 2, respectively.

[Table 2]

[Figure 3]

Focusing on the U.S. firms with Chinese suppliers as of December 31, 2019, the onset of the Covid-19 pandemic, the coefficient of -0.103 for the 2020q1 indicator in Table 2, column 3, statistically significant at the 1% level, indicates that U.S. firms lost 10.3% of their Chinese suppliers during the pandemic. This finding suggests that the negative effect of the pandemic on U.S. firms sourcing activities from Chinese suppliers was nearly 2% higher (in absolute value), -10.3% versus -8.4%, for the U.S. firms with Chinese suppliers at the end of 2019q4 relative to U.S. firms with Chinese suppliers in 2018q1, respectively. Altogether, our findings in Table 2, columns 1 to 3, suggest that the Covid-19 supply chain disruption led to a significant loss of Chinese suppliers for U.S. firms.

In Table 2, columns 4 to 6, we consider the Chinese suppliers with exposure to U.S. buyers as of March 7, 2018 (columns 4 and 5) and December 31, 2019 (column 6), respectively. For this sample, we estimate Eq. (1) using the log of U.S. customers as dependent variable. Column 4 shows that Chinese suppliers started to lose U.S. customers in 2018q4, coefficient of -0.075, statistically significant at the 1% level. The effect was highest (in absolute value) in 2019q3, coefficient of -0.187, statistically significant at the 1% level, and started to level off after that. This is confirmed by the evidence in Table 2, column 5, that the changes in the coefficients for the 2019q3 and 2019q4 indicators relative to the coefficients for the respective previous quarter indicators are both very small and statistically insignificant. Importantly, the coefficient of -0.262, statistically significant at the 1% level, for the 2020q1 indicator, is 10.3% higher (in absolute value), than the coefficient of -0.159, also statistically significant at the 1% level, for the 2009q4 indicator. As column 5 shows, the 10.3% effect is statistically significant at the 1% level and suggests that Chinese firms lost 10.3% more of their U.S. customers that can be explained by the ongoing trade war between the U.S. and China. See also Figure 3, Panels C and D, which plot the coefficients on the quarters and difference in quarter indicators from columns 4 and 5, respectively.

The coefficient of -0.120, significant at the 1% level, for the Chinese firms with U.S. customers as of December 31, 2019, shows that the effect of the supply chain disruption was 1.7% larger

(in absolute value), -0.120 versus -0.103, for the Chinese suppliers with U.S. customers at the end of 2019q4 relative to 2018q1. Unsurprisingly, all the findings in Table 2, columns 4 to 6, for the Chinese firms with U.S. customers, mirror the evidence in columns 1 to 3 from the perspective of U.S. firms with Chinese suppliers.

4 The Wealth Effects of the Covid-19 Supply Chain Disruption

We use a standard event study methodology to examine the wealth effects of the Covid-19 Supply Chain disruption. In this analysis, we consider the universe of non-financial U.S. firms in COMPUSTAT in 2019q4, the onset of the Covid-19 pandemic. For this sample, we start by estimating a cross-sectional linear probability model in which the dependent variable is an indicator for whether the firm has at least one Chinese supplier in FactSet as of December 31, 2019, and the independent variables include firm's level log of market capitalization, momentum, and book-to-market. As a dependent variable, we also use an ordinal variable that takes the value of 1 for firms without Chinese suppliers, and 2, 3, and 4 for firms with low, moderate, and high exposure to Chinese suppliers, respectively. We perform both estimations with and without Fama-French 49 industry indicators. The purpose of these estimations is to help us identify the more appropriate asset pricing models.

Table 3, column 1 shows that log of market capitalization, momentum, and book-to-market are positively related to a firm's propensity to have at least one Chinese suppliers. We reach similar conclusions in column 2 after adding industry fixed effects. Table 3, column 3 shows that log of market capitalization and book-to-market are positively related to the intensity of a firm's exposure to Chinese suppliers, but momentum is insignificant in this estimation. We find similar results in column 4 after adding industry fixed effects.

[Table 3]

Overall, Table 3 suggests that market capitalization, momentum, and book-to-market are important characteristics of the U.S. firms that source from China. To control for the possible effect of differences in these firm level characteristics on systematic factor exposures, we use the Carhart 4-factor (C-4) model (Carhart, 1997), with the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns (VW), as our base event study model. As documented in

Table 1, the U.S. firms in our sample have a significant international footprint. To account for these firms' exposure to the global economy, we also estimate an 8-factor version of the VW C-4 model augmented with international factors (VW C-8). For completeness, we also estimate abnormal returns using the C-4 and C-8 models with the equally weighted NYSE-AMEX-NASDAQ index returns (EW), EW C-4 and EW C-8, respectively, and the simple Capital Asset Pricing Model (CAPM), with the value-weighted and equally weighted NYSE-AMEX-NASDAQ index returns, VW CAMP and EW CAPM, respectively. We discuss our stock and bond event study methodologies in Sections A.1 and A.2, respectively, of the Appendix.

4.1 The Effects of the Covid-19 Supply Chain Disruption on U.S. Buyers, Bondholders, and Chinese Suppliers

In this section, we analyze the wealth effects of the supply chain disruption on U.S. firms with Chinese suppliers, as well as the bondholders and the Chinese suppliers of these U.S. firms. As discussed in the Introduction, we set January 6, 2020 as the first day of our event window, the day marking an increase of U.S. media coverage of the pandemic. We stop our event window on February 19, 2020. This allows us to focus on the consequences of the supply chain disruption, while limiting the effects of monetary policy, fiscal stimulus, and other interventions on U.S. capital markets, which started on March 3, 2020 with the Fed's sweeping reduction of the fed funds rate. Figure 4 reports a timeline of major events surrounding the Covid-19 pandemic.

[Figure 4]

Our sample of U.S. firms with Chinese suppliers started to report delays with their product shipments from China in their earnings calls starting with Procter & Gamble on January 23, 2020, followed by Avnet Inc., on January 24, and Apple Inc., Starbucks Corp., 3M Co., and Whirpool Corp., on January 28. Out of the 247 earning calls of U.S. firms with Chinese suppliers that took place from January 1, 2020 to March 31, 2020, 195 (or about 79%) explicitly indicate concerns due to the Covid-19 supply chain disruption. In line with these concerns, China's industrial production dropped by 13.5% year-on-year in both January and February, 2020, and by another 1.1% in March 2020, before resuming to grow at a rate of 3.9% in April 2020, compared to an average growth rate of 5.5% in the period from May 2019 to December 2019 (Source: National Bureau of Statistics of

China). China's top eight ports lost 19.8% of their container traffic year-on-year in February 2020, and an additional 5.6% in March 2020 (Source: China Ports and Harbors Association – China Ministry of Transport).

Relatedly, Figure 5, Panel A shows that U.S. imports from China dropped from $41.6 billion in January 2019 to $33.3 billion in January 2020, from $33.2 billion in February 2019 to $22.8 billion in February 2020, and from $31.2 billion in March 2019 to $19.8 billion in March 2020, corresponding to a decrease of 19.9%, 31.3%, and 36.5% year-on-year in January, February, and March 2020 (Source: U.S. Census Bureau), respectively. Figure 5, Panel B shows that U.S. exports to China also decreased during the first quarter of 2020, although the effect appears in general more modest. There was a slight increase in exports from $7.1 billion in January 2019 to $7.2 billion in January 2020, but exports decreased from $8.4 billion in February 2019 to $6.8 billion in February 2020, and from $10.4 billion in March 2019 to $8 billion in March 2020, corresponding to a decrease of 19.1% and 23.1% year-on-year in February and March 2020, respectively. We discuss next the wealth effects of the Covid-19 supply chain disruption for the U.S. firms with Chinese suppliers.

[Figure 5]

Table 4 reports cumulative average abnormal returns (CAARs) for U.S. firms with Chinese suppliers. U.S. firms with high exposure to Chinese suppliers experienced CAARs of -12.1% in the 31 trading days starting on January 6, 2020, using our base VW C-4 model. CAARs are slightly lower (in absolute value) – equal to -10.4% – with the VW C-8 model, but higher in all our additional estimations, ranging from -12.6% for the VW CAPM, to -15.4% for the EW C-4. The high exposure sample includes 58 U.S. firms, who have a total of 106 material Chinese suppliers as of December 31, 2019. Except for the VW C-8 CAARs, which are statistically significant at the 5% level, CAARs from the VW C-4 and the other four estimation models in Table 4 for the high exposure group, are statistically significant at the 1% level. To compute t-statistics we use standard errors adjusted for cross-sectional correlation of security returns due to event-date clustering, following the crude dependence adjustment (CDA) of Brown and Warner (1980).

[Table 4]

Turning to the U.S. firms with moderate and low exposure to Chinese suppliers, CAARs are

equal to -5.1% and -2.9%, respectively, using our base VW C-4 model, compared to -12.1% for U.S. firms with high exposure. The patterns of decreasing CAARs (in absolute value) for firms with lower exposure to Chinese suppliers hold across all the other five estimation models in Table 4. Importantly, the evidence that CAARs decrease (in absolute value) with the decreasing intensity of the U.S. firms' exposure to Chinese suppliers helps validate the logic of our identifying argument that our empirical framework and granular supply chain data are suitable to isolate the effect of the Covid-19 supply chain disruption. The moderate and low exposure groups include 54 (185) and 174 (541) U.S firms (Chinese suppliers) with Chinese suppliers as of December 31, 2019, respectively. Statistical significance for all CAARs in Table 4 ranges from 1% to 5% levels using CDA standard errors.

Table 4 also reports CAARs for the combined sample of U.S. firms with at least one Chinese suppliers, Chinese Suppliers$\geq$1. This sample is slightly larger than the sample combining high, moderate, and low exposure to Chinese suppliers because U.S. firms' sales, which are needed for our partitions, are missing for two of the U.S. firms. For this combined sample, CAARs range from -10.8% in the EW CAPM to -6.2% in the estimation with the VW C-8 model and are statistically significant at either the 5% level or the 1% level. The overall market capitalization of U.S. firms with at least one Chinese suppliers is $13 trillion as of December 31, 2019. Based on this figure, a simple back of the envelop calculation suggests that U.S. firms with material exposure to Chinese suppliers lost between $0.8 trillion (i.e., -6.2% of $13 trillion) to $1.4 trillion (i.e., -10.8% of $13 trillion) of their market value (on a risk-adjusted basis) because of the Covid-19 supply chain disruption. Overall, these findings suggest that the Covid-19 supply chain disruption was very costly for U.S. firms exposed to Chinese suppliers. As discussed in the Appendix Section A.3 and related Table A.3, U.S. firms with tier 2 and tier 3 Chinese supplier also suffered market value losses (albeit smaller) because of the pandemic.

Figure 6, Panels A to D display VW C-4 and VW C-8 CAARs over our 31-day event window for each of the four groups of U.S. firms with Chinese suppliers (high, moderate, low exposure, and at least one Chinese supplier), respectively. We also plot VW C-4 and VW C-8 CAARs for the sample of U.S. firms without Chinese suppliers. As Figure 6 shows, CAARs for the affected firms are decreasing throughout the 31-day trading window of our study. On the other hand, CAARs

are always nearly zero and statistically insignificant for the U.S. firms without Chinese suppliers.

[Figure 6]

One could be concerned that our findings are driven by a stock market trend specific to the U.S. firms with Chinese suppliers that started prior to the Covid-19 pandemic, rather than the consequences of the Covid-19 supply chain disruption that we are interested in. For instance, one could wonder whether we are capturing a trend that started on March 8, 2018, when the U.S. imposed tariffs on steel and aluminum imports from China escalating a trade war. Figure 7, Panels A to D show that VW C-4 and VW C-8 CAARs are always nearly zero and statistically insignificant in the 45 trading days preceding January 6, 2020 (i.e., the period from October 30, 2019 to January 3, 2020) for each of the four groups of U.S. firms with Chinese suppliers. On the other hand, CAARs decrease constantly during the 31 trading days starting on January 6, 2020. This pattern mitigates the concern that we are capturing a stock market trend specific to the U.S. firms with material Chinese suppliers that started prior to the Covid-19 pandemic. Notably, Figure 7 also shows that CAARs do not deviate significantly from the 31-day CAARs in the 15 trading days after day 30th. This finding suggests that the Covid-19 supply chain disruption is a major supply chain event that the market incorporated relatively quickly, and represents a departure from previous findings that the market tends to underreact to supply chain information, which can take up to 12 months to be fully incorporated into stock prices (e.g., Cohen and Frazzini, 2008; Menzly and Ozbas, 2010).

[Figure 7]

As we discuss in Section A.4 of the Appendix and related Tables A.4, A.5, and A.6, our event study results hold when we exclude, among the U.S. firms with Chinese suppliers (affected firms), those who have also suppliers from Mexico and Canada, to account for recent changes in the trading agreements between the U.S, Mexico, and Canada, when we exclude affected U.S. firms who have also customers from China, to account for the potential decrease in the demand of U.S. products by Chinese customers, when we use matching to control for potential differences between firm with and without suppliers from China, when we rely on cross-sectional regressions to assess the combined effects of possible alternative channels. Altogether, these robustness tests further confirm that the

Covid-19 supply chain disruption is the channel for the negative CAARs experienced by U.S. firms with Chinese suppliers during our event window.

4.1.1 The Effects of the Covid-19 Supply Chain Disruption on Bondholders and Chinese Suppliers

Our focus thus far has been on the shareholders of the U.S. firms with Chinese suppliers. We now analyze the effects of the Covid-19 supply chain disruption on two other classes of financial stakeholders, the bondholders of the U.S. firms with Chinese suppliers, as well as the Chinese suppliers of these U.S. firms. If the Covid-19 supply chain disruption leads to a higher risk of default for the U.S. firms with Chinese suppliers, we should expect this higher risk of default to be reflected into the bond prices of the affected firms. We could also expect Chinese suppliers of U.S. firms to be affected more than the Chinese firms without ties with the U.S. if, for instance, sales decrease more for the former group.

Table 5, Panel A confirms that the Covid-19 supply chain disruption affected the bondholders of U.S. firms with Chinese suppliers. 31-day buy-and-hold abnormal returns (BHARs), estimated using the methodology described in Section A.2 of the Appendix, are equal to -7.8%, statistically significant at the 1% level, for the U.S. firms with high exposure to Chinese suppliers, and decrease (in absolute value) to -3.0% and -2.7%, both statistically significant at the 5% level, for the samples with moderate and low exposure to Chinese suppliers, respectively. One important caveat with the high exposure group results is that they are based only on 7 bonds, so these findings should be interpreted with caution. Instead, the moderate and low exposure groups include 109 and 1,357 bonds, respectively, and, therefore, estimates are more reliable. For the overall group of firms with at least one Chinese suppliers, 31-day BHARs are equal to -2.8%, statistically significant at the 1% level. The overall market value for the bonds of the U.S. firms with at least one Chinese suppliers is $1.4 trillion as December 31, 2019. Based on this figure, a simple back of the envelop calculation suggests that bondholders lost about $39.2 billion (on a risk-adjusted basis) because of the Covid-19 supply chain disruption.

[Table 5]

Table 5, Panel B presents CAARs for the Chinese suppliers of the U.S. firms in our sample.

We report results based on the VW C-4 and VW C-8 models estimated using the factors and estimation methodology described in Section 4.1. Daily stock returns for Chinese suppliers are from COMPUSTAT Global Security Daily. We separate Chinese suppliers into four groups based on their exposure to U.S. firms at the end of 2019: 1) High U.S. Customers' Exposure: Chinese firms with one U.S. customer or more per $1 billion of sales; 2) Moderate U.S. Customers' Exposure: Chinese firms with one U.S. customer per $1+ billion to $3 billion of sales; 3) Low U.S. Customer' Exposure: Chinese firms with one U.S. customer per $3+ billion of sales; 4) At Least One U.S. Customer: Chinese firms with at least one U.S. customer.

VW C-4 CAARs are not statistically different from zero for any of the four groups of Chinese suppliers of U.S. firms for the event window from January 6, 2020 to February 19, 2020. Notably, however, VW C-4 CAARs are very sizable, ranging from -13.2% to -10.4%, statistically significant at either the 1% or 5% level, for the high exposure to low exposure groups, respectively, during the shorter 21-day window starting on January 6, 2020. We reach similar conclusions with VW C-8 CAARs.

Figure 8, Panels A and B for VW C-4 CAARs and VW C-8 CAARs, respectively, show that CAARs, for all four groups of Chinese suppliers of U.S. firms, started to decrease around day 12th, reached their peak (in absolute value) on day 20th, before starting to increase, and eventually becoming statistically equal to zero on day 30th. Overall, these patterns suggest that the stock prices of the Chinese suppliers of U.S. firms incorporated the effect of the Covid-19 supply chain disruption more quickly than the stock prices of their U.S. customers, 21 days for the Chinese suppliers (Table 5) versus 31 days for their U.S. customers (Table 4). However, the evidence that CAARs become equal to zero for Chinese suppliers by day 30th indicates that these firms more quickly absorbed the effect of the disruption, perhaps because of effective lockdown measures put in place by the Chinese government, while persisted at least until day 45th for the U.S. customers of these Chinese suppliers (as shown by Figure 7).

[Figure 8]

4.1.2 The Effects of the Demand Shock of the Covid-19 Pandemic on U.S. Suppliers of Chinese Firms, Bondholders, and Chinese Customers

Thus far we have focused on the wealth effects of the Covid-19 crisis on U.S. firms with Chinese suppliers and other financial stakeholders. However, because the U.S. is a major exporter to China, one should expect that the U.S. suppliers of Chinese firms, as well as the bondholders and Chinese customers of these U.S. firms will be affected by the Covid-19 pandemic through a 'demand channel.' To analyze the extent to which U.S. firms lost Chinese customers because of the pandemic, we estimate a regression model similar to Eq. (1) for U.S. firms with Chinese customers (but without Chinese suppliers) as of March 7, 2018, with the natural logarithm of Chinese customers as dependent variable. The sample periods span 2018q1 to 2020q1, with 2018q1, the pre trade war quarter, as the omitted case. We also estimate the model for the sample period 2019q4 to 2020q1, with 2019q4 as the omitted case. In this case, we consider the sample of U.S. firms with Chinese customers (but without Chinese suppliers) as of December 31, 2019 (the onset of the Covid-19 pandemic), the samples of firms used in our event study analysis discussed in this section.

The coefficient for the 2018q4 indicator, statistically significant at the 1% level, in Table 6, column 1 suggests that U.S. firms lost 13.3% of their customers by 2018q3, relative to 2018q1. By 2019q3, U.S. firms lost as many as 17.9% of their Chinese customers, with the size of the loss being a slightly lower 17.3% in 2019q3. Notably, the trade war seems to have had sizable consequences for the ability of U.S. firms to retain their Chinese customers. These effects materialized for most part by 2018q4, as confirmed by the statistically insignificant changes, in Table 6, column 2 for the coefficients for the 2019q1, 2019q2, 2019q3, and 2019q4 indicators relative to the coefficients for the respective previous quarter indicators. Importantly, the coefficient of -0.239 for the 2020q1 indicator, significant at the 1% level, compared to the coefficients of -0.173 for the 2019q4 indicator, in Table 6, column 1, suggests that U.S. firms lost an additional 6.6% of their Chinese customers during the pandemic. As confirmed by Table 6, column 3 this 6.6% decrease is statistically significant at the 1% level. For the sample of U.S. firms with Chinese customers as of December 31, 2019, the coefficient of -0.046 for the 2020q1 indicator, significant at the 1% level, suggests that these firms lost 4.6% of their customers.

[Table 6]

Turning briefly to the Chinese firms with U.S. suppliers, Table 6, column 4 shows that because of the trade war these firms lost 9% of their U.S. suppliers by 2019q1. The statistically insignificant coefficients for the 2019q2, 2019q3, and 2019q4 indicators relative to the coefficients for the respective previous quarter indicators in Table 6, column 5, suggest that the effect of the trade war leveled off after 2019q1, before the additional 9.2% loss, significant at the 1%, in 2020q1. For the sample of Chinese firms with U.S. customers as of December 31, 2019, the -0.102 coefficient for 2020q1 dummy, significant at the 1% level, suggests that these firms lost 10.2% of their customers during the first quarter of 2020.

Next, we analyze the wealth effects of the demand shock of the Covid-19 pandemic on U.S. firms with Chinese customers (but without Chinese suppliers) as of December 31, 2019. Table 7, Panel A shows 31-day VW C-4 CAARs of -11.7%, statistically significant at the 1% level, for U.S. firms with high exposure to Chinese customers, U.S. firms with one Chinese customer or more per $1 billion of sales. CAARs decrease (in absolute value) to -3.3% (statistically significant at the 5% level) and -4.4 (statistically significant at the 5% level) for U.S. firms with moderate and low exposure to Chinese customers, respectively. We define moderate and low exposure to Chinese customers for U.S. firms as having one Chinese customer per $1+ billion to $3 billion of sales and one Chinese customer per $3+ billion of sales, respectively.

CAARs are equal to -7.2%, statically significant at the 1% level, for the overall sample of U.S. firms with at least one Chinese customer. This group includes 176 U.S. firms, which have a total of 322 Chinese customers. A back of the envelop calculation indicates that these firms lost $0.2 trillion (i.e., -7.2% of $1.6 trillion) of their market value (on a risk adjusted basis) because of the demand shock caused by the Covid-19 pandemic. Figure A.1 in the Appendix displays 31-day VW C-4 for the four groups of U.S. firms with Chinese customers.

[Table 7]

Relatedly, Table 7, Panel B shows 31-day BHARs for the bondholders of U.S. firms with Chinese customers ranging from -4.9% to -2.6%, all statistically significant at the 5% level, for firms with high to low exposure to Chinese customers, respectively. Caution should be used with the interpretation of the BHARs for the high exposure group, which includes only 13 bonds. 31-day BHARs are equal to -2.7%, statistically significant at the 5% level, for the bonds of the overall sample of U.S. firms

with Chinese customers. This group includes a total of 1,253 bonds.

Turning to the Chinese customers of U.S. firms, in Table 7, Panel C, we find sizable 21-day VW C-4, for the overall group of Chinese customers with at least one U.S. supplier, of -12.3%, statistically significant at the 5% level. We do not find that CAARs vary for the Chinese customers in relationship to whether they have high, moderate, or low exposure to U.S. suppliers. Notably, CAARs are statistically equal to zero by day 30th of our event windows for all Chinese customers of U.S. firms, independently from their exposure to U.S. suppliers. As for the case of Chinese suppliers, this pattern suggests that Chinese customers rebounded more quickly than their U.S. suppliers to the Covid-19 pandemic. Figure A.2 in the Appendix displays 31-day VW C-4 for the four groups of Chinese customers of U.S. firms.

5 Sourcing Strategies, Inventory Management, and Operating Performance of U.S. Firms with Chinese Suppliers During the Covid-19 Pandemic

In this section, we analyze the consequences of the Covid-19 supply chain disruption on sourcing strategy, inventory management, and operating performance of the U.S. firms with Chinese suppliers as of December 31, 2019.

5.1 The Effect of the Covid-19 Supply Chain Disruption on the Sourcing Strategies of U.S. Firms with Chinese Suppliers

As shown, U.S. firms lost a significant number of Chinese suppliers in the first quarter of the Covid-19 pandemic, and this led to sizable negative wealth effects for these firms' shareholders and bondholders. We now analyze the extent to which the affected U.S. firms were able to remedy to the Covid-19 supply disruption by relocating their supply chain back to the U.S. or by sourcing from suppliers located outside of China. To address this question, we estimate the following difference-

in-difference model (e.g., Bertrand, Duflo and Mullainathan, 2004):

$$
\begin{aligned}
&Log\ of Suppliers_{i,q} \\
&\qquad = \beta_1(High\ Chinese\ Suppliers'\ Exposure_{i,Dec-31-2019} \times 2020q1) \\
&\qquad + \beta_2(Moderate\ Chinese\ Suppliers'\ Exposure_{i,Dec-31-2019} \times 2020q1) \\
&\qquad + \beta_3(Low\ Chinese\ Suppliers'\ Exposure_{i,Dec-31-2019} \times 2020q1) \\
&\qquad + 2020q1 + \boldsymbol{Controls}_{i,t}\gamma + y_i + \varepsilon_{i,t}, \qquad (2)
\end{aligned}
$$

where Log of Suppliers is the natural logarithm of the number of either U.S. or global suppliers (other than Chinese suppliers) of firm i in quarter q. High, Moderate, Low Chinese Suppliers' Exposures, are indicators for firms with high, moderate, and low exposure to Chinese suppliers (as defined above) as of December 31, 2019. The three indicators are all equal to zero for firms with no Chinese suppliers. We also estimate Eq. (2) by replacing the three indicators with Chinese Suppliers$\geq$1, an indicator for firms with at least one Chinese supplier as of December 31, 2019.

$2020q1$ is an indicator equal to one for the first quarter of 2020, and 0 for the fourth quarter of 2019, and y_i are firm fixed effects. Our analysis focuses on the sample period 2019q4–2020q1: a two-quarter time window centered on December 31, 2019. Our control variables include the following company characteristics: (1) Log of Assets, the natural logarithm of book assets; (2) Tobin's q, the ratio of the market value of assets to book assets; (3) Tangibility, the ratio of property, plant, and equipment to book assets. Table A.7 in the Appendix reports detailed descriptive statistics for all the variables used in the paper.

The focus of our analysis is the interaction terms in Eq. (2), our difference-in-difference estimators, which measure the change in the number of suppliers for U.S. firms exposed to Chinese suppliers (treated firms) relative to U.S. firms without exposure to Chinese suppliers (control firms) in 2020q1, relative to 2019q4. Table 8 reports results from these estimations. To put our findings in perspective, it is important to remember that our evidence in Table 2 indicates that U.S. firms lost between 8.4% and 10.3% of their Chinese suppliers in 2020q1.

Turning to Table 8, the insignificant coefficients for the interaction terms in columns 1 and 2 suggest that the number of U.S. suppliers did not change for U.S. firms exposed to Chinese

suppliers relative to unaffected firms (firms without Chinese suppliers) in 2020q1. For the case of global suppliers, the coefficient of -0.042 in column 3, statistically significant at the 10% level, suggests that U.S. firms with high exposure to Chinese suppliers lost 4.2% of their global suppliers relative to unaffected firms in 2020q1. We do not find any significant change in global suppliers for the moderate and low exposures groups (column 3), and the overall group of U.S. firms with at least one Chinese supplier (column 4). Combined with the evidence in Table 2, the findings in Table 8 indicate that during the pandemic U.S. firms were unable to replace their lost Chinese suppliers with domestic suppliers, and further lost some of their global suppliers.

[Table 8]

5.1.1 Inventory Management, Sales, and Operating Performance of U.S. Firms with Chinese Suppliers During the Covid-19 Pandemic

Did the Covid-19 supply chain disruption affect inventory management, sales, and operating performance of U.S. firms with Chinese suppliers? Table 9 reports results from estimating a model like Eq. (2) using as dependent variables the ratio of inventory to assets (columns 1 and 2), the ratio of accounts payable to assets (columns 3 and 4), the natural logarithm of sales (columns 5 and 6), and the ratio of operating income to assets (columns 7 and 8). In these estimations, we consider the quarters 2019q1 and 2020q1 to mitigate the effect of seasonality with quarterly variables. The coefficient of -0.008 in column 1, significant at the 1% level, suggests that inventory holdings decreased by 0.8 percentage points (pp), or 9.9% compared to the 2019q1 sample average (i.e., -0.008/0.081 = -0.099 or 9.9%), for U.S. firms with low exposures to Chinese suppliers relative to unaffected firms in 2020q1. Interestingly, the interaction terms are insignificant for both the high and the moderate Chinese suppliers' exposure groups. If these firms loaded their inventory from China at the end of 2019, as firms traditionally do to deal with the nearly month-long closure of factory in China during the Chinese New Year (which started on January 25, 2020), this could explain why inventory holdings for the high and moderate exposure groups did not decrease in 2020q1 as for the low exposure group. For the combined group of U.S. firms with at least one Chinese supplier, the coefficient of -0.006 for the interaction term in column 2, significant at the 1% level, suggests that inventory holdings decreased by 0.6 pp in 2020q1.

Columns 3 shows that accounts payable decreased by 0.7 pp, significant at the 10% level, for the moderate exposure group, but not significant effects for the high and low groups. For the combined group of U.S. firms with at least one Chinese supplier, the decrease is accounts payable in 2020q1 was 0.4 pp (column 4). Overall, the accounts payable results mirror the inventory results indicating that lower inventory holdings for U.S. exposed to Chinese suppliers led also to lower credit for these firms from their suppliers.

[Table 9]

Notably, columns 5 and 6 (7 and 8) show that in 2020q1 sales (operating performance) decreased by 6.1% and 5.4% (0.6 pp and 0.5 pp) for the moderate and low exposure groups (relative to firms without Chinese suppliers), respectively. We find no significant effects for the high exposure group. The combined group of U.S. firms with at least one Chinese supplier suffered a reduction in sale and operating performance of 3.8% and 0.4 pp, respectively. The overall evidence in Table 9 suggests that the Covid-19 supply chain disruption led to a decrease in inventory holdings and accounts payable for the affected firms, with the consequence that sales and operating performance were also negatively affected for these firms.

5.2 Access to Credit, Investment, and Employment of U.S. Firms with Chinese Suppliers During the Covid-19 Pandemic

Did affected U.S. firms use external financial resources to alleviate the consequences of the Covid-19 supply chain disruption? Table 10 reports results from estimating a model like Eq. (2) using as dependent variables the ratio of change in total debt to lagged assets (columns 1 and 2), change in long-term debt to lagged assets (columns 3 and 4), and change in short-term debt to lagged assets (columns 5 and 6). We consider the quarters 2019q1 and 2020q1.

Column 1 shows that firms in the moderate exposure group increased total debt by 10.1 pp. They did so by tapping the long-term debt market for 7.6 pp (column 2) and the short-term debt for 2.3 pp (column 3). The low exposure group increased total debt by 6.1 pp (column 1), but the funds came exclusively from the long-term debt market, as indicated by the significantly positive and insignificant coefficients for the low exposure interactions in the long-term and short-term debt change regressions in columns 3 and 5, respectively. The coefficients for the high exposure

interactions in columns 1, 3, and 5 are all positive but lack statistical significance. Overall, for the group of firms with at least one Chinese supplier, total debt increased by 6.6 pp (column 2), with 6.1 pp of the increased associated to long-term debt change (column 4), and the effect being insignificant for short-term debt change (column 6).

[Table 10]

Table 11, column 1 shows cash reserves increased by 1.8 pp and 2.2 pp for the low and moderate exposure groups, respectively. For these two groups, we find no effect on capital expenditures (column 3), while the number of employees decreased by 3.4% for the low exposure group and a very sizable 15.8% for the moderate exposure group (column 5), respectively. The coefficients for the high exposure interactions are all insignificant. For the combined group with at least one Chinese supplier, we find that cash holdings increased by 1.7 pp (column 2), investment remained unchanged (column 4), while number of employees decreased by 5.2% (column 6).

[Table 11]

Altogether, the evidence in Tables 10 and 11 suggests that, in response to the Covid-19 supply chain disruption, affected U.S. firms tapped the long-term debt market and partly used the funds to build up their cash reserves. Access to credit possibly also helped the affected firms not to cut investment, but they were unable to maintain their pre Covid-19 employment level compared to unaffected firms.

Overall, we find that the Covid-19 pandemic had milder effects on the Chinese suppliers of U.S. firms (Tables A.8 and A.9 in the Appendix), on the U.S. firms with Chinese customers (Table A.10, Panel A, and Table A.11), and on the Chinese customers of U.S. firms (Table A.10, Panel B, and Table A.12). We discuss these results briefly in Sections A.5 and A.6 of the Appendix.

6 Conclusion

Since Coase (1937) and Jensen and Meckling (1976), theory has recognized that non-financial stakeholders (e.g., employees, customers, suppliers), together with financial stakeholders (i.e., shareholders and debtholders), are vital for the prosperity of firms. In this article, we exploit the Covid-19 crisis to study how supply chain disruptions affect firm-supplier-customer relationships.

We find that U.S. firms lost as many as 10.3% of their Chinese suppliers in 2020q1 in excess of what can attributed to the ongoing trade war between the U.S. and China. We also find that because of the Covid-19 supply chain disruption U.S. firms with Chinese suppliers lost between $0.8 trillion and $1.4 trillion (on a risk-adjusted basis) of their market value. We find very similar results when we consider the U.S. suppliers of Chinese firms, suggesting that the 'demand shock' caused by the pandemic was also very costly for U.S. firms.

In addition, our analysis reveals that affected U.S. firms were unable to quickly replace their lost Chinese suppliers with suppliers from other countries, which led to a significant decrease in inventory holdings, sales, and performance for these firms. In response to the supply chain disruption, the affected U.S. firms tapped the long-term debt market, and partly used the funds to build up their cash reserves. Investment did not decrease for the affected firms in 2020q1, but they cut employment significantly. Overall, the Chinese counterparts of U.S. firms rebounded more quickly from the Covid-19 supply chain disruption.

Our findings can offer useful insights to both corporate executives and policymakers. On the one hand, our findings suggest that sourcing from a single manufacturing hub can be very costly for firms, highlighting the importance of a geographically diversified sourcing strategy. On the other hand, our results also indicate that firms are unable to quickly relocate their supply chain domestically or elsewhere. In response to the Covid-19 pandemic, there has been increasing political pressure to decouple the U.S. supply chain from China. For example, the "Protecting our Pharmaceutical Supply Chain from China Act", was introduced to end U.S. dependence on China for pharmaceutical manufacturing. Our findings suggest that trade tensions between the U.S. and China might inflict additional costs to the firms and consumers of both countries because it is costly for firms to relocate their supply chain.

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Table 1: Descriptive Statistics

This table reports descriptive statistics for the firms in our sample in 2019q4. The sample includes all U.S. firms in FactSet except financial firms (SICs 6000-6999). Chinese Suppliers≥1 is an indicator for firms with at least one Chinese supplier as of December 31, 2019. Assets is book asset. Tobin's q is the ratio of market value of assets to book assets. Tangibility is the ratio of property, plant, and equipment to book assets. Chinese, U.S., Other Global, are the number of Chinese, U.S., and other global suppliers (excluding Chinese), respectively, in percentage of total suppliers. Chinese Suppliers in % of Total Suppliers by Exposure is the number of Chinese suppliers in percent of total suppliers for the High, Moderate, and Low Chinese Suppliers' Exposure groups. High, Moderate, and Low Chinese Suppliers' Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. Supply chain relationship data if from the FactSet Revere Supply Chain Relationships database. Other firm level data is from COMPUSTAT North America. Refer to Table A.1 for detailed variable definitions. Standard errors are in parentheses.

				Suppliers in % of Total Suppliers			**Chinese Suppliers in % of Total Suppliers by Exposure**		
Mean	Assets ($ billion)	Tobin's q	Tangibility	Chinese	U.S.	Other Global	High CSE	Moderate CSE	Low CSE
Chinese Suppliers≥1: Yes	31.074	2.227	0.284	10.8%	44.5%	44.7%	25.8%	12.9%	4.9%
Num. of Firms	283	246	283	288	288	288	58	54	174
Chinese Suppliers≥1: No	5.511	2.478	0.283	N.A.	63.9%	36.1%	N.A.	N.A.	N.A.
Num. of Firms	1,339	1,230	1,338		2,240	2,240			
Yes–No	25.564***	-0.249*	0.001	N.A.	-19.4%***	8.6%***	N.A.	N.A.	N.A.
	(2.343)	(0.147)	(0.017)		(0.878)	(1.015)			

Table 2: Sourcing Strategies Before and During the Covid-19 Pandemic

This table presents estimations from supplier and customer regressions. The samples in columns (1) – (2) and (4) – (5) include all U.S. firms in FactSet with at least one Chinese supplier and all Chinese firms in FactSet with at least one U.S. customer as of March 31, 2018, respectively, for the period 2018q1 – 2020q1. The samples in columns (3) and (6) include all U.S. firms in FactSet with at least one Chinese supplier and all Chinese firms in FactSet with at least one U.S. customer as of December 31, 2019, respectively, for the period 2019q4 – 2020q1. We exclude financial firms (SICs 6000-6999). The dependent variable in columns (1) – (3) is Log of Chinese Suppliers, the natural logarithm of the number of Chinese suppliers. The dependent variable in columns (4) – (6) is Log of U.S. Customers, the natural logarithm of the number of U.S. customers. 2018q2 to 2020q1 are quarter dummies. Columns (2) and (5) report the differences in coefficients for the quarter dummies between two consecutive quarters. Firm level data for the U.S. and the Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively. Refer to Table A.1 for detailed variable definitions. Standard errors reported in parentheses are clustered at the firm level.

Dep. Variable:		Log of Chinese Suppliers			Log of U.S. Customers		
Sample:		**U.S. Firms with Chinese Suppliers**			**Chinese Firms with U.S. Customers**		
		2018q1–2020q1		2019q4–2020q1	2018q1–2020q1		2019q4–2020q1
		(1)	(2)	(3)	(4)	(5)	(6)
Pre Covid-19	2018q2	-0.044***			-0.014		
		(0.012)			(0.014)		
	2018q3	-0.010			-0.001		
		(0.015)			(0.019)		
	2018q4	-0.084***			-0.075***		
		(0.019)			(0.028)		
	2019q1	-0.089***			-0.152***		
		(0.022)			(0.031)		
	2019q2	-0.094***			-0.185***		
		(0.023)			(0.032)		
	2019q3	-0.104***			-0.187***		
		(0.024)			(0.032)		
	2019q4	-0.088***			-0.159***		
Covid-19		(0.026)			(0.035)		
	2020q1	-0.172***		-0.103***	-0.262***		-0.120***
		(0.030)		(0.025)	(0.042)		(0.022)
Pre Covid-19	2018q2–2018q1		-0.044***			-0.014	
			(0.012)			(0.014)	
	2018q3–2018q2		0.034***			0.013	
			(0.011)			(0.013)	
	2018q4–2018q3		-0.074***			-0.075***	
			(0.014)			(0.021)	
	2019q1–2018q4		-0.005			-0.077***	
			(0.013)			(0.023)	
	2019q2–2019q1		-0.005			-0.033***	
			(0.009)			(0.011)	
	2019q3–2019q2		-0.010			-0.002	
			(0.008)			(0.009)	
	2019q4–2019q3		0.016			0.028	
Covid-19			(0.011)			(0.018)	
	2020q1–2019q4		-0.084***			-0.103***	
			(0.018)			(0.023)	
	Log of Assets	0.033		-0.371***	0.034		0.328**
		(0.049)		(0.133)	(0.089)		(0.154)
	Tobin's q	-0.016		-0.056*	-0.010		0.064
		(0.013)		(0.030)	(0.022)		(0.073)
	Tangibility	0.003		0.394	0.072		-1.753**
		(0.014)		(0.446)	(0.377)		(0.824)
	Obs.	1,623	1,623	424	1,953	1,953	522
	Num. of Firms	220	220	212	239	239	261
	Num. of Chinese Suppliers	823	823	723			
	Num. of U.S. Customers				759	759	787
	R2 (within)	0.048	0.048	0.120	0.107	0.107	0.131
	Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
	Std. Errors Clustering	Firm	Firm	Firm	Firm	Firm	Firm

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 3: Propensity to Source from Chinese Suppliers

This table presents cross-sectional regressions from propensity to source from Chinese supplier regressions. The sample includes all U.S. firms in FactSet and COMPUSTAT North America except financial firms (SICs 6000-6999) for 2019q4. The dependent variable in Columns (1) and (2) is Chinese Suppliers≥1, an indicator for firms with at least one Chinese supplier as of December 31, 2019. The dependent variable in columns (3) and (4) is Chinese Suppliers' Exposure, a categorical variable that takes the value of 1 for firms with no exposure to Chinese suppliers and the values of 2 to 4 for firms in the Low, Moderate, and High Chinese Suppliers' Exposure groups, respectively, as of December 31, 2019. Industry fixed effects are based on the Fama and French (1997) 49 industries. Refer to Table A.1 for detailed variable definitions. Robust standard errors are reported in parentheses.

Dep. Variable:	Chinese Suppliers≥1: Yes = 1		Chinese Suppliers' Exposure from None = 1, Low = 2, Moderate = 3, to High = 4	
	(1)	(2)	(3)	(4)
Log of Market Capitalization	0.045***	0.044***	0.048***	0.047***
	(0.003)	(0.003)	(0.004)	(0.005)
Momentum	0.007**	0.008**	0.002	0.001
	(0.003)	(0.003)	(0.004)	(0.005)
Book-to-Market	0.023***	0.019***	0.044***	0.040**
	(0.007)	(0.007)	(0.017)	(0.016)
Obs.	2,716	2,665	2,707	2,657
Adjusted-R2	0.101	0.161	0.036	0.087
Industry Fixed Effects	No	Yes	No	Yes

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 4: The Wealth Effects of the Covid-19 Supply Chain Disruption

This table reports Cumulative Average Abnormal Returns (CAARs) during the 31 trading days starting on January 6, 2020 ("event date") for various groups of U.S. firms with Chinese suppliers in FactSet as of December 31, 2019. We exclude financial firms (SICs 6000-6999). High, Moderate, and Low Chinese Suppliers' Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. The CAARs in columns (1) and (2) are estimated using the Carhart 4-factor and Carhart 8-factor models (Carhart, 1997), with the U.S. and both the U.S. and other developed countries Carhart factors, respectively, and the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns, VW C-4 and VW C-8. The CAARs in columns (3) and (4) are estimated similarly to those in columns (1) and (2), respectively, except that the value-weighted index returns are replaced with the equally-weighted index returns, EW C-4 and EW C-8. The CAARs in columns (5) and (6) are estimated using a one factor CAPM model with the value-weighted and equally-weighted index returns, respectively. Daily stock returns are from COMPUSTAT North America and Carhart factors are from Kenneth French's website (`https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`). Refer to Table A.1 for detailed variable definitions. t-statistics are based on standard errors adjusted for cross-sectional correlation of security returns due to event-date clustering (Brown and Warner, 1980).

CAARs by Chinese Suppliers' Exposure (CSE)	**Base Estimation Models**		**Additional Estimation Models**			
	Value-Weighted 4-Factor	Value-Weighted 8-Factor	Equally-Weighted 4-Factor	Equally-Weighted 8-Factor	Value-Weighted CAPM	Equally-Weighted CAPM
	(1)	(2)	(3)	(4)	(5)	(6)
High CSE:						
CAARs	-0.121***	-0.104**	-0.154***	-0.128***	-0.126***	-0.145***
t-statistic	-2.851	-2.497	-3.386	-2.922	-2.934	-3.177
Num. of Firms	58	58	58	58	58	58
Num. of Chinese Suppliers	106	106	106	106	106	106
Moderate CSE:						
CAARs	-0.051**	-0.049**	-0.087**	-0.082**	-0.073***	-0.095**
t-statistic	-2.400	-2.349	-2.242	-2.151	-2.921	-2.379
Num. of Firms	54	54	54	54	54	54
Num. of Chinese Suppliers	185	185	185	185	185	185
Low CSE:						
CAARs	-0.029**	-0.024**	-0.061***	-0.047**	-0.068***	-0.092***
t-statistic	-2.331	-1.971	-2.700	-2.320	-3.025	-3.414
Num. of Firms	174	174	174	174	174	174
Num. of Chinese Suppliers	541	541	541	541	541	541
Chinese Suppliers$\geq$1:						
CAARs	-0.066***	-0.062**	-0.100***	-0.092***	-0.086***	-0.108***
t-statistic	-2.614	-2.476	-3.446	-3.269	-3.152	-3.551
Num. of Firms	288	288	288	288	288	288
Num. of Chinese Suppliers	837	837	837	837	837	837

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 5: The Wealth Effects of Bondholders and Chinese Suppliers of U.S. Firms

This table reports Buy-and-Hold Abnormal Returns (BHARs), column (1), and Cumulative Average Abnormal Returns (CAARs), columns (2) – (4), during the 31 trading days starting on January 6, 2020 ("event date") for various groups of U.S. firms with Chinese suppliers and various groups Chinese suppliers of U.S. firms, respectively, in FactSet as of December 31, 2019. CAARs are also reported for a 20-trading day window on January 6, 2020. We exclude financial firms (SICs 6000-6999). High, Moderate, and Low Chinese Suppliers' Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. High, Moderate, and Low U.S. Customers' Exposure (High, Moderate, Low U.S. CE) indicate high, moderate, and low exposure of Chinese firms to U.S. customers based on the number of U.S. customers per billions ($) of sales. BHARs are estimated using the market-adjusted model discussed in the text. VW C-4 and VW C-8 are estimated using the Carhart 4-factor and Carhart 8-factor models (Carhart, 1997), with the U.S. and both the U.S. and other developed countries Carhart factors, respectively, and the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns. Bond data is from TRACE and Mergent-FISD. Daily stock returns for Chinese firms are from COMPUSTAT Global and Carhart factors are from Kenneth French's website (`https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`). Refer to Table A.1 for detailed variable definitions. t-statistics are based on standard errors adjusted for cross-sectional correlation of security returns due to event-date clustering (Brown and Warner, 1980).

BHARs by Chinese Suppliers' Exposure (CSE)	Panel A: **Wealth Effects for Bondholders of U.S. Firms with Chinese Suppliers**	**CAARs by U.S. Customers' Exposure (CE)**	Panel B: **Wealth Effects for Chinese Firms with U.S. Customers**			
	Event Window [0,30]		Event Window [0,20]		Event Window [0,30]	
	Market Adjusted Model		Value-Weighted 4-Factor	Value-Weighted 8-Factor	Value-Weighted 4-Factor	Value-Weighted 8-Factor
	(1)		(2)	(3)	(4)	(5)
High CSE:		**High U.S. CE**:				
BHARs	-0.078***	CAARs	-0.132**	-0.125**	-0.039	-0.041
t-statistic	-3.033	t-statistic	-2.512	-2.396	-0.611	-0.646
Num. of Bonds	7	Num. of Firms	82	82	82	82
Moderate CSE:		**Moderate U.S. CE**				
BHARs	-0.030**	CAARs	-0.121***	-0.117**	-0.020	-0.028
t-statistic	-2.372	t-statistic	-2.608	-2.570	-0.362	-0.498
Num. of Bonds	109	Num. of Firms	74	74	74	74
Low CSE:		**Low U.S. CE**				
BHARs	-0.027***	CAARs	-0.104**	-0.094**	0.004	0.006
t-statistic	-2.533	t-statistic	-1.988	-1.971	0.060	0.096
Num. of Bonds	1,357	Num. of Firms	109	109	109	109
Chinese Suppliers≥1:		**U.S. Customers≥1**:				
BHARs	-0.028***	CAARs	-0.121**	-0.115**	-0.023	-0.026
t-statistic	-2.583	t-statistic	-2.471	-2.372	-0.289	-0.328
Num. of Bonds	1,473	Num. of Firms	288	288	288	288

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 6: Sourcing Strategies Before and During the Covid-19 Pandemic for U.S. with Chinese Customers and Chinese Firms with U.S. Suppliers

This table presents estimations from customer and supplier regressions. The samples in columns (1) – (2) and (4) – (5) include all U.S. firms in FactSet with at least one Chinese customer and all Chinese firms in FactSet with at least one U.S. supplier as of March 31, 2018, respectively, for the period 2018q1 – 2020q1. The samples in columns (3) and (6) include all U.S. firms in FactSet with at least one Chinese customer and all Chinese firms in FactSet with at least one U.S. supplier as of December 31, 2019, respectively, for the period 2019q4 – 2020q1. We exclude financial firms (SICs 6000-6999). The dependent variable in columns (1) – (3) is Log of Chinese Customers, the natural logarithm of the number of Chinese customers. The dependent variable in columns (4) – (6) is Log of U.S. Suppliers, the natural logarithm of the number of U.S. suppliers. 2018q2 to 2020q1 are quarter dummies. Columns (2) and (5) report the differences in coefficients for the quarter dummies between two consecutive quarters. Firm level data for the U.S. and the Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively. Refer to Table A.1 for detailed variable definitions. Standard errors reported in parentheses are clustered at the firm level.

Dep. Variable:		Log of Chinese Customers			Log of U.S. Suppliers		
Sample:		**U.S. Firms with Chinese Customers**			**Chinese Firms with U.S. Suppliers**		
		2018q1–2020q1		2019q4–2020q1	2018q1–2020q1		2019q4–2020q1
		(1)	(2)	(3)	(4)	(5)	(6)
Pre Covid-19	2018q2	-0.005			0.005		
		(0.020)			(0.012)		
	2018q3	-0.069**			-0.016		
		(0.030)			(0.020)		
	2018q4	-0.133***			-0.068**		
		(0.030)			(0.027)		
	2019q1	-0.118***			-0.090***		
		(0.034)			(0.027)		
	2019q2	-0.150***			-0.114***		
		(0.037)			(0.033)		
	2019q3	-0.179***			-0.123***		
		(0.040)			(0.034)		
	2019q4	-0.173***			-0.100***		
Covid-19		(0.041)			(0.037)		
	2020q1	-0.239***		-0.046**	-0.192***		-0.102***
		(0.045)		(0.018)	(0.040)		(0.017)
Pre Covid-19	2018q2–2018q1		-0.005			0.005	
			(0.020)			(0.012)	
	2018q3–2018q2		-0.064***			-0.020	
			(0.022)			(0.012)	
	2018q4–2018q3		-0.064***			-0.052***	
			(0.023)			(0.017)	
	2019q1–2018q4		0.015			-0.023	
			(0.020)			(0.018)	
	2019q2–2019q1		-0.032			-0.024	
			(0.024)			(0.019)	
	2019q3–2019q2		-0.029			-0.009	
			(0.022)			(0.011)	
	2019q4–2019q3		0.006			0.023	
Covid-19			(0.004)			(0.017)	
	2020q1–2019q4		-0.066***			-0.092***	
			(0.023)			(0.022)	
	Log of Assets	0.002		0.069	0.084		0.078
		(0.077)		(0.107)	(0.097)		(0.088)
	Tobin's q	-0.009		0.028	0.029		0.089
		(0.018)		(0.024)	(0.022)		(0.584)
	Tangibility	0.273		-0.346	-0.139		-0.765
		(0.384)		(0.275)	(0.318)		(0.681)
	Obs.	1,819	1,819	452	1,602	1,602	496
	Num. of Firms	252	252	226	197	197	248
	Num. of Chinese Suppliers	771	771	712			
	Num. of U.S. Customers				708	708	648
	R2 (within)	0.067	0.067	0.051	0.062	0.062	0.127
	Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
	Std. Errors Clustering	Firm	Firm	Firm	Firm	Firm	Firm

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 7: The Wealth Effects for U.S. Firms with Chinese Customers, their Bondholders, and their Chinese Customers

This table reports Cumulative Average Abnormal Returns (CAARs), Panel A, and Buy-and-Hold Abnormal Returns (BHARs), Panel B, during the 31 trading days starting on January 6, 2020 ("event date") for various groups of U.S. firms with Chinese customers (but without Chinese suppliers) in FactSet as of December 31, 2019. Panel C, columns (3) and (4) report CAARs during the 21- and 31-trading days starting on January 6, 2020, respectively, for various groups of Chinese firms with U.S. suppliers in FactSet as of December 31, 2019. We exclude financial firms (SICs 6000-6999). High, Moderate, and Low Chinese Customers' Exposure (High, Moderate, Low CCE) indicate high, moderate, and low exposure to Chinese customers based on the number of Chinese customers per billions ($) of sales. High, Moderate, and Low U.S. Suppliers' Exposure (High, Moderate, Low U.S. SE) indicate high, moderate, and low exposure of Chinese firms to U.S. suppliers based on the number of U.S. suppliers per billions ($) of sales. CAARs are estimated using the Carhart 4-factor model (Carhart, 1997), with U.S. factors and the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns, VW C-4. Daily stock returns for U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively. Carhart factors are from Kenneth French's website (`https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`). Bond data is from TRACE and Mergent-FISD. Refer to Table A.1 for detailed variable definitions. t-statistics are based on standard errors adjusted for cross-sectional correlation of security returns due to event-date clustering (Brown and Warner, 1980).

CAARs by Chinese Customers' Exposure (CCE)	Panel A: **Wealth Effects for Stockholders of U.S. Firms with Chinese Customers**	**BHARs by Chinese Customers' Exposure (CCE)**	Panel B: **Wealth Effects for Bondholders of U.S. Firms with Chinese Customers**	**CAARs by U.S. Suppliers' Exposure (SE)**	Panel C: **Wealth Effects for Chinese Firms with U.S. Suppliers**	
	Value-Weighted 4-Factor		Market Adjusted Model		Value-Weighted 4-Factor	
	Event Window [0,30] (1)		Event Window [0,30] (2)		Event Window [0,20] (3)	Event Window [0,30] (4)
High CCE:		**High CCE**:		**High U.S. SE**:		
CAARs	-0.117***	BHARs	-0.049**	CAARs	-0.101*	-0.028
t-statistic	-4.892	t-statistic	-2.315	t-statistic	-1.751	-0.392
Num. of Firms	104	Num. of Bonds	13	Num. of Firms	48	48
Moderate CCE:		**Moderate CSE**:		**Moderate U.S. SE**:		
CAARs	-0.033**	BHARs	-0.031**	CAARs	-0.111**	-0.016
t-statistic	-2.227	t-statistic	-2.477	t-statistic	-1.962	-0.234
Num. of Firms	36	Num. of Bonds	76	Num. of Firms	54	54
Low CCE:		**Low CSE**:		**Low U.S. SE**:		
CAARs	-0.044***	BHARs	-0.026**	CAARs	-0.128***	-0.030
t-statistic	-2.728	t-statistic	-2.462	t-statistic	-2.779	-0.535
Num. of Firms	36	Num. of Bonds	1,164	Num. of Firms	153	153
Chinese Customers≥1		**Chinese Customers≥1**		**U.S. Suppliers≥1**		
CAARs	-0.072***	BHARs	-0.027**	CAARs	-0.123**	-0.030
t-statistic	-3.439	t-statistic	-2.513	t-statistic	-2.538	-0.512
Num. of Firms	176	Num. of Bonds	1,253	Num. of Firms	278	278

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 8: Sourcing Strategies of U.S. Firms with Chinese Suppliers During the Covid-19 Pandemic

This table reports estimations from difference-in-difference supplier regressions. The dependent variables in columns (1) – (2) and (3) – (4) are the natural logarithm of the number of U.S. suppliers and the natural logarithm of the number of global suppliers (except Chinese suppliers), respectively. The sample includes all U.S. firms in COMPUSTAT North America except financial firms (SICs 6000-6999) for the period 2019q4 – 2020q1. Supplier data is from FactSet, as of December 31, 2019 and March 31, 2020. High, Moderate, and Low Chinese Suppliers' Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. 2020q1 is an indicator for 2020q1, and zero for 2019q4. Refer to Table A.1 for detailed variable definitions. Standard errors reported in parentheses are clustered at the firm level.

Sourcing by Chinese Suppliers' Exposure (CSE)				
Dep. Variable:	Log of U.S. Suppliers		Log of Other Global Suppliers	
	(1)	(2)	(3)	(4)
High CSE × 2020q1	-0.001		-0.042**	
	(0.018)		(0.021)	
Moderate CSE × 2020q1	-0.035		0.001	
	(0.026)		(0.016)	
Low CSE × 2020q1	0.029		-0.002	
	(0.022)		(0.023)	
Chinese Suppliers≥1 × 2020q1		0.007		-0.009
		(0.015)		(0.015)
2020q1	0.004*	0.004*	0.006**	0.006**
	(0.002)	(0.002)	(0.002)	(0.002)
Log of Assets	-0.002	-0.002	0.001	0.001
	(0.005)	(0.005)	(0.007)	(0.007)
Tobin's q	-0.002	-0.002	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Tangibility	-0.037	-0.037	-0.136***	-0.136***
	(0.030)	(0.030)	(0.050)	(0.050)
Obs.	4,942	4,942	4,942	4,942
Num. of Firms	2,471	2,471	2,471	2,471
Num. of Suppliers	11,751	11,751	9,393	9,393
R2 (within)	0.007	0.003	0.005	0.004
Firm Fixed Effects	Yes	Yes	Yes	Yes
Std. Errors Clustering	Firm	Firm	Firm	Firm

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 9: Inventory Management, Sales, and Operating Performance of U.S. Firms with Chinese Suppliers During the Covid-19 Pandemic

This table reports estimations from inventory management, sales, and operating performance difference-in-difference regressions. The dependent variables are the ratio of inventory to assets, columns (1) – (2), the ratio of accounts payable to assets, columns (3) – (4), the natural logarithm of sales, columns (5) – (6), and the ratio of operating income to assets, columns (7) – (8). The sample includes all U.S. firms in COMPUSTAT North America except financial firms (SICs 6000-6999) for the period 2019q1 – 2020q1. High, Moderate, and Low Chinese Suppliers' Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. Supplier data is from the FactSet Revere Supply Chain Relationships database, as of December 31, 2019. 2020q1 is an indicator for 2020q1, and zero for 2019q1. Refer to Table A.1 for detailed variable definitions. Standard errors reported in parentheses are clustered at the firm level.

Inventory and Performance by Chinese Suppliers' Exposure (CSE)								
Dep. Variable:	Inventory/Assets		Accounts Payable/Assets		Log of Sales		Operating Income/Assets	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
High CSE × 2020q1	0.001		-0.002		0.041		0.003	
	(0.001)		(0.001)		(0.0565)		(0.006)	
Moderate CSE × 2020q1	-0.008		-0.007*		-0.061*		-0.006**	
	(0.006)		(0.004)		(0.028)		(0.002)	
Low CSE × 2020q1	-0.008***		-0.003		-0.054**		-0.005**	
	(0.003)		(0.002)		(0.026)		(0.002)	
Chinese Suppliers≥1 × 2020q1		-0.006***		-0.004**		-0.038*		-0.004**
		(0.002)		(0.002)		(0.021)		(0.002)
2020q1	-0.003***	-0.003***	-0.001	-0.001	-0.019	-0.019	-0.012***	-0.012***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.017)	(0.017)	(0.002)	(0.002)
Log of Assets	-0.021***	-0.021***	-0.041***	-0.041***	0.522***	0.522***	0.065***	0.065***
	(0.003)	(0.003)	(0.005)	(0.005)	(0.078)	(0.078)	(0.007)	(0.007)
Tobin's q	-0.001***	-0.002***	0.001	0.001	-0.025	-0.025	-0.003**	-0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.019)	(0.019)	(0.001)	(0.001)
Tangibility	-0.099***	-0.099***	-0.019	-0.019	-0.379*	-0.381*	-0.051*	-0.051*
	(0.017)	(0.017)	(0.018)	(0.018)	(0.202)	(0.202)	(0.026)	(0.026)
Obs.	4,782	4,782	4,906	4,906	4,450	4,450	4,778	4,778
R2 (within)	0.118	0.117	0.202	0.203	0.097	0.098	0.175	0.175
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Std. Errors Clustering	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 10: Access to Credit of U.S. Firms with Chinese Suppliers During the Covid-19 Pandemic

This table reports estimations from access to credit difference-in-difference regressions. The dependent variables are the ratio of change in total debt to lagged assets, columns (1) – (2), change in long-term debt to lagged assets, columns (3) – (4), and change in short-term debt to lagged assets, columns (5) – (6). The sample includes all U.S. firms in COMPUSTAT North America except financial firms (SICs 6000-6999) for the period 2019q1 – 2020q1. High, Moderate, and Low Chinese Suppliers' Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. Supplier data is from the FactSet Revere Supply Chain Relationships database, as of December 31, 2019. 2020q1 is an indicator for 2020q1, and zero for 2019q1. Refer to Table A.1 for detailed variable definitions. Standard errors reported in parentheses are clustered at the firm level.

Access to Credit by Chinese Suppliers' Exposure (CSE)						
Dep. Variable:	ΔTotal Debt/Assets$_{t-1}$		ΔLong-Term Debt/Assets$_{t-1}$		ΔShort-Term Debt/Assets$_{t-1}$	
	(1)	(2)	(3)	(4)	(5)	(6)
High CSE × 2020q1	0.041		0.047		0.002	
	(0.043)		(0.040)		(0.011)	
Moderate CSE × 2020q1	0.101***		0.076**		0.023**	
	(0.038)		(0.037)		(0.011)	
Low CSE × 2020q1	0.061**		0.060**		-0.001	
	(0.031)		(0.028)		(0.007)	
Chinese Suppliers≥1 × 2020q1		0.066**		0.061**		0.001
		(0.030)		(0.027)		(0.008)
2020q1	-0.077***	-0.077***	-0.075***	-0.075***	0.002	0.002
	(0.029)	(0.029)	(0.026)	(0.026)	(0.008)	(0.008)
Log of Assets	0.392***	0.391***	0.425***	0.425***	-0.031	-0.031
	(0.083)	(0.083)	(0.067)	(0.067)	(0.043)	(0.043)
Tobin's q	0.011	0.011	0.012	0.012	0.002	0.002
	(0.013)	(0.013)	(0.012)	(0.012)	(0.002)	(0.002)
Tangibility	1.245***	1.244***	1.055***	1.055***	0.199**	0.198**
	(0.194)	(0.193)	(0.146)	(0.146)	(0.082)	(0.082)
Obs.	4,350	4,350	4,658	4,658	4,378	4,378
R2 (within)	0.204	0.204	0.196	0.195	0.043	0.041
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Std. Errors Clustering	Firm	Firm	Firm	Firm	Firm	Firm

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 11: Cash, Investment, and Employment of U.S. Firms with Chinese Suppliers During the Covid-19 Pandemic

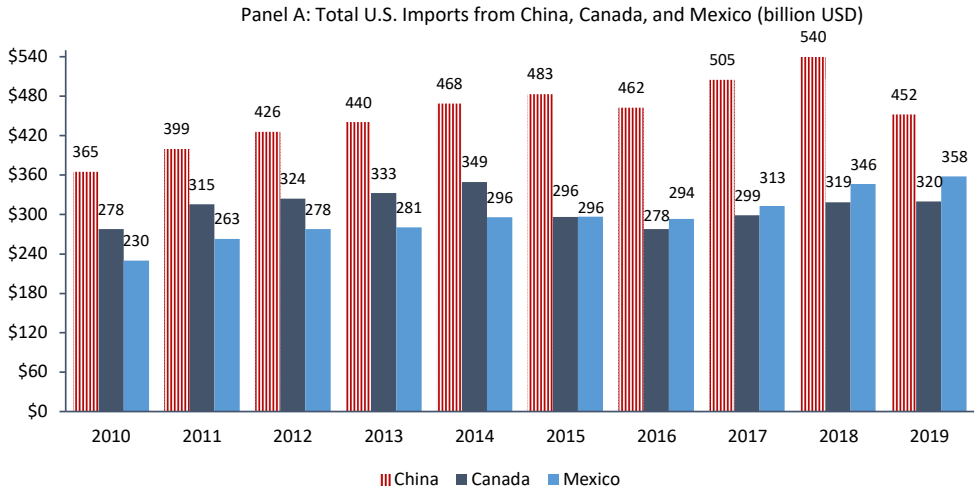
This table reports estimations from cash, investment, and employment difference-in-difference regressions. The dependent variables are the ratio of cash to assets, columns (1) – (2), capital expenditures to lagged assets, columns (3) – (4), and the natural logarithm of the number of employees, columns (5) – (6). The sample includes all U.S. firms in COMPUSTAT North America except financial firms (SICs 6000-6999) for the period 2019q1 – 2020q1. High, Moderate, and Low Chinese Suppliers' Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. Supplier data is from the FactSet Revere Supply Chain Relationships database, as of December 31, 2019. 2020q1 is an indicator for 2020q1, and zero for 2019q1. Refer to Table A.1 for detailed variable definitions. Standard errors reported in parentheses are clustered at the firm level.

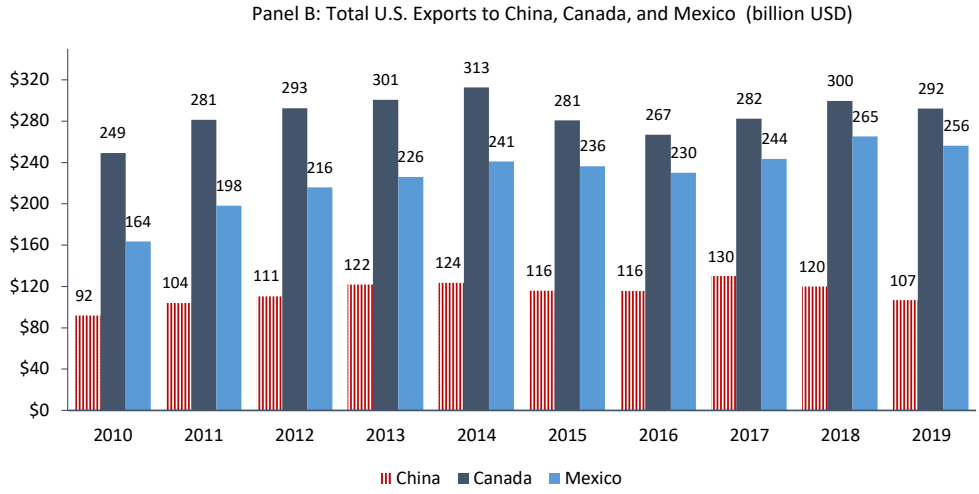
Cash, Investment, and Employment by Chinese Suppliers' Exposure (CSE)						
Dep. Variable:	Cash/ Assets		Capital Expenditures/ Assets_{t-1}		Log Number of Employees	
	(1)	(2)	(3)	(4)	(5)	(6)
High CSE × 2020q1	0.002		-0.002		-0.011	
	(0.016)		(0.003)		(0.022)	
Moderate CSE × 2020q1	0.022***		0.001		-0.158**	
	(0.009)		(0.001)		(0.074)	
Low CSE × 2020q1	0.018***		-0.001		-0.022**	
	(0.005)		(0.001)		(0.011)	
Chinese Suppliers≥1 × 2020q1		0.017***		-0.001		-0.052**
		(0.005)		(0.001)		(0.024)
2020q1	0.011***	0.011***	-0.003***	-0.003***	-0.001	-0.001
	(0.002)	(0.002)	(0.001)	(0.001)	(0.014)	(0.015)
Log of Assets	0.054***	0.054***	0.005***	0.005***	0.166**	0.173***
	(0.009)	(0.009)	(0.002)	(0.002)	(0.069)	(0.077)
Tobin's q	0.009***	0.009***	0.001**	0.001*	-0.008	-0.010
	(0.002)	(0.002)	(0.001)	(0.001)	(0.010)	(0.009)
Tangibility	-0.553***	-0.553***	0.001	0.001	-0.154	-0.164
	(0.047)	(0.047)	(0.008)	(0.008)	(0.098)	(0.107)
Obs.	4,940	4,940	4,598	4,598	314	314
R2 (within)	0.199	0.198	0.048	0.047	0.263	0.226
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Std. Errors Clustering	Firm	Firm	Firm	Firm	Firm	Firm

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Figure 1: U.S. Imports, Exports, and Total Trade

This figure displays U.S. imports, Panel A, U.S. exports, Panel B, combined U.S. imports and exports, Panel C, with China, Canada, and Mexico, in $ billion. Data is from the U.S. Census Bureau for the period of 2010 - 2019.





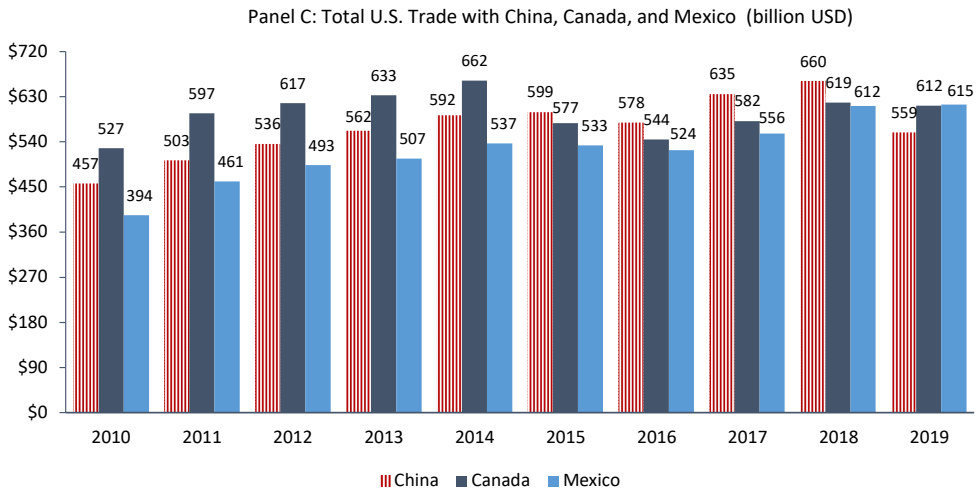


Figure 2: General Motors Supply Chain Relationships

This figure plots a snapshot of General Motors (GM) supply chain relationships in FactSet as of December 31, 2019. GM has also suppliers from Argentina, Bermuda, Brazil, Chile, Great Britain, Indonesia, Isle of Man, India, Japan, Malaysia, New Zealand, Philippines, Pakistan, Russia, Serbia, Singapore, South Korea, Sri Lanka, Switzerland, Thailand, Turkey, Taiwan, Ukraine, and Vietnam.

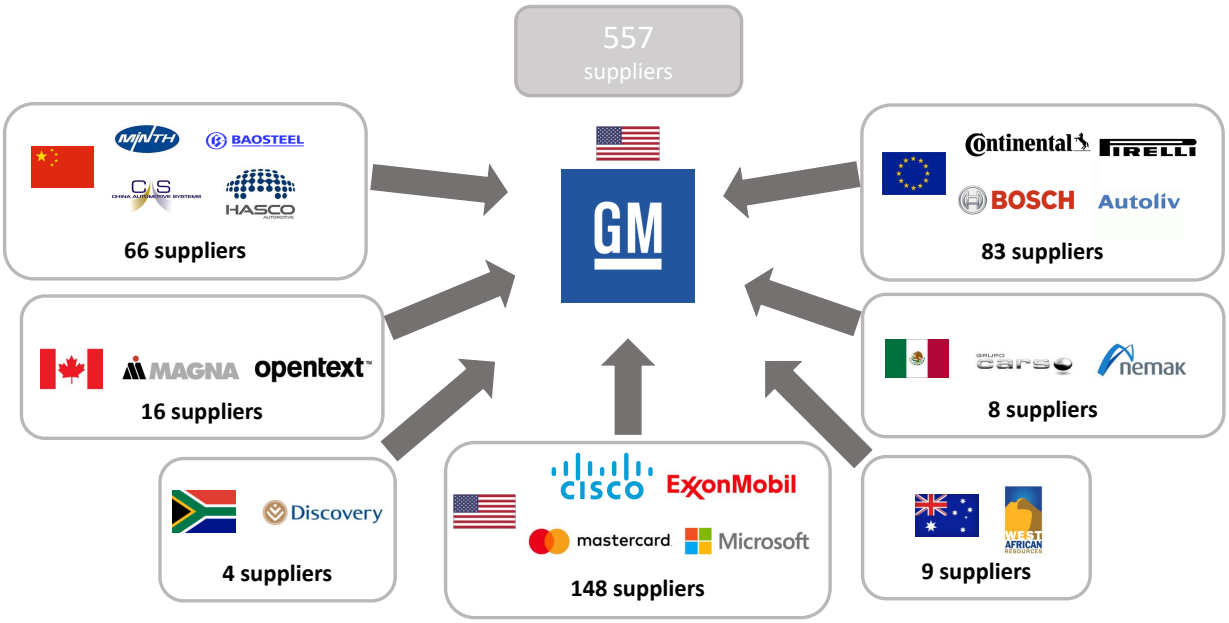


Figure 3: Sourcing Strategies Before and During the Covid-19 Pandemic

This figure plots the coefficient estimates in percentage from the supplier and customer regressions in Table 2, columns (1) – (2) and (4) – (5), respectively. The samples in columns Panels A and C include all U.S. firms in FactSet with at least one Chinese supplier and all Chinese firms in FactSet with at least one U.S. customer as of March 31, 2018, respectively, for the period 2018q1 – 2020q1. Panels B and D report the differences in coefficients in percentage for the quarter dummies between two consecutive quarters for the U.S. sample and the Chinese sample, respectively. We exclude financial firms (SICs 6000-6999). Firm level data for the U.S. and the Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively. Refer to Table A.1 for detailed variable definitions. 95% confidence interval bands are based on standard errors clustered at the firm level.

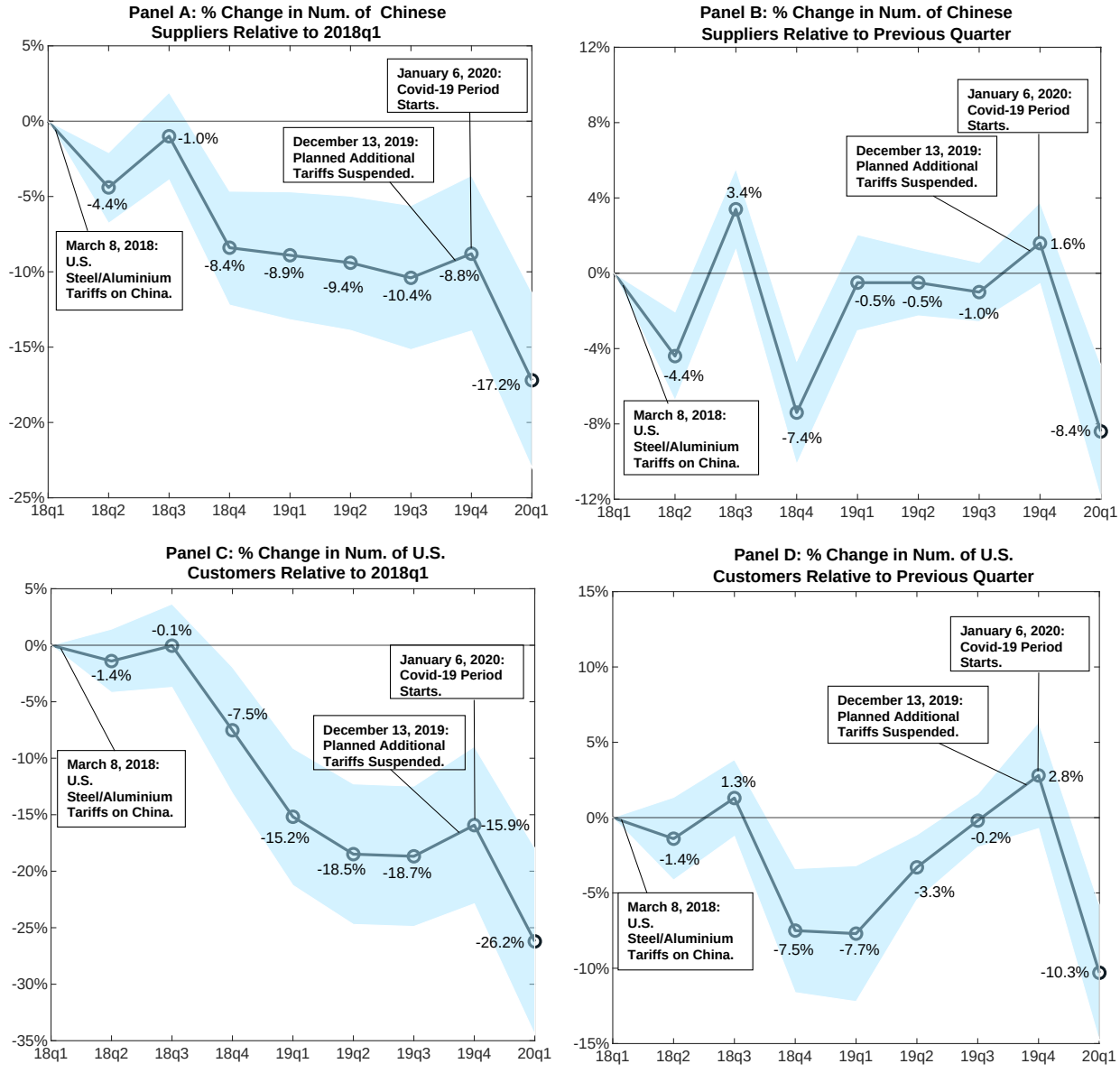


Figure 4: Timeline of the Covid-19 Pandemic

This figure presents a timeline of major events of the Covid-19 pandemic from December 31, 2019 when the first pneumonia cases in Wuhan, China where reported to the World Health Organization (WHO) until the first U.S. shelter-in-place order issued in San Francisco on March 17, 2020.

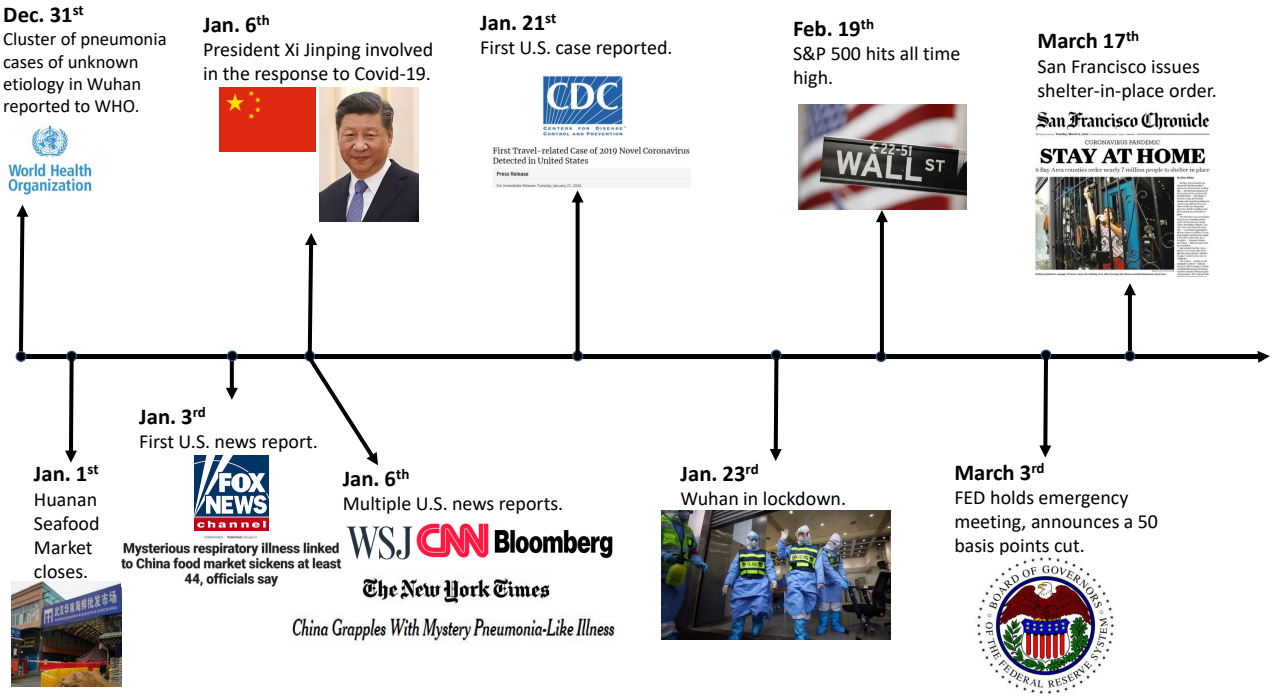
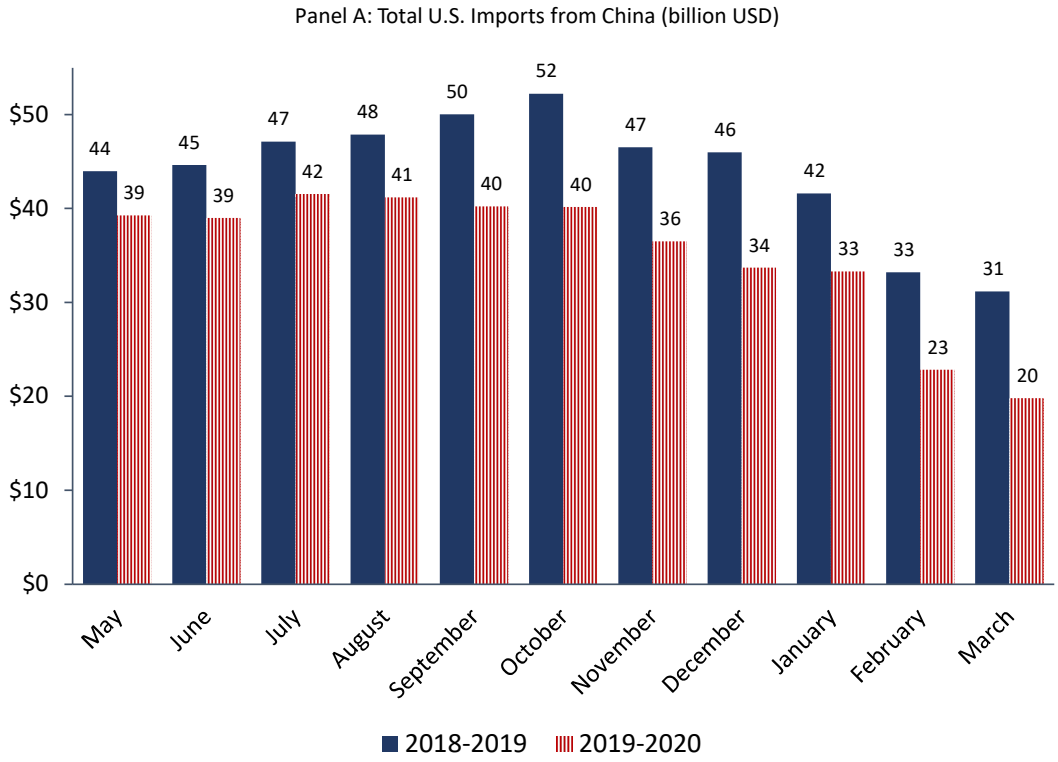


Figure 5: U.S. Monthly Trade Activities with China

This figure plots monthly imports from China, Panel A, and monthly exports to China, Panel B, respectively, for the periods from May 2018 to March 2019, blue bars, and from May 2019 to March 2020, red-stripped bars, in $ billion. Data is from the U.S. Census Bureau.



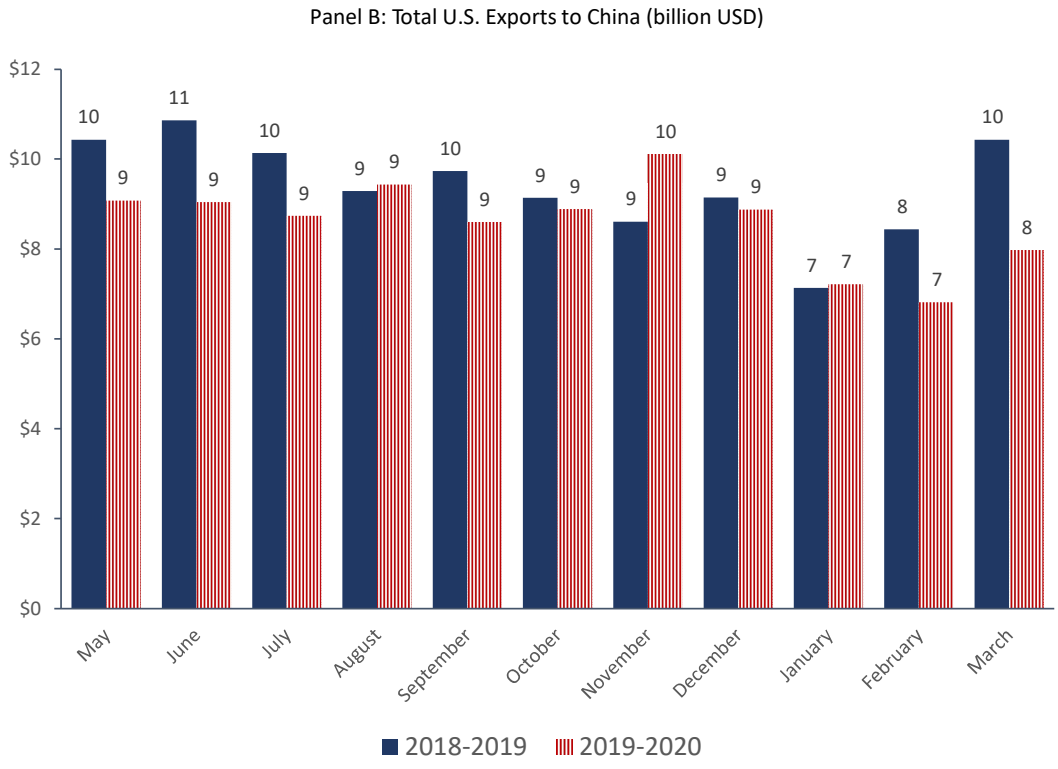


Figure 6: The Wealth Effects of Covid-19 Supply Chain Disruption

This figure plots Cumulative Average Abnormal Returns (CAARs) during the 31 trading days from January 6, 2020 ("event date") to February 19, 2020, for various groups of U.S. firms with Chinese suppliers in FactSet as of December 31, 2019. We exclude financial firms (SICs 6000-6999). Panels A, B, C, and D plot CAARs for the High, Moderate, Low Chinese Suppliers' Exposure, and for the Chinese Suppliers≥1 groups, respectively. High, Moderate, and Low Chinese Suppliers' Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. Chinese Suppliers≥1 are U.S. firms with at least one Chinese supplier. Each panel plots also CAARs for U.S. firms without exposure to Chinese suppliers. VW C-4 and VW C-8 CAARs are estimated using the Carhart 4-factor and Carhart 8-factor models (Carhart, 1997), with the U.S. and both the U.S. and other developed countries Carhart factors, respectively, and the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns. Daily stock returns are from COMPUSTAT North America and Carhart factors are from Kenneth French's website (`https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`). Refer to Table A.1 for detailed variable definitions.

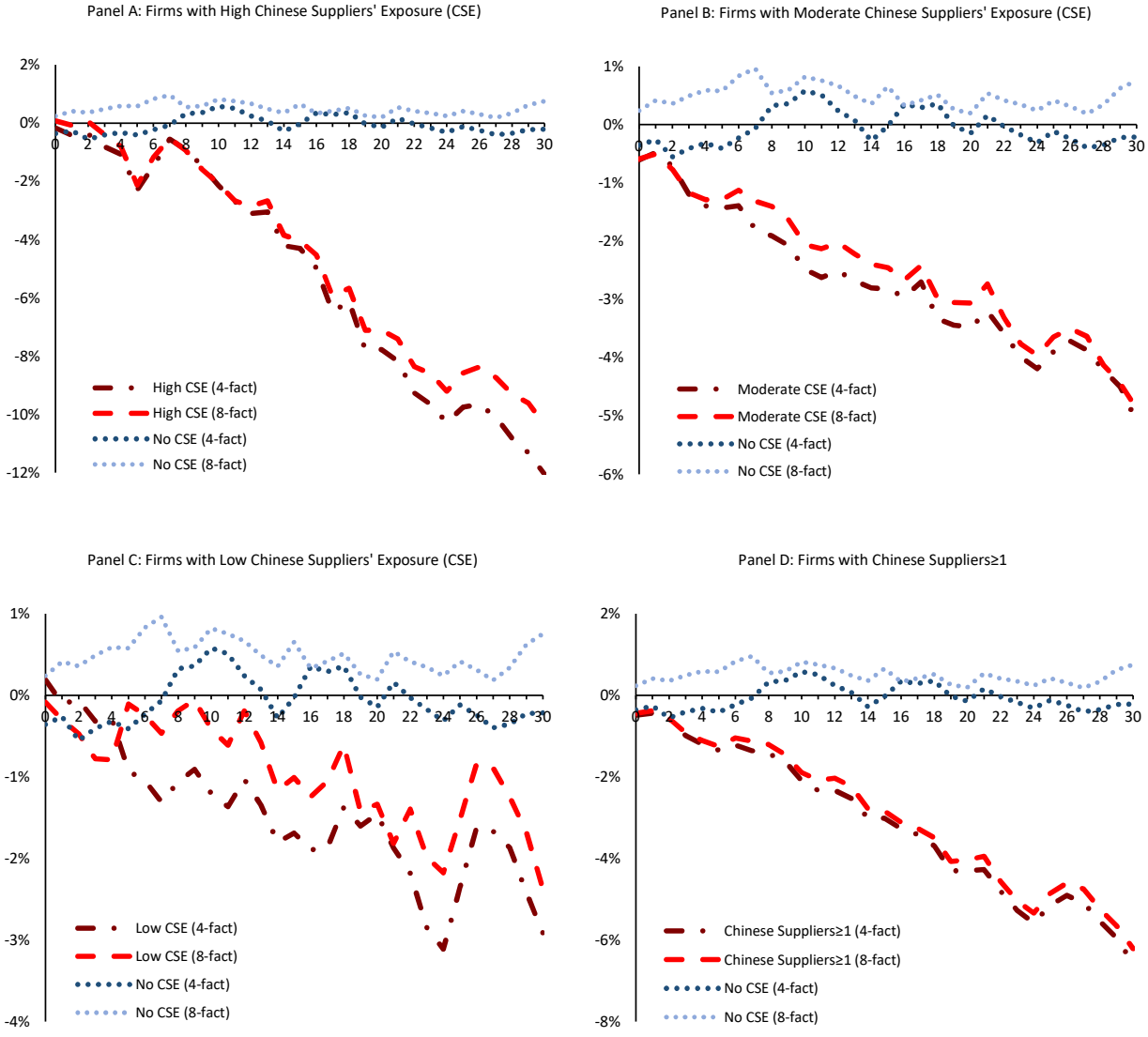


Figure 7: Wealth Effects Before and During the Covid-19 Supply Chain Disruption

This figure plots Cumulative Average Abnormal Returns (CAARs) during the 45 trading days prior and following January 6, 2020 ("event date"), i.e., the period from October 30, 2019 to March 10, 2020, for various groups of U.S. firms with Chinese suppliers in FactSet as of December 31, 2019. We exclude financial firms (SICs 6000-6999). Panels A, B, C, and D plot CAARs for the High, Moderate, Low Chinese Suppliers' Exposure, and for the Chinese Suppliers≥1 groups, respectively. High, Moderate, and Low Chinese Suppliers' Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. Chinese Suppliers≥1 are U.S. firms with at least one Chinese supplier. Each panel plots also CAARs for U.S. firms without exposure to Chinese suppliers. VW C-4 and VW C-8 CAARs are estimated using the Carhart 4-factor and Carhart 8-factor models (Carhart, 1997), with the U.S. and both the U.S. and other developed countries Carhart factors, respectively, and the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns. Daily stock returns are from COMPUSTAT North America and Carhart factors are from Kenneth French's website (`https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`). Refer to Table A.1 for detailed variable definitions.

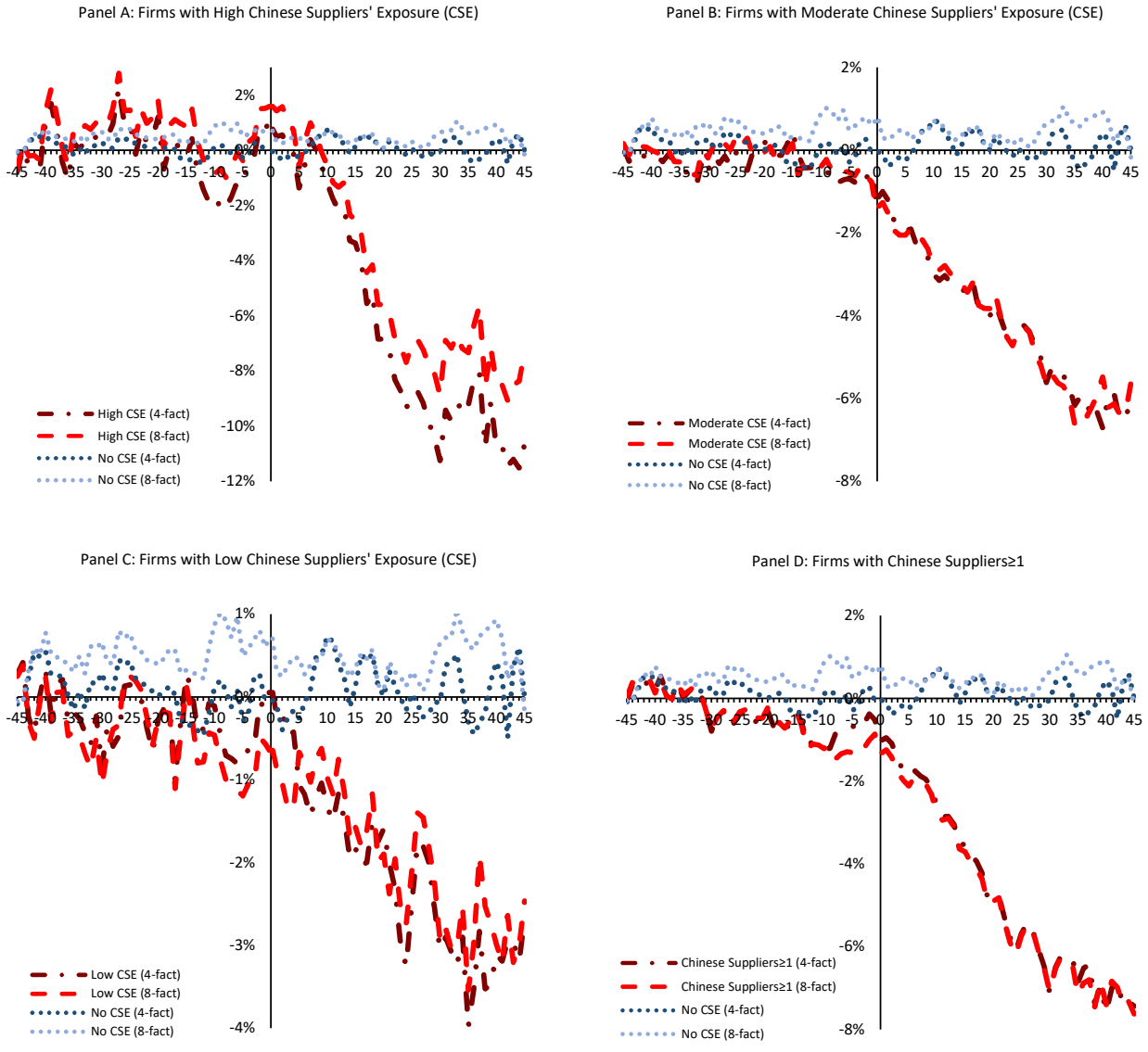
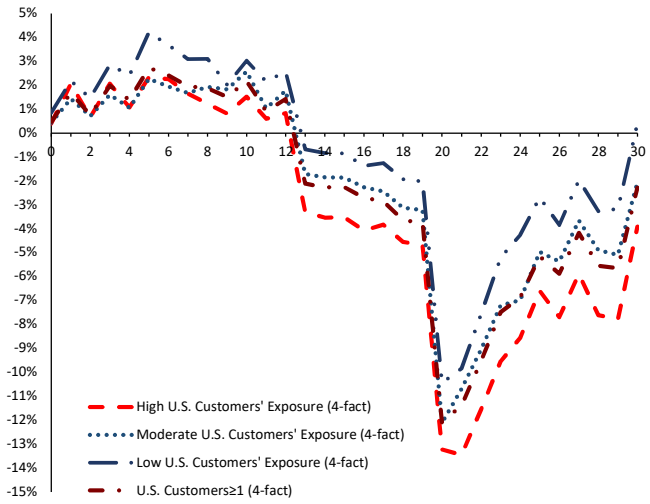


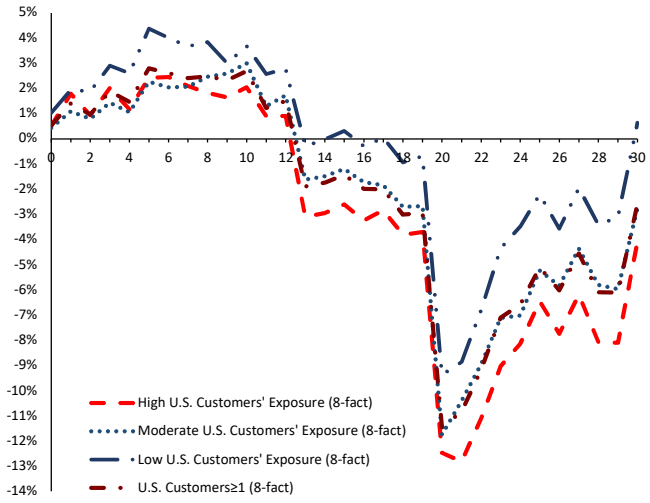
Figure 8: The Wealth Effects of Covid-19 Supply Chain Disruption on Chinese Firms with U.S. Customers

This figure plots Cumulative Average Abnormal Returns (CAARs) during the 31 trading days from January 6, 2020 ("event date") to February 19, 2020, for various groups of Chinese firms with U.S. customers in FactSet as of December 31, 2019. We exclude financial firms (SICs 6000-6999). Panels A and B plot VW C-4 and VW C-8 CAARs, respectively, estimated using the Carhart 4-factor and Carhart 8-factor models (Carhart, 1997), with the U.S. and both the U.S. and other developed countries Carhart factors, respectively, and the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns. Each panel plots CAARs for the High, Moderate, Low U.S. Customers' Exposure, and for the U.S. Customers≥1 groups, respectively. High, Moderate, and Low U.S. Customers' Exposure indicate high, moderate, and low exposure to U.S. customers based on the number of U.S. customers per billions ($) of sales. U.S. Customers≥1 are Chinese firms with at least one U.S. customers. Daily stock returns are from COMPUSTAT Global and Carhart factors are from Kenneth French's website (`https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`). Refer to Table A.1 for detailed variable definitions.

Panel A: Chinese Firms with U.S. Customers 4-Factor Model



Panel B: Chinese Firms with U.S. Customers 8-Factor Model



Appendix to

The Covid-19 Pandemic: Supply Chain Disruption, Wealth Effects, and Corporate Responses*

Karca D. Aral† Erasmo Giambona‡ Ricardo Lopez Aliouchkin§

This draft: September 3, 2020

Abstract

This is the Appendix to "The Covid-19 Pandemic: Supply Chain Disruption, Wealth Effects, and Corporate Responses", containing additional results and discussions.

Keywords: Firm-supplier-customer relationships, supply chain disruption, wealth effects, Covid-19, sourcing strategies, inventory, credit, cash reserves, investment, employment.

JEL Classification: G12; G14; G31; G32; G33; L1; L2; L5.

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Appendix

This Appendix contains additional results and discussions. We do not discuss tables and figures that are sufficiently discussed in the main text.

A.1 Event Study Methodology: Stocks

To estimate Cumulative Average Abnormal Returns (CAARs), we start by estimating the following model:

$$r_{i,\tau_{est}} = \alpha + \beta^{\top} r_{f,\tau_{est}} + \varepsilon_{i,\tau_{est}} \tag{A.1}$$

where $r_{i,\tau}$ are firm i daily returns during the estimation period τ_{est}, and $r_{f,\tau_{est}}$ are daily factor returns. We compute abnormal returns using several factor models: 1) the Carhart's (1997) 4-factor model, which includes size (SMB), value (HML), and momentum (MOM) factors, and either a value- or equal-weighted market factor based on the returns of all common stocks listed in the NYSE, AMEX or NASDAQ; 2) an 8-factor model extension of the Carhart (1997) model, where we also include the above four factors based on international stocks from all developed countries excluding the U.S; and 3) a one factor CAPM with either a value-weighted or equal-weighted factor. Our estimation period τ_{est} consists of $[t-250, t-60)$ trading days, where t is our event date of January 6, 2020. We obtain daily abnormal returns from the following equation:

$$AR_{i,t+n} = r_{i,t+n} - \widehat{\alpha} - \widehat{\beta}^{\top} r_{f,t+n} \tag{A.2}$$

where $AR_{i,t+n}$ is the abnormal return of firm i on day $t+n$, $r_{i,t+n}$ is the observed return of firm i on day $t+n$, $r_{f,t+n}$ are the factors' returns on day $t+n$, and $\widehat{\alpha}$ and $\widehat{\beta}$ are the estimated coefficients from Eq. (A.1). We calculate Cumulative Average Abnormal Returns (CAARs) over the event window period from $t+0$ (January 6, 2020) to $t+30$ (February 19, 2020). t-statistics are based on standard errors adjusted for cross-sectional correlation of security returns due to event-date clustering (Brown and Warner, 1980).

A.2 Event Study Methodology: Bonds

To measure bond abnormal returns, we start by computing buy-and-hold returns for each bond in our sample during our event window, $\tau_{ev} = [t+0, t+30]$, $r_{i,\tau_{ev}}$. Following the literature (e.g., Bao, Pan and Wang, 2011; Bai, Bali and Wen, 2019; Cao et al., 2019; Chung, Wang and Wu, 2019), we use buy-and-hold returns because bonds trade infrequently making it difficult to obtain usable series of daily returns. We only keep bonds that trade at $t+0$. For bonds that do not trade at $t+30$, we consider up to 7 trading days before and after $t+30$, and drop bonds that do not trade during that time window. We also calculate a bond market factor as the value-weighted return of all bonds in our sample, $r_{mkt,\tau_{ev}}$. We calculate Buy-and-Hold Abnormal Returns (BHARs) as the difference between the bond buy-and-hold return, $r_{i,\tau_{ev}}$, and the buy-and-hold value-weighted return of all bonds, $r_{mkt,\tau_{ev}}$. t-statistics are based on standard errors adjusted for cross-sectional correlation of security returns due to event-date clustering (Brown and Warner, 1980).

A.3 The Wealth Effects of the Covid-19 Supply Chain Disruption for U.S. Firms with Chinese Suppliers Beyond Tier 1

In our main analysis, we focus on U.S. firms with tier 1 Chinese suppliers. However, the Covid-19 supply chain disruption can affect U.S. firms that do not rely on Chinese suppliers directly, but whose suppliers do. We build U.S. firms supply chain networks up to tier 4. To identify U.S. firms with tier 2 Chinese suppliers, we start from the sample of U.S. firms without tier 1 Chinese suppliers, and then identify among these firms those whose suppliers have tier 1 Chinese suppliers. As Table A.3 shows, the group of U.S. firms with tier 2 Chinese suppliers includes 976 firms, which in total have 17,125 tier 2 Chinese suppliers. Next, we calculate the ratio of tier 2 Chinese suppliers to U.S. firm's sales, and we categorize U.S. firms with a ratio in the top quintile as high exposure, U.S. firms in the next lower quintile as moderate exposure, and the remaining U.S. firms as low exposure. Similarly, to identify U.S. firms with tier 3 Chinese suppliers, we focus on U.S. firms without tier 1 and tier 2 Chinese suppliers, but with tier 3 Chinese suppliers. This group includes 332 U.S. firms, which in total have 10,269 tier 3 Chinese suppliers. We then partition this group into high, moderate, and low exposure using the ratio of tier 3 Chinese suppliers to U.S. firm's sales. We repeat this procedure for U.S. firms with tier 4 Chinese suppliers. This group includes

only 41 U.S. firms, making it difficult to create groups based on exposure.

Table A.3, columns 1 and 3 show that 31-day VW C-4 CAARs for the tier 2 and tier 3 high exposure U.S. firms are -8.4%, statistically significant at the 1% level, and -5.4%, statistically significant at the 5% level, respectively. These are both sizable, but significantly smaller (in absolute value) compared to the to -12.1% for the tier 1 high exposure U.S. firms in Table 4, suggesting that the effect of the supply chain disruption is mitigated if U.S. firms have no direct supply chain relationships with Chinese suppliers.

[Table A.3]

Notably, for the tier 2 and tier 3 moderate exposure groups, 31-day VW C-4 CAARs are equal to -2.4% and -1.7%, respectively, both statistically significant at the 10% level (Table A.3, columns 1 and 3). 31-day VW C-4 CAARs decrease further (in absolute value) to -1.6% and -1.2% for the tier 2 and tier 3 low exposure groups, respectively, with only the tier 2 low exposure CAARs being marginally statistically significant. For the combined groups of U.S. firms with at least one tier 2 or one tier 3 Chinese supplier, 31-day VW C-4 CAARs are equal to -3.2% and -2.5%, respectively, with the former being statistically significant at the 5% level, and the latter lacking statistical significance. As Table A.3, columns 2 and 4 show, results are qualitatively and quantitatively very similar with 31-day VW C-8 CAARs. Finally, we note that both 31-day VW C-4 CAARs and 31-day VW C-8 CAARs (untabulated) are insignificant for the 41 U.S. firms with at least one tier 4 Chinese supplier.

A.4 Robustness Analysis

We discuss robustness tests for our event study results in this section. Table A.4, Panels A and B report these tests for the VW C-4 and the VW C-8 models, respectively. Because results are very similar with either models, we only discuss VW C-4 findings. As noted, Canada and Mexico are the two other major trading partners of the U.S. To ensure that our results are driven by the Covid-19 supply chain disruption, as opposed to possible changes in trading relationships with Canada and Mexico, we exclude from our sample of U.S. firms with Chinese suppliers, those firms that have also material suppliers in Canada and Mexico as of December 31, 2019. Although our sample decreases from 288 to 114 U.S. firms with Chinese suppliers, Table A.4, columns 1 shows that CAARs are

qualitatively and quantitatively very similar in the sample excluding firms with Canadian and Mexican suppliers compared to those in Table 4 in the main text for the full sample. CAARs for U.S. firms with high exposure to Chinese suppliers are equal to -12.6%, statistically significant at the 5% level, in the robustness test in Table A.4, column 1, compared to -12.1%, statistically significant at the 1% level, for the main estimation in Table 4 of the main text, column 1. Notably, in line with the pattern documented in Table 4 in the main text, we also find that CAARs decrease (in absolute value) to -4.0% for U.S. firms with moderate exposure to Chinese suppliers, and -1.8% for U.S. firms with low exposure to Chinese suppliers, both statistically significant at the 5% level. Relatedly, we find no evidence of significant CAARs for U.S. firms with Canadian suppliers but neither Chinese nor Mexican suppliers (column 2) and U.S. firms with Mexican suppliers but neither Chinese nor Mexican suppliers (column 3).

[Table A.4]

To mitigate the effect of the 'demand shock' caused by the Covid-19 pandemic, we exclude from our sample of U.S. firms with Chinese suppliers those who have also Chinese customers. As Table A.4, column 4 shows, CAARs in this sample are quantitatively and qualitatively very similar to those in Table 4 in the main text, column 1 for the full sample of U.S. firms with Chinese suppliers. In our next test, we compute the ratio of the combined sales of all Chinese suppliers of a given U.S. firm to this U.S. firm's sales. We then partition firms into high, moderate, and low exposure to Chinese suppliers based on whether this ratio is above the sample 80th percentile, between the sample 20th and 80th percentiles, and below the sample 20th percentile. Although we do not know how much each Chinese supplier sells to each of the U.S. firms in our sample, this test allows us to focus on those Chinese suppliers that could potentially play an important role in the supply chain of our U.S. firms. As column 5 shows, we find similar CAAR patterns for the three groups using this classification as those in Table 4 in the main text, column 1.

As shown, U.S. firms' propensity to source from Chinese suppliers is related to their own market capitalization, momentum, and book-to-market ratio. To mitigate the concern that these firm characteristics rather than the Covid-19 supply chain disruption could be driving our results, we identify a 'placebo' sample of U.S. firms without Chinese suppliers, but with similar market capitalization, momentum, and book-to-market ratio to the U.S. firms with Chinese suppliers. For this

purpose, in 2019q4, we match each U.S. firm with Chinese suppliers to its closest 'placebo' U.S. firm without Chinese suppliers, based on market capitalization, momentum, book-to-market ratio, and Fama-French 49 industries (exact matching). We perform our matching using the Abadie and Imbens' (2006) bias-corrected matching estimator. Table A.5 shows that the p-values for the mean difference t-tests and the Kolmogorov-Smirnov distributional tests for the matching variables in the matched samples are all above the 10% threshold. This suggests that our placebo firms are very similar to our U.S. firms with Chinese suppliers in the matched sample, with the main difference being that the placebo group is not exposed to Chinese suppliers. Importantly, Table A.4, column 6, shows no evidence of significant CAARs for the 'placebo' sample, further contributing to validate the logic of our empirical design that the significantly negative CAARs for U.S. firms with Chinese suppliers can be attributed to the Covid-19 supply chain disruption.

[Table A.5]

Finally, we assess the combined effects of these channels in a cross-sectional regression framework. Table A.6 reports results from these estimations. We regress 31-day VW C-4 (column 1) and VW C-8 CAARs (column 4) for the universe of COMPUSTAT firms on indicators for high, moderate, and low exposure to Chinese suppliers (alternatively, an indicator for firms with at least one Chinese supplier, columns 2 and 5, or the ratio of a U.S. firm's number of Chinese suppliers to the U.S. firm's sales, columns 3 and 6) and indicators to control for exposure to Canadian suppliers, Mexican suppliers, Chinese customers, and small Chinese suppliers, a dummy equal to one if the combined sales of all Chinese suppliers of a given U.S. firm to this U.S. firm's sales are below the sample 20th percentile. All indicator variables are defined as of December 31, 2019.

Except for the Chinese customer indicator, which is significantly negative in the VW C-8 CAAR regression in column 6, all the other control variables are economically small and statistically insignificant. Most importantly, Table A.6 shows that the combined effect of these control variables does not alter the size, patterns, and statistical significance of the unconditional 31-day VW C-4 and VW C-8 CAARs of U.S. firms with Chinese suppliers in Table 4 in the main text. For instance, Table A.6, column 1 shows that 31-day VW C-4 are -15.2%, -4.2%, and -2.8% for the high, moderate, and low exposure groups, respectively, compared to -12.1%, -5.1%, and -2.9%, for the same respective groups, in Table 4 in the main text, column 1. In both estimations, statistical

significance is 1% for the high exposure CAARs, and 5% for both the moderate and low exposure CAARs.

[Table A.6]

A.5 The Effect of the Covid-19 Pandemic on the Chinese Suppliers of U.S. Firms

We discuss here the effect of the Covid-19 pandemic on the Chinese suppliers of U.S. firms. Table A.8 shows, for the case of Chinese suppliers with at least one U.S. customers, that in 2020q1 their inventory holdings increased by 0.8 pp (column 1) and this was accompanied by a parallel decrease of 0.8 pp in accounts receivable (column 3) relative to Chinese firms without U.S. customers. We do not find any significant effect on sales, operating performance, access to credit, cash holdings, and investment for the affected Chinese suppliers relative to unaffected Chinese firms. Data on employment is not available for these firms.

[Table A.8]

Overall, the evidence in Table A.8 suggests that the reduced access to the U.S. market led to an increase in inventory (and a related decreased in receivables) for Chinese firms with U.S. customers during the first quarter of the pandemic. However, these firms were not otherwise more affected than similar Chinese firms without U.S. customers during the pandemic. This is different from the evidence for the U.S. firms discussed in the main text indicating that sales, operating performance, and employment decreased for firms with Chinese suppliers relative to firms with no exposure to Chinese suppliers. We reach similar conclusions when we estimate the different regression models in Table A.8 using indicators for high, moderate, and low exposure to U.S. customers. Table A.9 reports results from these estimations.

[Table A.9]

A.6 The Effects of the Covid-19 Pandemic on the U.S. Firms with Chinese Customers and the U.S. Firms' Chinese Customers

How did the 'demand shock' caused by the Covid-19 pandemic affect inventory management, performance, and corporate responses of U.S. firms with Chinese customers? How were the Chinese customer counterparts affected?

Table A.10, Panel A, for the case of U.S. firms with at least one Chinese customer, show that accounts receivable and sales decreased by 0.7 pp (column 2) and 4.9% (column 3), respectively. We do not find any other significant effects. We reach similar conclusions when we consider high, moderate, and low exposure to Chinese customers (Table A.11). Overall, the evidence in Table A.10, Panel A suggests that sales went down for U.S. firms with Chinese customers, but the overall consequences for these firms were milder than the effects of the Covid-19 supply chain disruption for U.S. firms with Chinese suppliers. These milder effects are consistent with the evidence discussed in the main text that U.S. firms with Chinese suppliers lost between 8.4% to 10.3% of their Chinese suppliers in 2020q1, while U.S. firms with Chinese customers only lost between 4.6% to 6.6% of their Chinese customers during the same quarter.

[Table A.10]

[Table A.11]

In Table A.10, Panel B, we consider the Chinese customers of U.S. suppliers. We find that inventory increased by 0.6 pp (column 1) for these firms in 2020q1 relative to Chinese firms without U.S. customers, perhaps because these firms started to hold more inventory in response to the effect of the pandemic on their ability to source from the U.S. We also find that access to credit went down for these firms during the pandemic by 1.8 pp (column 5), but this had no consequences for investment (column 9) possibly because these firms drew from their cash reserves, which went down by 1.4 pp (column 8), to counter the effect of less credit. We do not have data on employment for these firms. We reach similar conclusions when we consider high, moderate, and low exposure to U.S. suppliers (Table A.12).

[Table A.12]

Table A.1: Variable Definitions

This table provides the definitions of the main variables used in this paper.

Main Firm Level Variables:	**Definition:**
Assets	Book assets (COMPUSTAT item at). We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.
Tobin's q	Ratio of the market value of total assets (COMPUSTAT's items at - cqe + prcc×csho-txditc) to book assets (COMPUSTAT item at). We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.
Tangibility	Ratio of property, plant, and equipment (COMPUSTAT item ppent) to book assets (COMPUSTAT item at). We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.
Suppliers in % of Total Suppliers	Number of suppliers in percent of total suppliers. Data on suppliers (customers) is from the FactSet Revere Supply Chain Relationships database. We exclude financial firms (SICs 6000-6999)..
High, Moderate, Low Chinese Suppliers' (Customers') Exposure	Indicators for U.S. firms with Chinese suppliers (customers) as of December 31, 2019. We partition the U.S. firms in three groups: High Chinese Suppliers' Exposure (High CSE) (High Chinese Customers' Exposure, High CCE) are firms with one Chinese supplier (customer) or more per $1 billion of sales (COMPUSTAT item sale); Moderate CSE (CCE) are firms with one Chinese supplier (customer) per $1+ billion to $3 billion of sales (COMPUSTAT item sale); Low CSE (CCE) are firms with one Chinese supplier (customer) per $3+ billion of sales (COMPUSTAT item sale). Data on suppliers (customers) is from the FactSet Revere Supply Chain Relationships database as of December 31, 2019. Firm-level sales for the U.S. firms are from COMPUSTAT North America in 2019q4. We exclude financial firms (SICs 6000-6999).
High, Moderate, Low U.S. Suppliers' (Customers') Exposure	Indicators for Chinese firms with U.S. suppliers (customers) as of December 31, 2019. We partition the Chinese firms in three groups: High U.S. Suppliers' Exposure (High U.S. SE) (High U.S. Customers' Exposure, High U.S. CE) are firms with one U.S. supplier (customer) or more per $1 billion of sales (COMPUSTAT item sale); Moderate U.S. SE (U.S. CE) are firms with one U.S. supplier (customer) per $1+ billion to $3 billion of sales (COMPUSTAT item sale); Low U.S. SE (U.S. CE) are firms with one U.S. supplier (customer) per $3+ billion of sales (COMPUSTAT item sale). Data on suppliers (customers) is from the FactSet Revere Supply Chain Relationships database as of December 31, 2019. Firm-level sales for the Chinese firms are from COMPUSTAT Global in 2019q4. We exclude financial firms (SICs 6000-6999).

(Table continues on next page.)

Main Firm Level Variables:	**Definition:**
Chinese Suppliers (Customers)$\geq$1	Indicator for U.S. firms with at least one Chinese supplier (customer) as of December 31, 2019. Data on suppliers (customers) is from the FactSet Revere Supply Chain Relationships database. We exclude financial firms (SICs 6000-6999).
U.S. Suppliers (Customers)$\geq$1	Indicator for Chinese firms with at least one U.S. supplier (customer) as of December 31, 2019. Data on suppliers (customers) is from the FactSet Revere Supply Chain Relationships database. We exclude financial firms (SICs 6000-6999).
Log of Chinese Suppliers	Natural logarithm of the number of Chinese suppliers of U.S. firms over several sample periods. Data on suppliers is from the FactSet Revere Supply Chain Relationships database. We exclude financial firms (SICs 6000-6999).
Log of U.S. Customers	Natural logarithm of the number of U.S. customers of Chinese firms over several sample periods. Data on suppliers is from the FactSet Revere Supply Chain Relationships database. We exclude financial firms (SICs 6000-6999).
Log of Market Capitalization	Natural logarithm of total market capitalization (COMPUSTAT's items prcc$\times$csho) in 2019q4. We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. are from COMPUSTAT North America.
Momentum	Cumulative returns from months $t-13$ to $t-2$, where t is January 6, 2020 ("event date"). We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. are from COMPUSTAT North America.
Book-to-Market	Ratio of book value per share (COMPUSTAT item bkvlps) to market value per share (COMPUSTAT item prcc) in 2019q4. We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. are from COMPUSTAT North America.
Chinese but no Canadian or Mexican Suppliers, Canadian but no Chinese or Mexican Suppliers, Mexican but no Canadian or Chinese Suppliers, Chinese Suppliers but no Chinese Customers	U.S. firms with at least one Chinese supplier or more, but with neither Canadian nor Mexican suppliers as of December 31, 2019. High, Moderate, and Low Suppliers' Exposure are based on number of suppliers per billions ($) of sales. Refer to our definitions above for High, Moderate, Low U.S. Suppliers' (Customers') Exposure. Suppliers$\geq$1 are firms with at least one supplier from the country in this group. Canadian but no Chinese or Mexican Suppliers, Mexican but no Canadian or Chinese Suppliers, and Chinese Suppliers but no Chinese Customers are defined similarly. Data on suppliers and customers is from the FactSet Revere Supply Chain Relationships database. Firm-level sales are from COMPUSTAT North America. We exclude financial (SICs 6000-6999).
Chinese Suppliers' Exposure by Sales	Indicators based on the ratio of total Chinese suppliers' sales to U.S. firm's sales. We partition the U.S. firms in three groups, those with a ratio above the 80th percentile (High SE), those with a ratio between the 20th and 80th percentiles (Moderate SE), and those with a ratio below the 20th percentile (Low SE). Data on suppliers is from the FactSet Revere Supply Chain Relationships database as of December 31, 2019. Firm-level sales for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global in 2019q4, respectively. We exclude financial (SICs 6000-6999).

(Table continues on next page.)

Main Firm Level Variables:	**Definition:**
Chinese Suppliers' over Sales	Ratio of the number of Chinese suppliers to U.S. firm sales. Data on suppliers is from the FactSet Revere Supply Chain Relationships database as of December 31, 2019. We exclude financial firms (SICs 6000-6999). Firm-level sales are from COMPUSTAT North America.
Canadian Suppliers≥1	Indicator for U.S. firms with at least one Canadian supplier as of December 31, 2019. Data on suppliers is from the FactSet Revere Supply Chain Relationships database. We exclude financial firms (SICs 6000-6999).
Mexican Suppliers≥1	Indicator for U.S. firms with at least one Mexican supplier as of December 31, 2019. Data on suppliers is from the FactSet Revere Supply Chain Relationships database. We exclude financial firms (SICs 6000-6999).
Small Chinese Suppliers	Indicator for U.S. firms with one or more small Chinese suppliers based on the 20th percentile of the ratio of total Chinese suppliers' sales to U.S. firm's sales in 2019q4. Data on suppliers is from the FactSet Revere Supply Chain Relationships database as of December 31, 2019. Firm-level sales for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively. We exclude financial (SICs 6000-6999).
Log of Chinese Customers	Natural logarithm of the number of Chinese customers of U.S. firms over several sample periods. Data on customers is from the FactSet Revere Supply Chain Relationships database. We exclude financial firms (SICs 6000-6999).
Log of U.S. Suppliers	Natural logarithm of the number of U.S. suppliers of Chinese firms over several sample periods. Data on suppliers is from the FactSet Revere Supply Chain Relationships database. We exclude financial firms (SICs 6000-6999).
Log of other Global Suppliers	Natural logarithm of the number of global suppliers (excl. Chinese and U.S. suppliers) of U.S. firms as of December 31, 2019 and as of March 31, 2020. Data on suppliers is from the FactSet Revere Supply Chain Relationships database. We exclude financial firms (SICs 6000-6999).
Inventory/Assets	Ratio of inventory (COMPUSTAT item invt) to book assets (COMPUSTAT item at) in 2019q1 and 20202q1. We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.
Accounts Payable/Assets	Ratio of accounts payable (COMPUSTAT item ap) to book assets (COMPUSTAT item at) in 2019q1 and 20202q1. We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.
Log of Sales	Natural logarithm of sales (COMPUSTAT item sale) in 2019q1 and 20202q1. We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.

(Table continues on next page.)

Main Firm Level Variables:	**Definition:**
Operating Income/Assets	Ratio of operating income (COMPUSTAT item oibdp) to book assets (COMPUSTAT item at) in 2019q1 and 20202q1. We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.
ΔTotal Debt/Assets$_{t-1}$	Ratio of changes in total debt (COMPUSTAT's items dltt+dlc-dltt$_{t-1}$-dlc$_{t-1}$) to lagged book assets (COMPUSTAT item at$_{t-1}$) in 2019q1 and 20202q1. We exclude financial firms (SICs 6000-6999) in 2019q1 and 20202q1. Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.
ΔLong-Term Debt/Assets$_{t-1}$	Ratio of changes in long-term debt (COMPUSTAT item dltt–dltt$_{t-1}$) to lagged book assets (COMPUSTAT item at$_{t-1}$) in 2019q1 and 20202q1. We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.
ΔShort-Term Debt/Assets$_{t-1}$	Ratio of changes in short-term debt (COMPUSTAT item dlc-dlc$_{t-1}$) to lagged book assets (COMPUSTAT item at$_{t-1}$t) in 2019q1 and 20202q1. We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.
Cash/Assets	Ratio of cash and short-term investments (COMPUSTAT item che) to book assets (COMPUSTAT item at) in 2019q1 and 20202q1. We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.
Capital Expenditures/Assets$_{t-1}$	Ratio of capital expenditures (COMPUSTAT item capxy: capital expenditures year-to-date) to lagged book assets (COMPUSTAT item at$_{t-1}$) in 2019q1 and 20202q1. We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.
Log Number of Employees	Natural logarithm of total number of employees (COMPUSTAT item emp) in 2019 and 2020 (firms with fiscal years ending in January, February, and March). We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. firms are from COMPUSTAT North America.
Accounts Receivable/Assets	Ratio of accounts receivable (COMPUSTAT item rect) to book assets (COMPUSTAT item at) in 2019q1 and 20202q1. We exclude financial firms (SICs 6000-6999). Firm-level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively.

Table A.2: Top 10 U.S. Firms by Chinese Suppliers' Exposure

This table reports the names of the top 10 U.S. firms by 2019q4 sales in the High, Moderate, and Low Chinese suppliers' exposure groups. High, Moderate, and Low Chinese Suppliers' Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. % Chinese Suppliers is the number of Chinese suppliers in percentage of total suppliers. Supply chain relationship data from FactSet Revere Supply Chain Relationships, as of December 31, 2019. Sale data is from COMPUSTAT North America. Refer to Table A.1 for detailed variable definitions.

High Chinese Suppliers' Exposure			Moderate Chinese Suppliers' Exposure			Low Chinese Suppliers' Exposure		
Name	Sales ($ billion)	% Chinese Suppliers	Name	Sales ($ billion)	% Chinese Suppliers	Name	Sales ($ billion)	% Chinese Suppliers
Yum Brands Inc.	1.694	0.063	General Motors Co.	30.826	0.119	Walmart Inc.	127.991	0.055
Domino's Pizza Inc.	1.150	0.062	Coca-Cola Co.	9.068	0.075	Apple Inc.	91.819	0.062
Lennox International Inc.	0.885	0.381	Cummins Inc.	5.578	0.186	Amazon.com Inc.	87.436	0.038
Visteon Corp.	0.744	0.128	Whirlpool Corp.	5.382	0.108	CVS Health Corp.	66.889	0.025
Rent-A-Center Inc.	0.668	0.143	McDonald's Corp.	5.349	0.050	Exxon Mobil Corp.	63.024	0.038
Cypress Semiconductor Corp.	0.560	0.200	Hilton Worldwide Holdings	2.369	0.047	McKesson Corp.	59.172	0.009
Briggs & Stratton Corp.	0.438	0.100	CommScope Inc.	2.299	0.065	AmerisourceBergen Corp.	47.865	0.025
ePlus Inc.	0.429	0.017	Dana Inc.	1.987	0.125	AT&T Inc.	46.821	0.013
Air Transport Services Group	0.403	0.143	Tapestry Inc.	1.816	0.069	Cardinal Health Inc.	39.735	0.012
Plantronics Inc.	0.385	0.143	ON Semiconductor Corp.	1.402	0.091	Ford Motor Co.	39.715	0.095

Table A.3: The Wealth Effects of the Covid-19 Supply Chain Disruption Beyond Tier 1

This table reports Cumulative Average Abnormal Returns (CAARs) during the 31 trading days starting on January 6, 2020 ("event date") for U.S. firms without tier 1 Chinese suppliers, but with tier 2 Chinese suppliers, columns (1) and (2), and for U.S. firms without tier 1 and tier 2 Chinese suppliers, but with tier 3 Chinese suppliers, columns (3) and (4). Chinese suppliers data is from in FactSet as of December 31, 2019. We exclude financial firms (SICs 6000-6999). High, Moderate, and Low Chinese Suppliers' Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of tier 2 and tier 3 Chinese suppliers per billions ($) of sales, respectively. VW C-4 and VW C-8 are estimated using the Carhart 4-factor and Carhart 8-factor models (Carhart, 1997), with the U.S. and both the U.S. and other developed countries Carhart factors, respectively, and the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns. Daily stock returns are from COMPUSTAT North America and Carhart factors are from Kenneth French's website (`https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`). Refer to Table A.1 for detailed variable definitions. *t*-statistics are based on standard errors adjusted for cross-sectional correlation of security returns due to event-date clustering (Brown and Warner, 1980).

CAARs by Chinese Suppliers' Exposure (CSE)	**Tier 2 Chinese Suppliers**		**Tier 3 Chinese Suppliers**	
	Value-Weighted 4-Factor (1)	Value-Weighted 8-Factor (2)	Value-Weighted 4-Factor (3)	Value-Weighted 8-Factor (4)
High CSE:				
CAARs	-0.084***	-0.075***	-0.054**	-0.044*
t-statistic	-3.213	-2.881	-2.595	-1.820
Num. of Firms	213	213	70	70
Num. of Chinese Suppliers	6,412	6,412	3,034	3,034
Moderate CSE:				
CAARs	-0.024*	-0.021**	-0.017*	-0.016**
t-statistic	-1.922	-1.961	-1.943	-1.973
Num. of Firms	205	205	66	66
Num. of Chinese Suppliers	5,418	5,418	3,561	3,561
Low CSE:				
CAARs	-0.016*	-0.011	-0.012	-0.007
t-statistic	-1.752	-1.619	-1.149	-0.534
Num. of Firms	531	531	173	173
Num. of Chinese Suppliers	7,139	7,139	3,948	3,948
Chinese Suppliers$\geq$1:				
CAARs	-0.032**	-0.028***	-0.025	-0.019
t-statistic	-2.454	-2.968	-1.384	-1.216
Num. of Firms	976	976	332	332
Num. of Chinese Suppliers	17,125	17,125	10,269	10,269

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table A.4: Alternative Channels

This table reports Cumulative Average Abnormal Returns (CAARs) during the 31 trading days starting on January 6, 2020 ("event date") for various samples of U.S. firms with and without Chinese suppliers in FactSet as of December 31, 2019. We exclude financial firms (SICs 6000-6999). The samples in columns (1) to (5) include various groups of U.S. firms with and without Chinese suppliers. The sample in column (6) includes U.S. firms without Chinese suppliers identified as the closest match to U.S. firms with Chinese suppliers based on log of market capitalization, momentum, book-to-market, and Fama-French 49 industries (Fama and French, 1997) using the Abadie and Imbens (2006) bias-corrected matching estimator. High, Moderate, and Low Suppliers' Exposure (High, Moderate, Low SE) indicate high, moderate, and low exposure to suppliers from a certain country based on the number of suppliers from that country per billions ($) of sales. For the matched sample, exposure refers to exposure for the reference firms, U.S. firms with Chinese suppliers. The CAARs in Panels A and B are estimated using the Carhart 4-factor and Carhart 8-factor models (Carhart, 1997), with the U.S. and both the U.S. and other developed countries Carhart factors, respectively, and the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns, VW C-4 and VW C-8. Daily stock returns are from COMPUSTAT North America and Carhart factors are from Kenneth French's website (`https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`). Firm-level data for U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively. Refer to Table A.1 for detailed variable definitions. *t*-statistics are based on standard errors adjusted for cross-sectional correlation of security returns due to event-date clustering (Brown and Warner, 1980).

CAARs by Suppliers' Exposure (SE)	Panel A: **Value-Weighted 4-Factor Model**					
	Chinese but no Canadian or Mexican Suppliers (1)	Canadian but no Chinese or Mexican Suppliers (2)	Mexican but no Canadian or Chinese Suppliers (3)	Chinese Suppliers but no Chinese Customers (4)	Chinese Suppliers' Exposure by Sales (5)	Matched Firms (6)
High SE:						
CAARs	-0.126**	0.003	0.009	-0.121***	-0.091***	0.004
t-statistic	-2.353	0.069	0.129	-3.795	-3.591	0.118
Num. of Firms	45	94	6	26	38	57
Moderate SE:						
CAARs	-0.040**	-0.026	-0.008	-0.059**	-0.056***	-0.009
t-statistic	-2.289	-1.310	-0.233	-2.396	-2.745	-0.560
Num. of Firms	27	97	8	26	198	54
Low SE:						
CAARs	-0.018**	0.013	-0.023	-0.051***	-0.019**	0.007
t-statistic	-2.134	0.830	-0.786	-2.799	-2.115	0.047
Num. of Firms	41	97	16	74	46	174
Suppliers≥1:						
CAARs	-0.079**	-0.004	-0.015	-0.067***	-0.056**	-0.003
t-statistic	-2.518	-0.683	-0.645	-4.362	-2.269	-0.176
Num. of Firms	114	294	30	126	282	286
CAARs by Suppliers' Exposure (SE)	Panel B: **Value-Weighted 8-Factor Model**					
	Chinese but no Canadian or Mexican Suppliers (1)	Canadian but no Chinese or Mexican Suppliers (2)	Mexican but no Canadian or Chinese Suppliers (3)	Chinese Suppliers but no Chinese Customers (4)	Chinese Suppliers' Exposure by Sales (5)	Matched Firms (6)
High SE:						
CAARs	-0.105**	0.009	0.034	-0.091***	-0.088***	0.009
t-statistic	-1.991	0.184	0.479	-2.806	-2.738	0.231
Num. of Firms	45	94	6	26	38	57
Moderate SE:						
CAARs	-0.036**	-0.029	-0.017	-0.054**	-0.054**	-0.006
t-statistic	-2.067	-1.461	-0.510	-2.258	-2.683	-0.335
Num. of Firms	27	97	8	26	198	54
Low SE:						
CAARs	-0.016*	0.011	-0.024	-0.054***	-0.018**	0.006
t-statistic	-1.692	0.713	-0.839	-2.916	-1.989	0.036
Num. of Firms	41	97	16	74	46	174
Suppliers≥1:						
CAARs	-0.073**	-0.006	-0.007	-0.062***	-0.050***	-0.001
t-statistic	-2.342	-0.939	-0.331	-3.911	-2.082	-0.053
Num. of Firms	114	294	30	126	282	286

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table A.5: Mean Difference and Distributional Tests for Treated and Control Firms

This table reports the mean difference t-test p-value and the Kolmogorov-Smirnov distributional test p-value of log of market capitalization, momentum, and book-to-market for treated firms (U.S. firms with at least one Chinese supplier as of December 31, 2019) and control firms (U.S. firms without Chinese suppliers as of December 31, 2019). The treated groups include U.S. firms with at least one Chinese supplier (Panel A) and U.S. firms with High (Panel B), Moderate (Panel C), and Low (Panel D) exposure to Chinese suppliers as of December 31, 2019. High, Moderate, and Low Chinese Suppliers" Exposure (High, Moderate, Low CSE) indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. Control firms are identified as the closest match to U.S. firms with Chinese suppliers based on log of market capitalization, momentum, book-to-market, and Fama-French 49 industries (Fama and French, 1997) using the Abadie and Imbens (2006) bias-corrected matching estimator. Supply chain relationship data is from the FactSet Revere Supply Chain Relationships database. Other firm level data is from COMPUSTAT. Refer to Table A.1 for detailed variable definitions.

Panel A: Characteristics of U.S. Firms with Chinese Suppliers ≥1 and Control Firms: Matched Sample

		Mean	Treated-Control	Mean Difference t-Test p-value	Kolmogorov-Smirnov Test p-value	Num. of Firms
Log of Market Capitalization	Treated	8.656	-0.005	0.364	0.516	286
	Control	8.661				286
Momentum	Treated	0.101	0.001	0.840	0.753	286
	Control	0.100				286
Book-to-Market	Treated	0.501	-0.005	0.311	0.586	286
	Control	0.506				286

Panel B: Characteristics of U.S. Firms with High Chinese Suppliers' Exposure and Control Firms: Matched Sample

		Mean	Treated-Control	Mean Difference t-Test p-value	Kolmogorov-Smirnov Test p-value	Num. of Firms
Log of Market Capitalization	Treated	6.022	-0.017	0.537	0.610	57
	Control	6.039				57
Momentum	Treated	0.036	-0.005	0.845	0.779	57
	Control	0.041				57
Book-to-Market	Treated	0.841	0.007	0.760	0.803	57
	Control	0.834				57

Panel C: Characteristics of U.S. Firms with Moderate Chinese Suppliers' Exposure and Control Firms: Matched Sample

		Mean	Treated-Control	Mean Difference t-Test p-value	Kolmogorov-Smirnov Test p-value	Num. of Firms
Log of Market Capitalization	Treated	8.090	0.011	0.504	0.644	54
	Control	8.079				54
Momentum	Treated	-0.054	-0.010	0.678	0.798	54
	Control	-0.044				54
Book-to-Market	Treated	0.483	0.012	0.445	0.867	54
	Control	0.471				54

Panel D: Characteristics of U.S. Firms with Low Chinese Suppliers' Exposure and Control Firms: Matched Sample

		Mean	Treated-Control	Mean Difference t-Test p-value	Kolmogorov-Smirnov Test p-value	Num. of Firms
Log of Market Capitalization	Treated	9.774	-0.006	0.369	0.575	174
	Control	9.780				174
Momentum	Treated	0.165	0.006	0.825	0.737	174
	Control	0.159				174
Book-to-Market	Treated	0.398	0.006	0.435	0.545	174
	Control	0.393				174

Table A.6: Cross-Sectional Regressions of Cumulative Average Abnormal Returns

This table presents estimations from cross-sectional Cumulative Average Abnormal Return (CAAR) regressions. The dependent variables in column (1) – (3) and (4) – (6) are the VW C-4 and VW C-8 CAARs, respectively, calculated over the 31 trading days starting on January 6, 2020 ("event date") for U.S. firms with Chinese suppliers in FactSet as of December 31, 2019. VW C-4 and VW C-8 are estimated using the Carhart 4-factor and Carhart 8-factor models (Carhart, 1997), with the U.S. and both the U.S. and other developed countries Carhart factors, respectively, and the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns. High, Moderate, and Low Chinese Suppliers' Exposure indicate high, moderate, and low exposure to Chinese suppliers based on the number of Chinese suppliers per billions ($) of sales. Refer to Table A.1 for detailed variable definitions. Robust standard errors are reported in parentheses.

Dep. Variable:	Value-Weighted 4-Factor CAARs			Value-Weighted 8-Factor CAARs		
	(1)	(2)	(3)	(4)	(5)	(6)
High Chinese Suppliers' Exposure	-0.152***			-0.144***		
	(0.043)			(0.040)		
Moderate Chinese Suppliers' Exposure	-0.042**			-0.044**		
	(0.020)			(0.020)		
Low Chinese Suppliers' Exposure	-0.028**			-0.028**		
	(0.013)			(0.013)		
Chinese Suppliers≥1		-0.056**			-0.062**	
		(0.028)			(0.030)	
Chinese Suppliers over Sales			-0.047**			-0.042**
			(0.023)			(0.020)
Canadian Suppliers≥1	0.00481	0.008	-0.002	0.003	0.006	-0.005
	(0.022)	(0.022)	(0.023)	(0.021)	(0.022)	(0.022)
Mexican Suppliers≥1	-0.011	-0.007	-0.022	-0.012	-0.007	-0.023
	(0.022)	(0.022)	(0.019)	(0.022)	(0.021)	(0.018)
Chinese Customers≥1	-0.019	-0.016	-0.024	-0.026	-0.022	-0.031**
	(0.017)	(0.017)	(0.016)	(0.016)	(0.017)	(0.015)
Small Chinese Suppliers	0.051	-0.024	0.008	0.055	-0.010	0.010
	(0.051)	(0.053)	(0.052)	(0.046)	(0.046)	(0.052)
Obs.	2,739	2,739	2,739	2,739	2,739	2,739
Adjusted-R2	0.023	0.022	0.016	0.024	0.020	0.015

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table A.7: Descriptive Statistics for the Variables in the Difference-in-Difference Regressions

This table reports descriptive statistics for the U.S. firms (Panel A) and the Chinese firms (Panel B) in our difference-in-difference regressions in Tables 8 to 11 in the main text, and Tables A.8 to A.12 in the Appendix. Supplier and customer data are from the FactSet Revere Supply Chain Relationships database as of December 31, 2019 and March 31, 2020. Firm level data for the U.S. and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively, for the period 2019q1 – 2020q1. Refer to Table A.1 for detailed variable definitions.

Panel A: U.S. Firms	Mean	St. Dev.	25^{th} Pctle	Median	75^{th} Pctle	Obs.
High CSE	0.014	0.117	0.000	0.000	0.000	4,942
Moderate CSE	0.018	0.132	0.000	0.000	0.000	4,942
Low CSE	0.048	0.213	0.000	0.000	0.000	4,942
Chinese Suppliers$\geq$1	0.080	0.271	0.000	0.000	0.000	4,942
Num. of U.S. Suppliers	3.477	9.970	0.000	0.000	3.000	4,942
Num. of Other Global Suppliers	2.711	10.852	0.000	0.000	1.000	4,942
Num. of Chinese Suppliers	0.169	1.228	0.000	0.000	0.000	4,942
Log of Assets	6.842	2.205	5.288	6.902	8.365	4,906
Tobin's q	2.216	1.949	1.073	1.500	2.541	4,906
Tangibility	0.277	0.264	0.074	0.173	0.422	4,906
Inventory/Assets	0.079	0.112	0.000	0.023	0.119	4,782
Accounts Payable/Assets	0.063	0.067	0.019	0.043	0.084	4,906
Accounts Receivable/Assets	0.099	0.097	0.024	0.074	0.144	4,450
Log of Sales	5.058	2.492	3.803	5.405	6.678	4,450
Operating Income/Assets	-0.014	0.093	-0.015	0.018	0.031	4,778
ΔTotal Debt/Assets$_{t-1}$	0.082	0.199	-0.005	0.024	0.099	4,350
ΔLong-Term Debt/Assets$_{t-1}$	0.070	0.184	-0.007	0.016	0.084	4,658
ΔShort-Term Debt/Assets$_{t-1}$	0.012	0.056	-0.001	0.003	0.018	4,378
Cash/Assets	0.243	0.282	0.036	0.115	0.357	4,940
Capital Expenditures/Assets$_{t-1}$	0.014	0.020	0.002	0.007	0.018	4,598
Log Number of Employees	2.256	1.481	1.089	1.973	3.171	314
Chinese Customers$\geq$1	0.090	0.291	0.000	0.000	0.000	4,940
High CCE	0.042	0.201	0.000	0.000	0.000	4,940
Moderate CCE	0.020	0.142	0.000	0.000	0.000	4,940
Low CSE	0.027	0.162	0.000	0.000	0.000	4,940
Panel B: Chinese Firms	**Mean**	**St. Dev.**	**25^{th} Pctle**	**Median**	**75^{th} Pctle**	**Obs.**
U.S. Customers$\geq$1	0.071	0.257	0.000	0.000	0.000	6,748
Log of Assets	8.411	1.323	7.486	8.258	9.141	6,748
Tobin's q	1.871	1.972	0.692	1.286	2.314	6,748
Tangibility	0.243	0.175	0.105	0.211	0.342	6,748
High U.S. CE	0.026	0.160	0.000	0.000	0.000	6,748
Moderate U.S. CE	0.025	0.157	0.000	0.000	0.000	6,748
Low U.S. CE	0.034	0.181	0.000	0.000	0.000	6,748
Inventory/Assets	0.126	0.099	0.056	0.108	0.171	6,612
Accounts Receivable/Assets	0.190	0.131	0.089	0.168	0.262	6,748

(Table continues on next page.)

Log of Sales	6.058	1.617	5.040	5.962	7.014	6,740
Operating Income/Assets	0.009	0.015	0.000	0.008	0.016	6,746
ΔTotal Debt/Assets$_{t-1}$	0.025	0.098	-0.028	0.013	0.068	3,024
ΔLong-Term Debt/Assets$_{t-1}$	0.009	0.067	-0.021	0.000	0.032	3,192
ΔShort-Term Debt/Assets$_{t-1}$	0.016	0.076	-0.023	0.009	0.051	4,818
Cash/Assets	0.186	0.138	0.088	0.147	0.244	6,748
Capital Expenditures/Assets$_{t-1}$	0.012	0.015	0.002	0.006	0.015	6,356
U.S. Suppliers$\geq$1	0.065	0.246	0.000	0.000	0.000	6,746
High U.S. SE	0.015	0.123	0.000	0.000	0.000	6,746
Moderate U.S. SE	0.019	0.135	0.000	0.000	0.000	6,746
Low U.S. SE	0.047	0.212	0.000	0.000	0.000	6,746

Table A.8: Real and Financial Effects for Chinese Suppliers of U.S. Firms During the Covid-19 Pandemic

This table reports estimations from several difference-in-difference regressions. The dependent variables are the ratio inventory to assets, column (1), the natural logarithm of sales, column (2), the ratio accounts receivables to assets, column (3), the ratio of operating income to assets, column (4), the ratio of change in total debt to lagged assets, column (5), the ratio of change in long-term debt to lagged assets, column (6), and the ratio of change in short-term debt to lagged assets, column (7), the ratio of cash to assets (column (8), and the ratio of capital expenditures to lagged assets, column (9). The sample includes all Chinese firms in COMPUSTAT Global except financial firms (SICs 6000-6999) for the period 2019q1 – 2020q1. U.S. Customers≥1 is an indicator for Chinese firms with at least one U.S. customer. Customer data is from the FactSet Revere Supply Chain Relationships database, as of December 31, 2019. 2020q1 is an indicator for 2020q1, and zero for 2019q1. Refer to Table A.1 for detailed variable definitions. Standard errors reported in parentheses are clustered at the firm level.

	Inventory and Performance				Access to Credit			Cash and Investment	
Dep. Variable:	Inventory/ Assets	Log of Sales	Accounts Receivable/ Assets	Operating Income/ Assets	ΔTotal Debt/ Assets_{t-1}	ΔLong-Term Debt/ Assets_{t-1}	ΔShort-Term Debt/ Assets_{t-1}	Cash/ Assets	Capital Expenditures/ Assets_{t-1}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
U.S. Customers≥1 × 2020q1	0.008***	0.036	-0.008**	0.001	-0.016	-0.001	0.001	-0.003	0.001
	(0.003)	(0.026)	(0.004)	(0.001)	(0.010)	(0.008)	(0.008)	(0.005)	(0.001)
2020q1	-0.004***	-0.284***	-0.001	-0.006***	-0.019***	-0.003	-0.019***	0.024***	-0.003***
	(0.001)	(0.011)	(0.001)	(0.001)	(0.004)	(0.003)	(0.002)	(0.002)	(0.001)
Log of Assets	-0.009	1.058***	-0.017	0.007***	0.153***	0.053***	0.106***	0.003	0.005***
	(0.008)	(0.078)	(0.010)	(0.001)	(0.024)	(0.017)	(0.014)	(0.014)	(0.002)
Tobin's q	-0.001	0.078***	0.009***	0.003***	0.002	-0.003	0.001	-0.006	-0.001
	(0.002)	(0.020)	(0.003)	(0.001)	(0.014)	(0.008)	(0.005)	(0.004)	(0.001)
Tangibility	0.020	0.511**	-0.140***	-0.009	-0.064	0.049	-0.085*	-0.466***	0.008
	(0.021)	(0.241)	(0.035)	(0.006)	(0.080)	(0.073)	(0.046)	(0.041)	(0.006)
Obs.	6,612	6,740	6,748	6,746	3,024	3,192	4,818	6,748	6,356
R2 (within)	0.009	0.301	0.041	0.231	0.102	0.020	0.079	0.119	0.038
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Std. Errors Clustering	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table A.9: Real and Financial Effects for the Chinese Suppliers of U.S. Firms During the Covid-19 Pandemic

This table reports estimations from several difference-in-difference regressions. The dependent variables are the ratio inventory to assets, column (1), the natural logarithm of sales, column (2), the ratio accounts receivables to assets, column (3), the ratio of operating income to assets, column (4), the ratio of change in total debt to lagged assets, column (5), the ratio of change in long-term debt to lagged assets, column (6), and the ratio of change in short-term debt to lagged assets, column (7), the ratio of cash to assets (column (8), and the ratio of capital expenditures to lagged assets, column (9). The sample includes all Chinese firms in COMPUSTAT Global except financial firms (SICs 6000-6999) for the period 2019q1 – 2020q1. High, Moderate, and Low U.S. Customers' Exposure (High, Moderate, Low U.S. CE) indicate high, moderate, and low exposure to U.S. customers based on the number of U.S. customers per billions ($) of sales. Customer data is from the FactSet Revere Supply Chain Relationships database, as of December 31, 2019. 2020q1 is an indicator for 2020q1, and zero for 2019q1. Refer to Table A.1 for detailed variable definitions. Standard errors reported in parentheses are clustered at the firm level.

	Inventory and Performance				Access to Credit			Cash and Investment	
Dep. Variable:	Inventory/ Assets	Log of Sales	Accounts Receivable/ Assets	Operating Income/ Assets	ΔTotal Debt/ Assets_{t-1}	ΔLong-Term Debt/ Assets_{t-1}	ΔShort-Term Debt/ Assets_{t-1}	Cash/ Assets	Capital Expenditures/ Assets_{t-1}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
High U.S. CE × 2020q1	-0.005	-0.016	0.010	0.001	-0.009	-0.001	-0.004	-0.004	0.001
	(0.007)	(0.037)	(0.007)	(0.001)	(0.021)	(0.017)	(0.015)	(0.009)	(0.001)
Moderate U.S. CE × 2020q1	0.008***	-0.051	-0.013**	-0.001	-0.018	0.017	-0.009	-0.008	0.001
	(0.003)	(0.040)	(0.006)	(0.001)	(0.017)	(0.014)	(0.013)	(0.009)	(0.001)
Low U.S. CE × 2020q1	0.007	0.034	-0.014***	0.001	-0.007	-0.006	0.005	0.002	0.001
	(0.005)	(0.024)	(0.005)	(0.001)	(0.013)	(0.010)	(0.011)	(0.007)	(0.001)
2020q1	-0.004***	-0.286***	-0.001	-0.006***	-0.020***	-0.004	-0.019***	0.024***	-0.0029***
	(0.001)	(0.011)	(0.001)	(0.001)	(0.004)	(0.003)	(0.002)	(0.002)	(0.001)
Log of Assets	-0.010	1.057***	-0.016	0.007***	0.153***	0.052***	0.106***	0.002	0.005***
	(0.008)	(0.078)	(0.010)	(0.001)	(0.024)	(0.017)	(0.014)	(0.014)	(0.002)
Tobin's q	-0.001	0.078***	0.009***	0.003***	0.002	-0.003	0.001	-0.006	-0.001
	(0.002)	(0.020)	(0.003)	(0.001)	(0.015)	(0.008)	(0.005)	(0.004)	(0.001)
Tangibility	0.018	0.515**	-0.138***	-0.008	-0.064	0.049	-0.086*	-0.466***	0.008
	(0.020)	(0.242)	(0.035)	(0.006)	(0.080)	(0.073)	(0.046)	(0.041)	(0.007)
Obs.	6,612	6,740	6,748	6,746	3,024	3,192	4,818	6,748	6,356
R2 (within)	0.008	0.251	0.043	0.231	0.101	0.021	0.079	0.119	0.038
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Std. Errors Clustering	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table A.10: Real and Financial Effects for U.S. Firms with Chinese Customers and for the Chinese Customers of U.S. Firms During the Covid-19 Pandemic

This table reports estimations from several difference-in-difference regressions. The dependent variables are the ratio inventory to assets, column (1), the natural logarithm of sales, column (2), the ratio accounts receivables to assets, column (3), the ratio of operating income to assets, column (4), the ratio of change in total debt to lagged assets, column (5), the ratio of change in long-term debt to lagged assets, column (6), and the ratio of change in short-term debt to lagged assets, column (7), the ratio of cash to assets (column (8), the ratio of capital expenditures to lagged assets, column (9), and the natural logarithm of the number of employees, column (10). Employment information is not available for Chinese firms. The samples in Panels A and B include U.S. firms with Chinese Customers and the Chinese customers of U.S. firms, respectively, for the period 2019q1 – 2020q1. We exclude financial firms (SICs 6000-6999). Firm level data for U.S. firms and Chinese firms are from COMPUSTAT North America and COMPUSTAT Global, respectively. Chinese Customers$\geq$1 is an indicator for U.S. firms with at least one Chinese customer. U.S. Suppliers$\geq$1 is an indicator for Chinese firms with at least one U.S. supplier. Customer and supplier data is from the FactSet Revere Supply Chain Relationships database, as of December 31, 2019. 2020q1 is an indicator for 2020q1, and zero for 2019q1. Refer to Table A.1 for detailed variable definitions. Standard errors reported in parentheses are clustered at the firm level.

	Panel A: U.S. Firms with Chinese Customers									
	Inventory and Performance				Access to Credit			Cash, Investment, and Employment		
Dep. Variable:	Inventory/ Assets	Log of Sales	Accounts Receivable/ Assets	Operating Income/ Assets	ΔTotal Debt/ Assets_{t-1}	ΔLong-Term Debt/ Assets_{t-1}	ΔShort-Term Debt/ Assets_{t-1}	Cash/ Assets	Capital Expenditures/ Assets_{t-1}	Log of Num. of Employees
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Chinese Customers$\geq$1 × 2020q1	0.001	-0.007***	-0.049*	0.002	0.021	0.018	0.001	0.005	-0.001	-0.053
	(0.003)	(0.003)	(0.026)	(0.004)	(0.019)	(0.018)	(0.007)	(0.006)	(0.001)	(0.066)
2020q1	-0.004***	-0.003***	-0.001	-0.010***	-0.042***	-0.038***	-0.001	0.016***	-0.002***	-0.006
	(0.001)	(0.001)	(0.023)	(0.002)	(0.009)	(0.008)	(0.003)	(0.003)	(0.001)	(0.011)
Log of Assets	-0.022***	-0.024***	0.516***	0.064***	0.311***	0.294***	0.021**	0.054***	0.005***	0.164**
	(0.003)	(0.004)	(0.078)	(0.007)	(0.028)	(0.024)	(0.010)	(0.008)	(0.002)	(0.067)
Tobin's q	-0.001***	-0.001	-0.021	-0.001	0.012**	0.010*	0.003*	0.008***	0.001***	-0.011
	(0.001)	(0.001)	(0.018)	(0.001)	(0.005)	(0.005)	(0.002)	(0.002)	(0.001)	(0.010)
Tangibility	-0.103***	-0.041***	-0.429**	-0.065**	1.043***	0.882***	0.161***	-0.541***	-0.003	-0.189*
	(0.017)	(0.013)	(0.205)	(0.026)	(0.124)	(0.100)	(0.041)	(0.046)	(0.008)	(0.100)
Obs.	4,782	4,798	4,450	4,778	4,350	4,658	4,378	4,940	4,598	314
R2 (within)	0.111	0.065	0.074	0.151	0.182	0.180	0.022	0.206	0.022	0.218
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Std. Errors Clustering	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm

	Panel B: Chinese Customers of U.S. Firms								
	Inventory and Performance				Access to Credit			Cash and Investment	
Dep. Variable:	Inventory/ Assets	Log of Sales	Accounts Receivable/ Assets	Operating Income/ Assets	ΔTotal Debt/ Assets_{t-1}	ΔLong-Term Debt/ Assets_{t-1}	ΔShort-Term Debt/ Assets_{t-1}	Cash/ Assets	Capital Expenditures/ Assets_{t-1}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
U.S. Suppliers$\geq$1 × 2020q1	0.006*	-0.002	-0.040	-0.001	-0.018*	-0.010	0.002	-0.014***	-0.001
	(0.003)	(0.003)	(0.034)	(0.001)	(0.011)	(0.008)	(0.008)	(0.005)	(0.001)
2020q1	-0.004***	-0.001	-0.278***	-0.006***	-0.019***	-0.003	-0.019***	0.025***	-0.003***
	(0.001)	(0.001)	(0.011)	(0.001)	(0.004)	(0.003)	(0.002)	(0.002)	(0.001)
Log of Assets	-0.010	-0.001	1.056***	0.007***	0.153***	0.052***	0.106***	0.002	0.005***
	(0.008)	(0.007)	(0.078)	(0.001)	(0.024)	(0.017)	(0.014)	(0.014)	(0.002)
Tobin's q	-0.013	0.018	0.783***	0.034***	0.018	-0.025	0.006	-0.063	-0.003
	(0.019)	(0.014)	(0.203)	(0.005)	(0.014)	(0.079)	(0.053)	(0.043)	(0.006)
Tangibility	0.018	0.064***	0.502**	-0.009	-0.065	0.049	-0.085*	-0.466***	0.007
	(0.021)	(0.019)	(0.241)	(0.006)	(0.080)	(0.074)	(0.046)	(0.041)	(0.007)
Obs.	6,612	6,730	6,740	6,746	3,024	3,192	4,818	6,748	6,356
R2 (within)	0.008	0.011	0.301	0.231	0.102	0.020	0.079	0.120	0.038
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Std. Errors Clustering	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Table A.11: Real and Financial Effects for the U.S. Firms with Chinese Customers During the Covid-19 Pandemic

This table reports estimations from several difference-in-difference regressions. The dependent variables are the ratio inventory to assets, column (1), the natural logarithm of sales, column (2), the ratio accounts receivables to assets, column (3), the ratio of operating income to assets, column (4), the ratio of change in total debt to lagged assets, column (5), the ratio of change in long-term debt to lagged assets, column (6), and the ratio of change in short-term debt to lagged assets, column (7), the ratio of cash to assets (column (8), the ratio of capital expenditures to lagged assets, column (9), and the natural logarithm of the number of employees, column (10). The sample includes all U.S. firms in COMPUSTAT North America except financial firms (SICs 6000-6999) for the period 2019q1 – 2020q1. High, Moderate, and Low Chinese Customers' Exposure (High, Moderate, Low CCE) indicate high, moderate, and low exposure to Chinese customers based on the number of Chinese customers per billions ($) of sales. Customer data is from the FactSet Revere Supply Chain Relationships database, as of December 31, 2019. 2020q1 is an indicator for 2020q1, and zero for 2019q1. Refer to Table A.1 for detailed variable definitions. Standard errors reported in parentheses are clustered at the firm level.

	Inventory and Performance				Access to Credit			Cash, Investment, and Employment		
Dep. Variable:	Inventory/ Assets	Log of Sales	Accounts Receivable/ Assets	Operating Income/ Assets	ΔTotal Debt/ $Assets_{t-1}$	ΔLong-Term Debt/ $Assets_{t-1}$	ΔShort-Term Debt/ $Assets_{t-1}$	Cash/ Assets	Capital Expenditures/ $Assets_{t-1}$	Log of Num. of Employees
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
High CCE × 2020q1	-0.002	-0.009*	-0.048	0.005	0.023	0.028	-0.008	0.006	-0.002	0.013
	(0.005)	(0.005)	(0.037)	(0.005)	(0.031)	(0.029)	(0.010)	(0.010)	(0.001)	(0.020)
Moderate CCE × 2020q1	0.003	-0.008*	-0.037	0.005	0.006	-0.011	0.018	0.003	-0.001	-0.208
	(0.003)	(0.004)	(0.029)	(0.003)	(0.036)	(0.032)	(0.012)	(0.011)	(0.001)	(0.210)
Low CCE × 2020q1	0.002	-0.004*	-0.058**	-0.006	0.029	0.026	-0.001	0.003	0.001	-0.018
	(0.002)	(0.002)	(0.029)	(0.006)	(0.025)	(0.023)	(0.008)	(0.007)	(0.001)	(0.016)
2020q1	-0.004***	-0.003***	-0.001	-0.010***	-0.042***	-0.038***	-0.001	0.016***	-0.002***	-0.002
	(0.001)	(0.001)	(0.023)	(0.002)	(0.009)	(0.008)	(0.003)	(0.003)	(0.001)	(0.012)
Log of Assets	-0.022***	-0.024***	0.517***	0.064***	0.310***	0.294***	0.021**	0.054***	0.004***	0.161***
	(0.003)	(0.004)	(0.078)	(0.007)	(0.028)	(0.024)	(0.010)	(0.008)	(0.001)	(0.060)
Tobin's q	-0.001***	-0.001	-0.021	-0.001	0.012**	0.009*	0.003*	0.008***	0.001***	-0.009
	(0.001)	(0.001)	(0.018)	(0.001)	(0.005)	(0.005)	(0.002)	(0.002)	(0.001)	(0.009)
Tangibility	-0.103***	-0.041***	-0.429**	-0.065**	1.043***	0.883***	0.161***	-0.541***	-0.002	-0.165*
	(0.017)	(0.013)	(0.205)	(0.026)	(0.124)	(0.100)	(0.041)	(0.046)	(0.006)	(0.090)
Obs.	4,782	4,798	4,450	4,778	4,350	4,658	4,378	4,940	4,598	314
R2 (within)	0.111	0.066	0.074	0.151	0.183	0.181	0.023	0.206	0.030	0.274
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Std. Errors Clustering	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm

Table A.12: Real and Financial Effects for the Chinese Customers of U.S. Firms During the Covid-19 Pandemic

This table reports estimations from several difference-in-difference regressions. The dependent variables are the ratio inventory to assets, column (1), the natural logarithm of sales, column (2), the ratio accounts receivables to assets, column (3), the ratio of operating income to assets, column (4), the ratio of change in total debt to lagged assets, column (5), the ratio of change in long-term debt to lagged assets, column (6), and the ratio of change in short-term debt to lagged assets, column (7), the ratio of cash to assets (column (8), and the ratio of capital expenditures to lagged assets, column (9). The sample includes all Chinese firms in COMPUSTAT Global except financial firms (SICs 6000-6999) for the period 2019q1 – 2020q1. High, Moderate, and Low U.S. Suppliers' Exposure (High, Moderate, Low U.S. SE) indicate high, moderate, and low exposure to U.S. suppliers based on the number of U.S. suppliers per billions ($) of sales. Supplier data is from the FactSet Revere Supply Chain Relationships database, as of December 31, 2019. 2020q1 is an indicator for 2020q1, and zero for 2019q1. Refer to Table A.1 for detailed variable definitions. Standard errors reported in parentheses are clustered at the firm level.

	Inventory and Performance				Access to Credit			Cash and Investment	
Dep. Variable:	Inventory/ Assets	Log of Sales	Accounts Receivable/ Assets	Operating Income/ Assets	ΔTotal Debt/ Assets_{t-1}	ΔLong-Term Debt/ Assets_{t-1}	ΔShort-Term Debt/ Assets_{t-1}	Cash/ Assets	Capital Expenditures/ Assets_{t-1}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
High U.S. SE × 2020q1	0.011**	0.003	-0.102	0.001	-0.008	-0.006	0.026	-0.011	0.002
	(0.005)	(0.003)	(0.073)	(0.002)	(0.035)	(0.030)	(0.018)	(0.011)	(0.001)
Moderate U.S. SE × 2020q1	0.004	-0.009	-0.126*	-0.001	-0.066***	-0.030*	-0.007	-0.004	0.001
	(0.006)	(0.006)	(0.069)	(0.001)	(0.019)	(0.016)	(0.013)	(0.010)	(0.001)
Low U.S. SE × 2020q1	0.007*	-0.003	0.007	-0.001	-0.013	-0.005	-0.004	-0.013***	0.001
	(0.004)	(0.003)	(0.032)	(0.001)	(0.011)	(0.008)	(0.009)	(0.005)	(0.001)
2020q1	-0.004***	-0.001	-0.277***	-0.006***	-0.018***	-0.003	-0.019***	0.025***	-0.003***
	(0.001)	(0.001)	(0.011)	(0.001)	(0.004)	(0.003)	(0.002)	(0.002)	(0.001)
Log of Assets	-0.010	-0.001	1.053***	0.007***	0.154***	0.053***	0.107***	0.003	0.005***
	(0.008)	(0.007)	(0.078)	(0.001)	(0.024)	(0.017)	(0.014)	(0.014)	(0.002)
Tobin's q	-0.013	0.015	0.780***	0.035***	0.025	-0.022	0.008	-0.062	-0.003
	(0.019)	(0.013)	(0.204)	(0.005)	(0.143)	(0.078)	(0.053)	(0.043)	(0.006)
Tangibility	0.018	0.065***	0.508**	-0.009	-0.058	0.051	-0.085*	-0.467***	0.008
	(0.021)	(0.019)	(0.241)	(0.006)	(0.080)	(0.073)	(0.046)	(0.041)	(0.007)
Obs.	6,612	6,730	6,740	6,746	3,024	3,192	4,818	6,748	6,356
R2 (within)	0.008	0.013	0.302	0.232	0.106	0.022	0.080	0.119	0.038
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Std. Errors Clustering	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% (two-tail) test levels, respectively.

Figure A.1: The Wealth Effects of the Covid-19 Supply Chain Disruption for U.S. Firms with Chinese Customers

This figure plots Cumulative Average Abnormal Returns (CAARs) during the 31 trading days from January 6, 2020 ("event date") to February 19, 2020, for various groups of U.S. firms with Chinese customers in FactSet as of December 31, 2019. We exclude financial firms (SICs 6000-6999). The figure plots VW C-4 CAARs for the High, Moderate, Low Chinese Customers' Exposure, and for the Chinese Customers≥1 groups, respectively. High, Moderate, and Low Chinese Customers' Exposure indicate high, moderate, and low exposure to Chinese customers based on the number of Chinese customers per billions ($) of sales. Chinese Customers≥1 are U.S. firms with at least one Chinese customer. VW C-4 CAARs are estimated using the Carhart 4-factor (Carhart, 1997), with the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns. Daily stock returns are from COMPUSTAT North America and Carhart factors are from Kenneth French's website (`https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`). Refer to Table A.1 for detailed variable definitions.

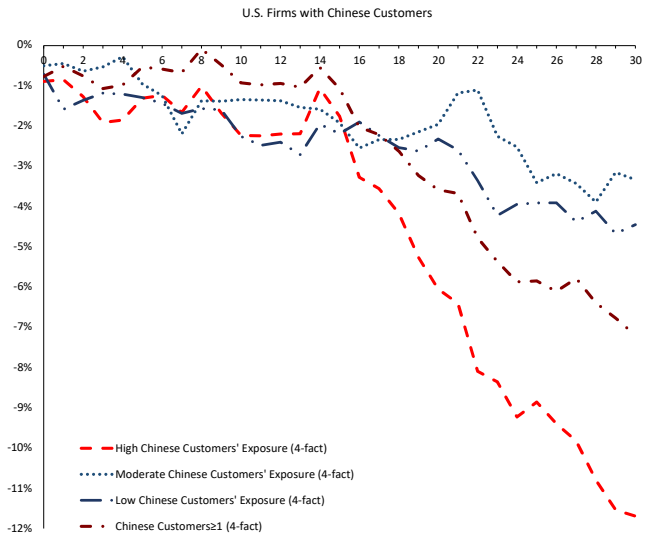

Figure A.2: The Wealth Effects of the Covid-19 Supply Chain Disruption on Chinese Firms with U.S. Suppliers

This figure plots Cumulative Average Abnormal Returns (CAARs) during the 31 trading days from January 6, 2020 ("event date") to February 19, 2020, for various groups of Chinese firms with U.S. suppliers in FactSet as of December 31, 2019. We exclude financial firms (SICs 6000-6999). The figure plots VW C-4 CAARs for the High, Moderate, Low U.S. Suppliers' Exposure, and for the U.S. Suppliers≥1 groups, respectively. High, Moderate, and Low U.S. Suppliers' Exposure indicate high, moderate, and low exposure to U.S. suppliers based on the number of U.S. suppliers per billions ($) of sales. U.S. Suppliers≥1 are Chinese firms with at least one U.S. supplier. VW C-4 CAARs are estimated using the Carhart 4-factor (Carhart, 1997), with the market portfolio proxied by the NYSE-AMEX-NASDAQ value-weighted index returns. Daily stock returns are from COMPUSTAT Global and Carhart factors are from Kenneth French's website (`https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html`). Refer to Table A.1 for detailed variable definitions.