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Abstract

This paper examines how firms' exposure to supply chain disruptions (SCD) affects firm outcomes in the European Union (EU). Exploiting heterogeneous responses to workplace closures imposed by sourcing countries during the pandemic as a shock to SCD, we provide empirical evidence that firms in industries relying more heavily on foreign inputs experience a significant decline in sales compared to other firms. We document that external finance, particularly bank financing, plays a critical role in mitigating the effects of SCD. Furthermore, we highlight the unique importance of bank loans for small and solvent firms. Our findings also indicate that highly diversified firms and those sourcing inputs from less distant partners are less vulnerable to SCD.

Keywords: bank debt, external finance, firm sales, supply chains, supply chain disruptions

JEL classification: D22, F14, G21, L14

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1 Introduction

The production of goods and services today is organized around complex, global, and interconnected supply chains (Carvalho et al., 2021). While this structure can generate substantial efficiency gains (Halpern et al., 2015), regional disruptions to the orderly flow of goods and services can trigger systemic risks worldwide. Since the outbreak of the COVID-19 pandemic, and subsequently the war in Ukraine, supply chain disruptions (SCD) have emerged as one of the most pressing challenges for firms.

[Insert Figure 1]

How do firms respond to these developments, and what factors might help them mitigate the severe effects of supply chain disruptions (SCD)?

To address our research question, we rely on three primary datasets. First, we use data from Amadeus, which provides financial information on all non-financial firms in the EU. Second, we measure each firm's exposure to the global supply chain by combining its industry and location with data from the OECD inter-country input-output tables, which quantify the extent to which an industry relies on foreign inputs to produce total final outputs. For each firm-year, we observe a range of firm-level characteristics, including size, return on assets, leverage, liquidity, and solvency. Third, we measure supply chain disruptions during the pandemic using the Oxford Workplace Closure Stringency Index for sourcing countries (Hale et al., 2021).[1] We hypothesize that when a sourcing country imposes workplace closure restrictions, industries in the home country may experience shortages of intermediate goods, potentially impacting firm outcomes in those industries.[2] This is motivated by the empirical findings of Acemoglu et al. (2012) which documents that intermediate input linkages across industries create propagation effects, amplifying economic shocks.

[1]The stringency index is normalized to a scale from 0 to 100, with 100 representing the strictest restrictions.
[2]There is a strong correlation relationship between workplace closure stringency index in home country and the cost of intermediate goods: See Figure A1.

Using a difference-in-differences estimation, we examine the impact of supply chain disruptions on firms by comparing the sales growth of firms highly exposed to global supply chains (GSC) with a control group of firms with low exposure to GSC. We focus on sales growth because it serves as a key outcome indicator that directly links to GDP growth in an economy. There are studies which provide insights on how firms highly exposed to the global supply chains are affected depending on factors like trade shocks, supply chain disruptions, and access to intermediate inputs. Antràs and Chor (2013) documents how firms' growth depends on their position within the global value chains (GVCs). In addition, Boehm et al. (2019) show how United States (U.S.) firms dependent on Japanese suppliers suffered severe disruptions after the earthquake, leading to temporary drops in growth.

Our findings shows that, on average, when a sourcing country increases its workplace closure stringency during the pandemic by one standard deviation, the sales growth of highly exposed firms in the home country declines by approximately 0.5 percentage points (equivalent to a 16% reduction compared to the mean sales growth of lowly exposed firms). This result remains robust across various model specifications, particularly when we employ a continuous treatment measure—specifically, the ratio of total foreign inputs to total outputs for each industry in the firms' home countries' industries.

Moreover, by leveraging a large sample of EU firms, we are able to examine how our findings vary across different firm characteristics. Specifically, we investigate whether access to external finance can mitigate the risk of slower growth for highly exposed firms during disruptions. We focus on the role of external finance because more than 90% of firms in our sample are small and medium-sized enterprises (SMEs), for whom access to external financing is crucial for survival and sustainable growth. Moreover, Moretto and Caniato (2021) documents that supply chain finance can be an effective tool to address financial disruptions caused by supply chain interruptions, helping firms maintain liquidity and continue operations despite adverse conditions. We analyze various measures of external finance, including total

leverage, bank debt, and non-bank debt. Our findings suggest that access to bank credit helps firms mitigate the effects of supply chain disruptions (SCD).

Drawing on academic literature, we consider two main channels through which external finance can influence firm outcomes: the debt-overhang channel and the bank relationship channel. The debt-overhang literature highlights how heavily indebted firms, including large ones, can struggle during downturns (Kalemli-Özcan et al., 2022; Hennessy, 2004; Lamont, 1995; Myers, 1977). Conversely, the bank relationship channel suggests that banks tend to support their existing borrowers during crises (Bolton et al., 2016; Puri et al., 2011; Berlin and Mester, 1999). Our findings align with the bank relationship channel. Specifically, the decline in sales growth among highly leveraged firms is less pronounced compared to low-leverage firms, with bank debt playing a significant role in mitigating the impact of SCD. The data further suggest that bank relationships enable lenders to learn about firm characteristics, helping them provide support during crises. For instance, among highly leveraged firms, only those without credit constraints prior to the pandemic experience an increase in sales growth when they have access to higher levels of bank debt.

Further evidence reveals that firms with more diversified sources of foreign inputs and those sourcing inputs from less distant partners are more resilient to disruptions. Taken together, while our findings provide substantial evidence on the effects of supply chain disruptions (SCD), they also highlight several strategies to mitigate these impacts. Specifically, maintaining a broad network of suppliers across multiple countries and establishing strong bank relationships during normal times can reduce the severity of such disruptions.

The context of our study offers several advantages. First, our dataset covers a representative sample of 1.6 million firms across 17 EU countries, where global trade has been a key driver of economic growth over recent decades. Given the similarities between EU and US firms, our results are likely to be applicable beyond the EU context. Second,

our research period was carefully selected to exclude overlap with prior crises, allowing us to accurately capture the unique nature of the pandemic-induced shock in 2020.

I consider some sensitivity analysis to substantiate my results. First, we show that our result on the effect of SCD hold on other firm outcomes, namely, profitability, employment, and investment. In addition, we show that the observed decline in firm outcomes are as a result of the global disruption across many sourcing countries industry which our home country industry are dependent upon for producing final outputs.

This paper will contribute to a three strands of literature. First, it extends and complements the growing literature emphasizing the role of supply chain links as mechanisms for the propagation and amplification of shocks. For instance, Carvalho et al. (2021) demonstrates how supply disruptions caused by the Great East Japan Earthquake affected firms both upstream and downstream along supply chains. Using a standard production network model, Barrot et al. (2021) shows that social distancing policies during the pandemic created labor supply shocks and disrupted national production through input-output linkages. Empirically, leveraging COVID-19 as a global supply chain shock, Ersahin et al. (2024) finds that firms facing higher supply chain risks establish relationships with closer and domestic suppliers or suppliers that are industry leaders. Additionally, firms without financial constraints are more likely to pursue vertical mergers and acquisitions in response to supply chain risks. Meinen et al. (2021) argue that labor shortages during the pandemic, coupled with regional sectoral structures, were key determinants of the heterogeneous economic impacts across four EU economies. Unlike these studies, we provide micro-level evidence on the effects of global supply chain disruptions (SCD) on firm outcomes in the EU while highlighting several factors that can mitigate these effects.

Second, this paper contributes to the growing body of work examining the economic impacts of the COVID-19 pandemic. While many studies focus on the pandemic's effects on firms and the broader economy within a single country (Guerrieri et al., 2022; Bonadio et al., 2021; Acemoglu et al., 2020; Alon et al., 2020; Kaplan et al., 2020), our work expands

the scope by studying firms across multiple EU countries. For example, Li et al. (2020) document that banks were able to accommodate firms' heightened liquidity demands during the pandemic due to coinciding inflows of funds from Federal Reserve liquidity injection programs and increased depositor activity. By focusing on the EU context, we offer a broader perspective on how firms respond to global shocks and the mechanisms that help mitigate their impacts.

Third, our findings complement the literature on the uniqueness of bank loans. Previous studies have shown that receiving bank loans—especially those obtained through existing banking relationships—signals positive firm developments to the stock market and other investors (Lamont, 1995; James, 1987). Diamond (1991) provides a model illustrating how firms opt for high-cost bank debt as a signal of their reputation with suppliers and customers. Similarly, Bolton et al. (2016) highlights how established bank relationships offer more favorable continuation-lending terms during crises. However, the debt-overhang literature emphasizes that during financial crises, firms with higher debt levels tend to reduce their investments more significantly than other firms (Kalemli-Özcan et al., 2022; Hennessy, 2004; Myers, 1977). In contrast to this body of work, we show that during a non-financial crisis, such as the COVID-19 pandemic, firms with access to debt markets—particularly those borrowing more from banks—are less likely to experience a decline in sales growth.

Finally, our paper has important policy implications, as it provides insights into the costs of globalization during a global shock. Specifically, we document how a firm's exposure to global supply chains within its industry significantly influences its outcomes during disruptions.

2 Institutional Background

2.1 Global Supply Chain and the Reliance on Foreign Inputs

Our aim is to investigate how disruptions to the global supply chain affects firm outcome. To do so, we first measure the reliance of each firm to the GSC. We follow Krugman et al. (1995) and Timmer et al. (2014) and exploit inter-country input-output (ICIO) tables. In this approach, each industry in a country acts as an upstream supplier and provides inputs to the final product of another industry in the destination country.[3] Specifically, we measure how much an industry in a home country depends on foreign inputs using the following equation:

$$SCI_{ic} = \frac{\sum_{k \neq c}^{N} Inputs_{ik}}{Outputs_{ic}}, \tag{1}$$

where the indices i, c, and k represent the industry, home country, and sourcing country of inputs, respectively. SCI_{ic} denotes the share of total inputs that industry i in the home country c sources from all foreign countries $k \neq c$, scaled by the total output produced by industry i in the home country c.

We collect information on foreign inputs and industry outputs of 45 industries across 17 EU countries from the OECD inter-country input-output tables for 2018. Figure 2 shows that on average, to produce 1 unit of final output, each EU country in our sample needs around 0.45 to 0.75 units of input from other industries in other countries. While countries like Sweden and Norway seem to be less reliant, Belgium, Czechia, Slovakia and Bulgaria rely quite heavily on foreign inputs.

[Insert Figure 2]

[3]This methodology dates back to Leontief (1936) who shows that the complex linkages among different industries in an economy can be expressed as various inter-industry transactions into chessboard-type matrices

Table 3 decomposes the level of reliance on foreign inputs of each country into 45 industries. Overall, energy intensive industries such as the production of Coke and refined petroleum, Chemical and Chemical Products, and Manufacturing and Repairs need more foreign inputs to deliver final outputs more than other industries. Among others, Food production, Water Transportation, and Air Transportation also rely heavily on foreign inputs. On the other hand, industries such as Real estate activities and Education etc. requires less foreign inputs to produce a unit of final outputs.

[Insert Table 3]

2.2 Covid-19 and Global Supply Chain Disruptions

Researchers have previously focused on global supply chain disruptions caused by natural disasters, such as storms, earthquakes, volcanic eruptions, floods, and landslides. However, the recent COVID-19 pandemic, with its unprecedented spread and scale, has been far more disruptive than any other supply chain disruption in recent decades (Bonadio et al., 2021), prompting significant academic attention to the crisis.

Two key measures have significantly affected supply chain operations worldwide in the effort to combat the virus. First, persistent social distancing measures, and second, widespread lockdowns, particularly the closure of workplaces. These actions were implemented by nearly every country, whether severely impacted by the virus or not, in an attempt to curtail its spread. As a result, the scale of disruption caused to global supply chains has been enormous.

In this paper, we use the closure of workplaces, the Oxford stringency index, developed by Hale et al. (2021) to capture the severity of supply chain disruptions. This index varies between 0 and 100 whereby 100 represents the most restrictive lockdown of workplaces in a country. Our approach shares similarity with Ersahin et al. (2024) and Li et al. (2020). Specifically, to measure disruption, we calculate the weighted average of workplace closure stringency index of all sourcing countries that provide inputs for each industry in the home

country. To account for the differences in the importance of each sourcing country of inputs for each industry in the home country, we use the total amount of inputs provided by each sourcing country as the weight to calculate the weighted average stringency index as follows:

$$\overline{StringencyIndex}_{ict} = \frac{\sum_{k \neq c}^{N} StringencyIndex_{kt} * Inputs_{ick}}{\sum_{k \neq c}^{N} Inputs_{ick}}, \tag{2}$$

where indices i, c, k, t refer to industry, home country, sourcing country, and time, respectively. $\overline{StringencyIndex}_{ict}$ is the weighted stringency index representing the disruption in supply chain that industry i in home country c at time t faces. This index equals 0 for the year 2018 and 2019 where the pandemic has not happened. $Inputs_{ick}$ is the amount of inputs in dollars that industry i in home country c needs from the sourcing country k in 2018. $StringencyIndex_{kt}$ is the workplace closure stringency index of the sourcing country k at time t.

Figure 4 shows the heterogeneity in the workplace closure index across sourcing countries. For example, this index is 82 for China whereas it was only 23 for the United States (US) in 2020.

[Insert Figure 4]

We show that the weighted average workplace stringency index of the sourcing countries reflect supply chain disruptions since an increase in this index strongly correlates with an increase in the cost of intermediate goods (see Figure A1).

2.3 Supply chain disruptions and firm outcomes

Theories offer valuable insights into how supply chain disruptions affect firms. Hopp et al. (2008) argue that supply chain disruptions can lead to both tactical consequences (e.g., loss of short-term sales) and strategic consequences (e.g., loss of long-term market share). They model the impact of regional supply disruptions on competing supply chains and outline a two-stage generic strategy: the preparation stage, where firms identify potential supply chain

risks, and the response stage, where firms react to disruptions. The post-disruption responses outlined by Hopp et al. (2008) have important implications for our study and suggest that firms may suffer a decline in sales. Based on this, we test the following hypothesis:

H1: Firms that are more exposed to supply chain disruptions experience a significant difference in sales growth compared to firms that are less exposed to such disruptions.

Can firms mitigate the effect of supply chain disruptions? Previous literature on managing supply chain risk has focused on diversifying supply sources and frequently stress testing the supply chain risk (Chopra and Sodhi, 2004). However, the disruption during the recent pandemic is not caused by idiosyncratic shocks by some suppliers but a global systemic risk where almost all firms are hit. In such circumstances, suppliers have to choose the best customers to send their limited goods to maintain a longer term relationship and avoid delayed payments.

We focus our next analysis on the role of external finance and ask whether access to external finance can mitigate the risk of slower growth during the pandemic. Drawing from the academic literature, we propose two main channels through which external finance can affect firm outcome: debt-overhang and bank relationship. The debt-overhang literature have shown how firms who are heavily indebted can suffer in a downturn (Lamont, 1995). The intuition for this is that the cost of obtaining external funds for these firms can be counter-cyclical and become extreme when a crisis is expected, reducing the likelihood of them to raise external funds.

In contrast, the bank relationship literature suggests that banks stick with their best performed customers in time of crises because they learn about firm types during normal times. Bolton et al. (2016) shows that bank relationship is more favorable for firms in crisis times than transaction banks provided these firms are profitable. Bank relationship tend to compensate for this by charging higher intermediation spreads during normal times compared to transaction banks. We expect firms relying on bank relationship to be more exposed to risks in business cycle and to have a riskier cash flow. This implies that these

firms can pay higher interest rates on their relationship loans in normal times in order to secure longer continuation of financing during a crisis. Moreover, the most notable is the effort of policy makers around the world to limit the financial consequences for firms during the Covid-19 crisis and this credit has been provided to firms through bank lending channels. Li et al. (2020) show that firms in the advent of the COVID-19 crisis, demand massive cash to pay their employees, suppliers, and creditors and draw up all credit lines they have with banks. Putting this together, we test the following hypothesis:

H2: External finance does not mitigate the effect of SCD

Rejecting this null hypothesis means that our result is in line with the uniqueness of bank relationship lending while accepting it supports the findings of the debt overhang literature. On one hand, obtaining credit from banks may give firms, especially smaller and new firms, a reputation advantage because it signals the creditworthiness of firms and their payment ability. James (1987) document a positive effect of obtaining bank loans on firm stock performance. On the other hand, firms with higher debt level reduce their investment more than other firms which makes it less likely to obtain external funds (Kalemli-Özcan et al., 2022; Hennessy, 2004; Myers, 1977). We acknowledge that bank relationship can take different forms and interconnected roles: better screening abilities of new loan applications Puri et al. (2011); better monitoring role Hauswald and Marquez (2003), Boot and Thakor (2000); insurance against risk of future credit terms Berlin and Mester (1999).

3 Data, Sample, and Descriptive Statistics

3.1 Data and Sample

Firm-level data: Our main data source is from the Bureau Van Dijk Amadeus which contains annual financial information, stock prices, ownership, and subsidiaries information

for 95% of all public and private companies in European countries. We obtain firm information for 17 EU countries for three years between 2018 and 2020. As our main variable of interest is firm sales growth, we require that all firms in our sample report firm sales in all three years (2018, 2019 & 2020). For ease of comparability, we keep only firm information that trades in Euros. Through the Standard Industrial Classification (SIC) codes, we identify the industry classification of the firms. Thus, we remove firms with no industry identification. In total, there were 2,284,565 firms. In our baseline, we controlled for differences in firm characteristics across the time period. After this process, we obtain the final dataset for 1,605,007 firms (4,611,717 firm-year observations). This approximates to about 70% of all firms reported in Amadeus.

Supply chain linkages data: This is collected from the OECD, Inter-Country Input-Output (ICIO) table of 2018. In total, the ICIO covers 45 sectors and 66 sourcing countries. In this table, we are able to extract information on how much inputs each industry in an EU country needs from another industry in another country. We scale these foreign inputs by the total output from each industry in the home countries (supply chain intensity). We construct our measure of highly exposed firms as firms that belongs to industries whose supply chain intensity exceeds the 75th percentile of all industries within a country.

Based on each firm's industry and location, we match the firm data with the OECD inter-country input-output tables on how much its industry uses foreign inputs to produce total final output.

Data on disruptions to the supply chains: This is measured by the Oxford stringency index developed by Hale et al. (2021). We collect daily data from Hale et al. (2021) and calculate the mean of stringency index in 2020 for all countries to merge it to our yearly firm level data. The stringency index is a composite measure based on nine response indicators including school closures, workplace closures, cancellation of public events and travel bans, rescaled to a value from 0 to 100 with 100 as the strictest measure. Since we focus on the disruptions in the production of intermediate goods, we employ only the workplace closure

stringency indexes for the main analysis.[4] We calculate the weighted average of the stringency index for all countries using the input amount from each country as weights. We treat the stringency index in 2018 and 2019 as 0 because no workplace closure has taken place in these two years.

Treated and Control groups are based on the supply chain intensity (SCI) of each industry in a home country. We classify treated firms as firms that belong to an industry that relies heavily on foreign inputs (highly exposed firms) and control firms as firms that belong to a less exposed industry (lowly exposed firms). Highly exposed industries are industries with SCI above the 75th percentile of all industries in a country and lowly exposed industries are ones with SCI below the 75th percentile. Later on, instead of using the dummy for treated and control firms, we check the sensitivity of the results by using the continuous measurement of SCI. We use the 2018 pre-pandemic data to measure the SCI to reduce endogeneity concerns because we will not capture changes in firms' sales growth due to changes in the way each industry in a country sources their inputs in response to the pandemic.

3.2 Descriptive Statistics

Table 1 presents the summary statistics for our main variables, with detailed variable definitions provided in Table A1. Merging all primary data sources results in a final sample of 4,611,717 firm-year observations. On average, annual sales growth for EU firms is approximately 3.9%. The distribution of firm sales, as shown in Figure A2, indicates that the majority of firms in our dataset are small and medium-sized, with total sales of less than 2 million EUR. Additionally, Table A2 reports the number of active firms in each EU country from Amadeus included in our final dataset. On average, annual growth rates are as follows: profit margin (5.8%), employment (6%), and investment (30%).

For our main variable of interest, High exposure, we find that 16.8% of firms belong to the highly exposed group, with a standard deviation (SD) of 0.374. The continuous measurement

[4]Unreported analyses using the overall stringency index based on nine different responses of a country during the pandemic do not change our findings.

of the Supply Chain Integration (SCI) variable averages 0.487, with an SD of 0.151. The stringency index, measured as the weighted average of the workplace closure index, has a mean value of 18.219. At the home-country level, the weighted average of the workplace closure index is slightly higher, with a mean of 18.376. To address concerns regarding outliers, all firm-level variables are winsorized at the 1st and 99th percentiles.

[Insert Table 1]

4 Identification strategy and Empirical results

To test our first hypothesis, we employ a difference-in-differences (DiD) estimation to establish a causal relationship between supply chain disruptions and firm sales growth. We estimate the following equation:

$$\begin{aligned} Y_{fict} = \beta_1 HighlyExposed_{ic} \times \overline{StringencyIndex_{ict}} + \beta_2 \overline{StringencyIndex_{ict}} \\ + \gamma_1 C_{ct} + \gamma_2 F_{ft} + \zeta_f + \zeta_{it} + \varepsilon_{fict}, \end{aligned} \tag{3}$$

where Y_{fict} is the growth rate of firm sales for firm f in industry i locating in home country c at time t. $HighlyExposed_{ic}$ is a dummy variable that equals 1 if the SCI of its industry exceeds the 75th percentile in the distribution of SCI in the home country c in 2018. $\overline{StringencyIndex_{ict}}$ is the Weighted Average of the workplace closure index at time t of all sourcing countries that provide goods to industry i in home country c with the amount of inputs from each sourcing country used as weights as in Equation (2). C_{ct} is a vector of home country characteristics including work place closure index of the home country c at time t. F_{ft} is a vector of firm characteristics which includes total assets, ROA, leverage ratio, solvency ratio and liquidity ratio.

We saturate the equation with firm fixed-effects ζ_f to control for factors that are firm specific and time invariant. We also control for industry-time fixed-effects, ζ_{it}, for industry specific factors that vary over time. We cluster our standard errors at the firm level.

The main coefficient of interest is β_1 which shows whether highly exposed firms to SCD caused by the pandemic experienced lower sales growth compared to lowly exposed firms. Since our variation in treatment status comes from the industry level and the supply chain disruptions are from cross-industry, cross-country, and cross-time variation, we are not able to comment in details about the effect across firm characteristics at this stage. For example, both BMW and Volkswagen in Germany would face the same level of supply chain disruptions in our settings because they both have the headquarters in Germany and belong to the Automobile industry.

In the next step, we investigate the heterogeneity in our findings based on firms' access to external finance. In particular, to test the second hypothesis, we collect information on firm's total leverage, the amount of bank debt and non-bank debt. We do this by interacting the continuous variable of our measure of external finance to our baseline model as in Equation (4).

$$\begin{aligned} Y_{fict} = {} & \alpha_1 HighlyExposed_{ic} \times Exfin_{ft} \times \overline{StringencyIndex_{ict}} + \alpha_2 \overline{StringencyIndex_{ict}} + \alpha_3 Exfin_{ft} \\ & + \alpha_4 \overline{StringencyIndex_{ict}} \times Exfin_{ft} + \alpha_5 HighlyExposed_{ic} \times \overline{StringencyIndex_{ict}} \\ & + \alpha_6 HighlyExposed_{ic} \times Exfin_{ft} + \gamma_1 C_{ct} + \gamma_2 F_{ft} + \zeta_f + \zeta_{it} + \varepsilon_{fict}, \end{aligned} \tag{4}$$

Our main variable of interest, α_1, captures the effect of disruptions—measured by the Weighted Average of the workplace closure index—on firm sales growth, conditional on firms' exposure to the global supply chain (GSC) and their access to external finance. Furthermore, we examine the role of bank relationships by analyzing how disruptions impact the sales growth of highly exposed firms that have greater access to bank debt. For this analysis, we utilize data from Amadeus Banker, which provides information on the number of banks from which these firms obtain credit.

4.1 Parallel trends

Critical to our identification strategy is the exogeneity of the pandemic with respect to firm sales growth. Since the pandemic is an unprecedented event, it is plausible that firms are caught by surprise with the disruptions of intermediate goods from sourcing countries. However, the validity of our DiD design still depends on the assumption that the treated and control groups would follow the same trend in the absence of treatment. Using information on firm characteristics on the pre-shock year of 2018, we follow the approach by Imbens and Wooldridge (2009) and calculate the normalized differences by treatment status in various firm characteristics. As suggested by Imbens and Wooldridge (2009), an absolute normalized difference smaller than 0.25 indicates that there is no significant difference between treated and control groups. Table 2 shows that highly and lowly exposed firms are not significantly different in firm size, return on total assets, leverage ratios, solvency ratios, and liquidity ratios before the shock.

[Insert Table 2]

5 Evidence on the effect of supply chain disruptions

5.1 Baseline results

Table 3 presents the estimate of equation (3) using firm sales growth as the dependent variable. We first present the result without any control variables in Column 1. Column 2 includes the firm control variables. We exclude the year 2019 from our sample in Column 3 and 4 because China started some measurements to contain the Covid-19 virus in the last month of 2019 and no data is available to sufficiently measure the workplace closure at that time. We perform a collapsed DiD in Column 5 and 6 where we take the difference of all variables between 2020 and 2018 and run a cross-sectional regression analysis. Taking these

differences mean we effectively control for all differences in firm characteristics over time and the coefficient β_1 shows the effect of supply chain disruptions on firm sales growth.

[Insert Table 3]

Across all specifications, we find strong evidence on the effect of global supply chain disruptions. An one standard deviation (26.6) increase in the workplace closure stringency index of a sourcing country reduces the sales growth of highly exposed firms in the home country by 0.5 percentage points (p.p.) (26.6*0.02) compared to lowly exposed firm. To understand the economic magnitude, we compare the estimated coefficient with the average sales growth of lowly exposed firms which is 3.2% in our sample and find that our estimated coefficient represents a 16% decline in firm sale growth of highly exposed firms, relative to the counterfactual. This effect decreases only moderately when we control for the firm characteristics suggesting that our findings are unlikely to be biased by omitted variables. To some extent, our result is inline with Bonadio et al. (2021) who find that the pandemic at home country causes on average 29.6% GDP drop whereas around 23.3% of the contraction of GDP comes from foreign shocks. Our result is different in the sense that we zoom in the shrink of the economy to the firm level and focus more on the foreign shocks. In column 3 and 4, we exclude the year 2019 from the sample, given that some countries like China have imposed some Covid restrictions in 2019 which is not sufficiently captured in our data. Our results are robust to this change.

[Insert Table 4]

Table 4 shows that using a continuous treatment measure where GSC is measured by the firms' SCI does not change our findings. An one SD increase in the workplace closure stringency index in a sourcing country reduces the sales growth rate of firms in the home country with 1 SD higher in SCI by 0.15 p.p.[5]

[5] 1 SD of the workplace stringency index is 26.6 and 1 SD of the SCI is 0.151 (or 15.5%). Thus, the coefficient on Column 1 of Table 3.4 implies (-0.0375)*26.6*0.15 = -0.15 p.p change in sales growth of a firm operating in an industry with 1 SD higher in SCI when a sourcing country increases its workplace closure index by 1 SD.

5.2 The role of external finance

Next, we ask whether external finance can mitigate the risk of slower growth for highly exposed firms during the pandemic.

[Insert Table 5]

In Table 5, we approach this by interacting the external finance measure which varies at the firm-level to our exposure and disruption measure. In column 1, we use the firm's total leverage and examine whether the effect of supply chain disruptions vary with the level of a firm's leverage ratio. The study reveals that firms with a higher leverage ratio suffer less from SCD. An one SD increase in the workplace closure stringency index raises sales growth of highly exposed firms that have total leverage ratio by 0.8 p.p, ceteris paribus. This result is counter-intuitive from the first impression because highly leveraged firms may be ones that are more risky. However, several studies suggest that leverage increases growth of firms with good investment opportunities (Aivazian et al., 2005; Lang et al., 1996).

In column 2, we examine whether bank debt helps firms to mitigate the effect of supply chain disruptions. Our result shows that an one SD increase in workplace closure stringency index leads to about 1.03 p.p. increase in sales growth of highly exposed firms if their bank debt ratios increase by 1 p.p. We view our results as an evidence for the uniqueness of bank loans as in Diamond (1991); James (1987), and Johnson (1998). Column 3 of Table 5 reveals that other forms of external finance that are not bank debt do not mitigate the effect of supply chain disruptions.

We go one step further to investigate the positive effect of bank debt by using information on bank-firm relationships from Amadeus Banker. While we do not have complete information on bank-firm links for all firms in the data set, our results still provide some insights into the effect of bank relationship. Specifically, we test whether firms with multiple bank relationships benefit more compared to firms that have relationship with only one main bank. We find evidence of a bank relationship. This echoes the findings of Bolton et al. (2016)

that bank relationship tend to protect their clients in an economic downturns and effectively, given banks entered the crisis with a larger equity capital cushion (Li et al., 2020). Our result suggests that most of our sampled firms could be solvent and as such are able to obtain loan from banks during the downturn.

In a bid to further examine the role of banks, we test if we find any heterogeneous effects depending on whether firms are financially constrained (see Table 6). Boissay and Gropp (2013) document empirical evidence that credit constrained firms that face liquidity shocks are more likely to default on their payments to suppliers. We examine the firm's financial constraint by using three major indexes which includes: Kaplan and Zingales index (KZ index), Whited-Wu index (WW index), and Hadlock and Pierce index (SA index). We use the median measure to split the sample of financially constrained firms. This means that constrained firms are those firms whose index exceeds the median measure of the whole sample. Unconstrained firms, in contrast, are below this median measure.

[Insert Table 6]

In column 1 and 2 of table 6, we found evidence that both firms are able to mitigate the shock using the K-Z index. However, in column 3 and 4, where we adopted a different measure of financial constraint, we found evidence that unconstrained firms are able to mitigate the effect of the disruption. We also used a more conservative measure proposed by Hadlock and Pierce (2010). Taken together, the study found evidence that firms which are not constrained financially are able to mitigate the shock compared to firms which are financially constrained. This could mean that these firms are less likely to default on their payments to suppliers and as such they are able to obtain bank loans. We also check for qualitative similarity with our baseline result. Our result show that firms faced with financial constraint were also affected by the disruption (Table A4).

6 Further findings

6.1 Diversification and distance

We additionally examine several ways firms can improve resilience to the supply chain disruption: diversification in the source of intermediate goods to produce final outputs and transportation cost. The diversification measure was measured by the Herfindahl-Hirschman Index (HHI) which shows the level of input market concentration for each sector. Specifically, the higher the HHI, the lower the diversification in the source of inputs from sourcing countries that an industry in the home country has. We define diversified firms as firms with HHI of its industry below the median within the country. In Column 1 of Table 7, we find evidence that more diversification among our sampled firms can provide resilience to supply chain disruption. This result suggests that while there is substantial evidence on the effect of supply chain disruption, having a broader network of suppliers from a number of countries reduces the effect of a global disruption. Miroudot (2020) finds that firms with multiple supplier sources were less affected by pandemic-related shocks than firms heavily reliant on a single country (e.g., China).

Next, we proxy transportation costs by the distance between a sourcing country and the home country. Column 2 show that firms that source their inputs from countries more distant from them are more vulnerable to the supply chain disruption.

[Insert Table 7]

In column 3-5 of Table 7, we examine the effect of countries that are a strong participant in the supply chain. Barrot and Sauvagnat (2016) show that firms reliant on specific (non-substitutable) suppliers suffer more when their suppliers face shocks, leading to persistent output declines. Among 66 sourcing countries, Russia, USA, and China are three most important countries that provide intermediate goods to the EU. We then regress the workplace closure stringency index of these countries separately and see how supply chain

disruption from these countries affects firm sales growth. Column 3-5 of Table 7 shows that one SD increase in workplace closure stringency index of China leads to 0.12 p.p. decline in sales growth for treated firms compared to the control firms. Column 4 and 5 also show that supply chain disruptions caused by workplace closure in Russia and the USA significantly reduces sales growth of firms in the EU. Given the current Russia-Ukraine war and the trade tension between the US and China, our results shed light to the issues of supply chain disruptions caused by these events.

6.2 The effect on firm profitability, employment and investment

Next, we examine the effect of supply chain disruptions on other firm outcomes, namely, profitability, employment and investment. In addition to the firm sales growth, we show that the disruption affects firm profitability, employment and investment based on their exposure to the GSC. We consider two measures for profitability: profit margins and return on total assets (ROA). Our result show that the disruption also affects firm profitability. Specifically, an increase in the workplace stringency index of a sourcing country reduces the profit margin of highly exposed firms in the home country. In terms of magnitude, the result becomes stronger when we include the control variables. Similarly, we also observe that the disruption also affects the firm's ROA.

We examine firm employment by the growth in the number of employees for each firm in a given year. We find that an one S.D.increase in the workplace closure stringency index of a sourcing country reduces employment growth rates of highly exposed firms by 0.43 p.p compared to lowly exposed firms. The decline increases moderately when the control variables were included.

Following Lenarčič and Papadopoulos (2020), we examine firm investment as the annual change in capital stock which is the sum of the firms' tangible and intangible assets minus depreciation. We also obtain similar result for firm investment growth for highly exposed

firms. Taken together, our result suggests that firm outcomes are negatively affected by the global SCD during the pandemic.

[Insert Table 8]

7 Robustness checks

7.1 Falsification Tests

We implement several falsification tests where we assume the pandemic would have happened prior to 2020. Table 9 shows that sales growth in earlier years did not respond to the workplace closure stringency index of 2020. This confirms that our previous findings capture the causal effect of supply chain disruption on firm sales growth.

[Insert Table 9]

7.2 Effect of workplace stringency index in the home country

Here, we show that the decline in firm outcomes that we observed from the result are as a result of the supply chain disruptions in the sourcing countries and not merely from the home country alone. We do this by modifying the measure of disruptions in two ways: First, we replaced the workplace closure stringency index in the sourcing countries with workplace stringency index in the home country alone so that the variations are coming from the home country sectors (see column 1 and 2 of table 10). Secondly, we also examine the disruption measure using a yearly dummy that equals one for the disruption year (2020) and, 0 otherwise (columns 3 and 4). Our result shows that this workplace closure stringency index in the home country affects firm sales growth in the home country. However, we do not find any significant result when we include the firm controls. This result could imply how global disruptions were able to significantly affect firm sales growth in the home country. In addition, when we include a set of yearly dummies as a disruption measure, we see that the

result turned positive. However, when we include the firm controls, we found a statistically significant effect of the disruption on the sales growth of highly exposed firms.

[Insert Table 10]

Taken together, we show that the decline in firms' sales growth are the result of the global disruption across many sourcing countries industry which our home country industry are dependent upon for producing final outputs.

7.3 Maximum stringency index on workplace closure

We also consider when the government of the sourcing countries imposed the highest stringency on workplace in our sample. This will enable us to gauge the effect of the disruption. For example in countries like India where the highest workplace stringency index is 100 and 31.48 in Taiwan. This measure differs somewhat relatively when we use the median measure which are 66 and 25 for India and Taiwan respectively. The baseline result of our study is also consistent when we include the maximum level of workplace closure stringency index across the sourcing country

[Insert Table 11]

8 Conclusion

This paper presents a micro-level evidence that supply chain disruptions at the global level negatively affects firm sales growth. When a country of suppliers implement workplace closure measures, firms that belong to an industry that relies more on foreign inputs suffer 16% decline in sales growth compared to the counterfactual. This first order effect of supply chain disruption supports the findings in the macroeconomic literature on the shrinking of economies during the pandemic such as in Bonadio et al. (2021).

We also found that bank debt plays an important role in mitigating the effect of supply chain disruptions particularly for financially unconstrained firms. We link our findings to the literature on the uniqueness of bank loans for small and solvent firms. We found evidence for the bank relationship channel which means that firms with bank relationship mitigates the effect of the disruption compared to those that do not. Intuitively, firms that have access to external finance, particularly ones that receive loans from banks benefit during the pandemic because these external finance channels may signal their reputation and make firms appear more credible to their suppliers.

We also show that firms which are less concentrated in their sources of foreign inputs and firms that source their inputs from less distant partners are more resilient to the disruption.

Our findings are applicable beyond the scope of the pandemic and show how vulnerable EU firms are to disruptions in trade partners in other parts of the world. We also point out which firm characteristics could help to mitigate the effect of a global supply shock.

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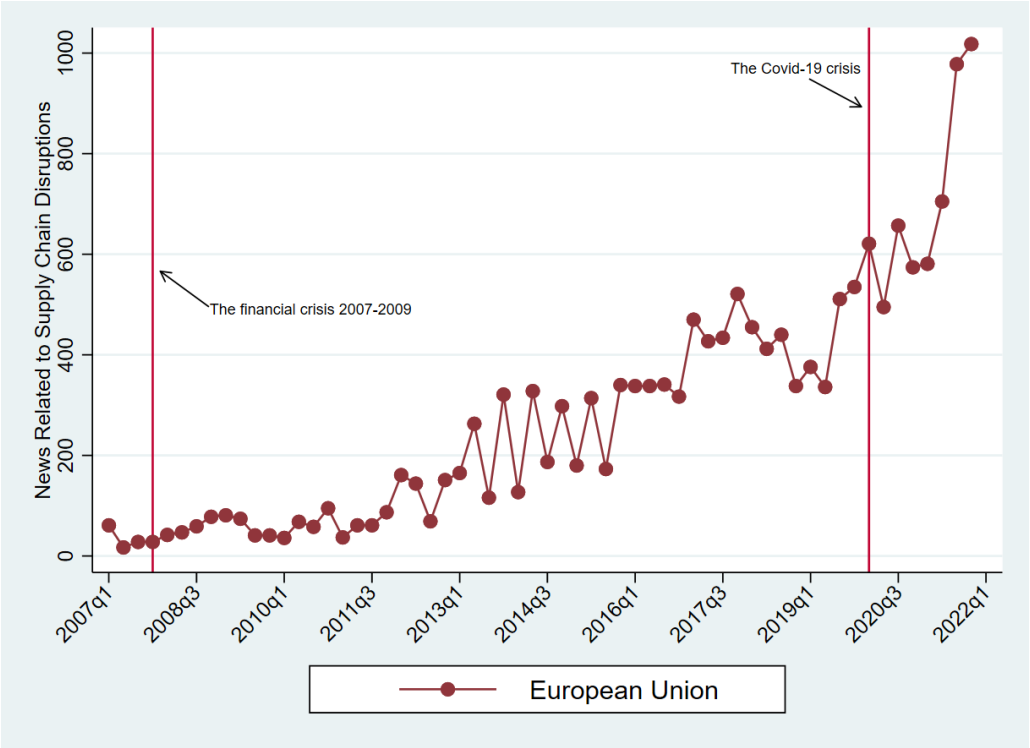
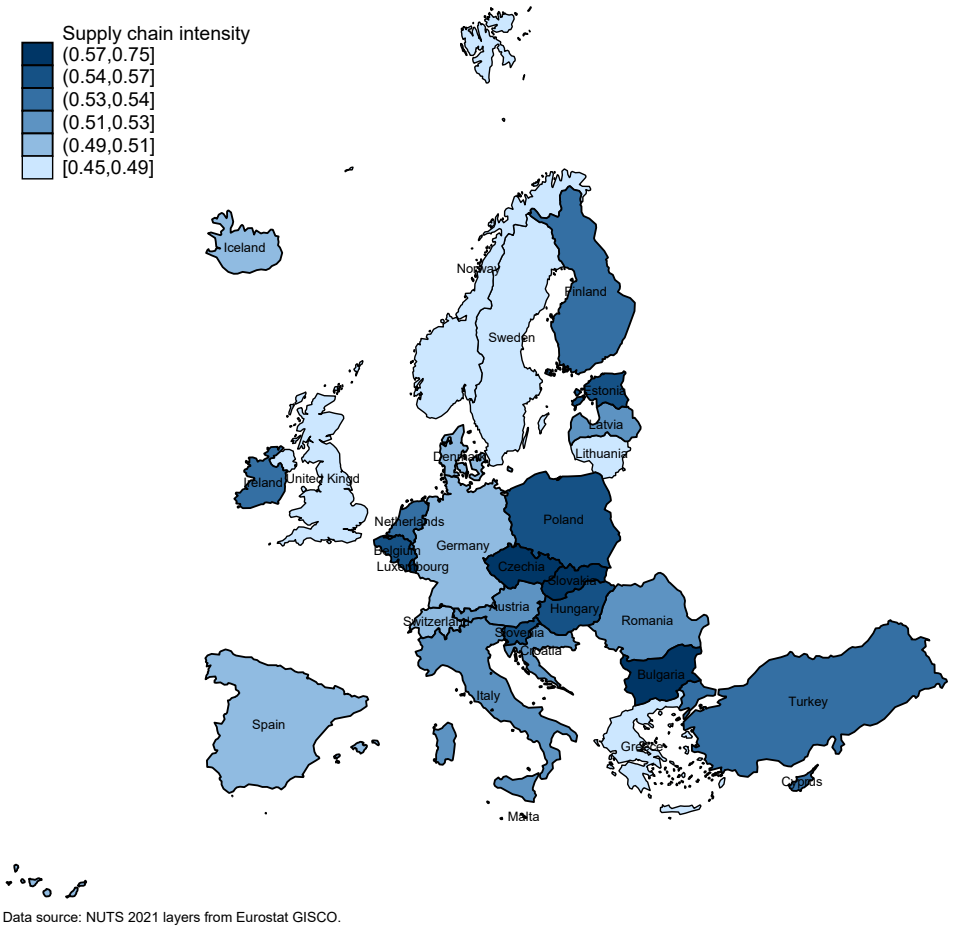
Figure 1: Bad news related to supply chain disruptions



Source: Reprisk and Authors' own calculation (2022)
Notes: This figure shows the number of news related to supply chain disruption issues for EU firms between 2007Q1 and 2022Q1. The data is collected from Reprisk.

Figure 2: Intensity of European countries' exposure to the global supply chain



Source: Authors' own calculation (2022)
Notes: Supply chain intensity is measured by the total amount of input a given country uses from other countries scaled by the total output of that country.

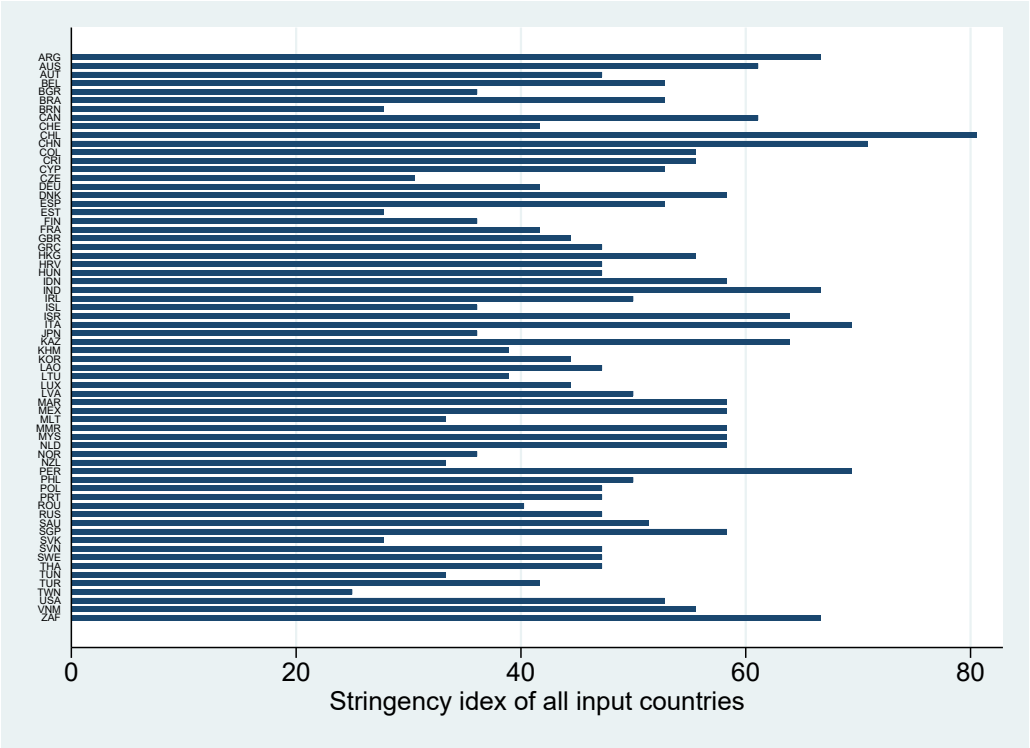
Figure 3: Heatplot: Supply chain intensities among country-industry

S/N	Sector name	Austria	Belgium	Estonia	Finland	France	Germany	Greece	Italy	Latvia	Lithuania	Luxembourg	Malta	Netherlands	Portugal	Slovakia	Slovenia	Spain
1	Agriculture, hunting, forestry	0.56	0.76	0.66	0.48	0.57	0.59	0.48	0.43	0.64	0.61	0.70	0.47	0.60	0.54	0.52	0.50	0.44
2	Fishing & aquaculture	0.68	0.71	0.55	0.46	0.71	0.43	0.31	0.46	0.41	0.66	0.00	0.89	0.40	0.40	0.57	0.67	0.46
3	Min. and quarry, energy producing prod.	0.39	0.00	0.46		0.13	0.73	0.39	0.65	0.63	0.52		0.74	0.26	0.00		0.38	0.12
4	Min. & quarry, non-energy producing prod.	0.59	0.70	0.46	0.60	0.64	0.32	0.41	0.11	0.56	0.56	0.57	0.52	0.62	0.52	0.61	0.69	0.57
5	Mining support service	0.40	0.87	0.50	0.62	0.10	0.28	0.49	0.10	0.77	0.34	0.58	0.36	0.55	0.74	0.20	0.76	0.62
6	Food products, beverages and tobacco	0.72	0.81	0.76	0.76	0.73	0.75	0.66	0.80	0.73	0.63	0.72	0.67	0.77	0.76	0.73	0.70	0.79
7	Textiles, textile products, etc.	0.66	0.71	0.67	0.59	0.70	0.66	0.69	0.70	0.55	0.47	0.74	0.66	0.68	0.63	0.57	0.68	0.53
8	Wood and wood products	0.72	0.73	0.76	0.79	0.71	0.71	0.72	0.67	0.72	0.61	0.82	0.58	0.67	0.71	0.55	0.66	0.72
9	Paper products and printing	0.67	0.71	0.70	0.75	0.66	0.68	0.66	0.71	0.66	0.58	0.82	0.62	0.70	0.73	0.71	0.72	0.69
10	Coke and refined petroleum products	0.83	0.95	0.72	0.93	0.87	0.92	0.95	0.94	0.63	0.93	0.00	0.90	0.96	0.93	0.91	0.79	0.92
11	Chemical and chemical products	0.81	0.72	0.73	0.72	0.71	0.66	0.59	0.78	0.72	0.73	0.73	0.63	0.77	0.83	0.70	0.72	0.77
12	Pharma., med-chemical and botanical prod.	0.50	0.72	0.52	0.29	0.54	0.54	0.57	0.67	0.56	0.38	0.77	0.83	0.54	0.56	0.60	0.54	0.54
13	Rubber and plastics products	0.62	0.72	0.71	0.66	0.65	0.64	0.67	0.71	0.69	0.60	0.94	0.50	0.67	0.70	0.69	0.65	0.70
14	Other non-metallic mineral products	0.61	0.66	0.65	0.64	0.67	0.62	0.58	0.67	0.62	0.57	0.75	0.77	0.66	0.65	0.65	0.63	0.70
15	Basic metals	0.74	0.86	0.95	0.82	0.79	0.78	0.76	0.85	0.96	0.70	0.85	0.44	0.74	0.83	0.77	0.82	0.80
16	Fabricated metal products	0.61	0.70	0.69	0.65	0.63	0.58	0.63	0.63	0.64	0.61	0.65	0.70	0.65	0.64	0.63	0.60	0.69
17	Computer, electronic equipment	0.59	0.61	0.89	0.62	0.54	0.53	0.59	0.63	0.68	0.49	0.48	0.75	0.86	0.79	0.87	0.59	0.61
18	Electrical equipment	0.58	0.67	0.71	0.67	0.68	0.57	0.72	0.72	0.66	0.64	0.79	0.71	0.61	0.76	0.73	0.70	0.75
19	Machinery and equipment, nec	0.62	0.65	0.68	0.66	0.69	0.61	0.57	0.70	0.57	0.56	0.71	0.78	0.63	0.67	0.71	0.68	0.67
20	Motor vehicles, trailers & semi-trailers	0.77	0.83	0.74	0.66	0.81	0.66	0.57	0.78	0.70	0.66	0.77	0.57	0.82	0.84	0.88	0.80	0.82
21	Other transport equipment	0.68	0.61	0.70	0.78	0.80	0.70	0.37	0.73	0.63	0.58	0.72	0.63	0.82	0.76	0.73	0.70	0.72
22	Manufacturing, repairs etc.	0.62	0.66	0.68	0.58	0.59	0.59	0.50	0.65	0.58	0.54	0.57	0.57	0.55	0.60	0.62	0.57	0.54
23	Electricity, gas, steam etc.	0.81	0.59	0.55	0.56	0.69	0.60	0.53	0.72	0.68	0.64	0.70	0.88	0.54	0.71	0.81	0.53	0.62
24	Water supply; sewerage etc.	0.58	0.65	0.59	0.55	0.60	0.53	0.41	0.61	0.50	0.47	0.49	0.58	0.61	0.63	0.52	0.73	0.59
25	Construction	0.61	0.72	0.64	0.61	0.61	0.55	0.67	0.65	0.72	0.47	0.61	0.70	0.70	0.64	0.59	0.67	0.55
26	Wholesale and retail trade	0.44	0.50	0.48	0.47	0.51	0.42	0.43	0.48	0.44	0.27	0.62	0.39	0.44	0.41	0.49	0.46	0.41
27	Land transport & pipelines	0.47	0.61	0.64	0.55	0.52	0.52	0.50	0.53	0.62	0.51	0.35	0.77	0.60	0.59	0.56	0.64	0.56
28	Water transport	0.93	0.70	0.79	0.74	0.91	0.76	0.70	0.71	0.53	0.41	0.70	0.87	0.70	0.77	0.67	0.57	0.66
29	Air transport	0.74	0.86	0.99	0.71	0.68	0.72	0.72	0.75	0.78	0.86	0.75	0.88	0.69	0.79	0.90	0.93	0.75
30	Warehousing & transportation support	0.41	0.62	0.68	0.67	0.54	0.63	0.44	0.55	0.70	0.48	0.53	0.57	0.51	0.54	0.62	0.55	0.58
31	Postal and courier activities	0.53	0.55	0.61	0.48	0.33	0.60	0.45	0.55	0.56	0.46	0.53	0.83	0.68	0.50	0.54	0.44	0.52
32	Accommodation and food service	0.37	0.58	0.60	0.58	0.47	0.49	0.46	0.47	0.54	0.39	0.50	0.60	0.50	0.43	0.45	0.53	0.45
33	Publishing, & broadcasting	0.58	0.59	0.52	0.56	0.55	0.56	0.62	0.63	0.51	0.70	0.77	0.69	0.72	0.59	0.56	0.60	0.56
34	Telecommunications	0.53	0.53	0.51	0.46	0.54	0.60	0.50	0.54	0.54	0.41	0.70	0.60	0.48	0.56	0.43	0.61	0.57
35	IT & other information services	0.50	0.52	0.41	0.49	0.40	0.42	0.41	0.48	0.33	0.39	0.89	0.65	0.54	0.44	0.48	0.45	0.53
36	Financial and insurance activities	0.49	0.52	0.38	0.52	0.64	0.55	0.25	0.44	0.43	0.40	0.86	0.90	0.43	0.41	0.48	0.41	0.43
37	Real estate activities	0.33	0.26	0.32	0.26	0.17	0.24	0.10	0.13	0.25	0.29	0.34	0.40	0.45	0.13	0.29	0.17	0.15
38	Professional, & scientific activ.	0.49	0.52	0.49	0.44	0.53	0.44	0.41	0.41	0.39	0.41	0.55	0.66	0.52	0.53	0.51	0.48	0.47
39	Administrative and support services	0.34	0.47	0.44	0.41	0.41	0.40	0.55	0.53	0.50	0.45	0.75	0.56	0.41	0.37	0.54	0.42	0.44
40	Public admin. & defence; compul social sec	0.34	0.26	0.32	0.48	0.27	0.34	0.18	0.31	0.27	0.28	0.26	0.38	0.39	0.24	0.29	0.33	0.26
41	Education	0.18	0.14	0.27	0.29	0.18	0.21	0.10	0.17	0.25	0.17	0.13	0.15	0.23	0.12	0.23	0.23	0.15
42	Human health and social work activities	0.33	0.44	0.37	0.38	0.24	0.31	0.30	0.42	0.33	0.27	0.26	0.37	0.29	0.41	0.37	0.37	0.33
43	Arts, entertainment and recreation	0.36	0.58	0.55	0.55	0.46	0.36	0.41	0.60	0.44	0.39	0.52	0.78	0.51	0.51	0.80	0.53	0.40
44	Other service activities	0.37	0.53	0.56	0.50	0.39	0.28	0.48	0.38	0.46	0.35	0.38	0.45	0.43	0.40	0.43	0.51	0.32
45	Activities of households as employers		0.00	0.00	0.00		0.00		0.00	0.00					0.00		0.00	0.00

Source: Authors' own calculation (2022)

Notes: The amount of input is scaled by the total output from each industry in the home country. 0 represents less supply chain intensity while 1 represents higher supply chain intensity.

Figure 4: Workplace closure stringency index in 2020



Source: OxCGRT (2020).
Notes: The index is a construct measure based on government stringency towards workplace closures normalised to a value ranging from 0 to 100 (100 = strictest). A higher score indicates a stricter response (i.e. 100 = strictest response).

Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Dependent variable					
Sales growth (%)	3.872	37.958	-66.857	110.553	4,611,717
Profit margin (%)	5.789	19.895	-72.36	79.320	4,401,523
Employment (%)	6.01	35.64	-66.667	200	3,105,890
Investment (%)	30.06	281.503	-877.677	2106.315	3,771,085
Firm characteristics					
Ln(assets)	13.304	1.893	7.363	18.357	4,611,717
ROA (%)	5.013	15.756	-63.68	68.75	4,611,717
Solvency ratio	38.143	32.212	-65.09	100	4,611,717
Leverage ratio	0.528	0.321	0	5.292	4,611,717
Liquidity ratio	0.187	0.217	0	0.999	4,611,717
Bank debt	0.044	0.098	0	0.690	4,575,014
Non-bank debt	0.365	0.287	0	3.983	4,575,014
Firms financial constraint					
Kaplan & Zingales index	24.277	119.996	-306.096	973.906	3,642,158
Whited & Wu index	-0.05	1.328	-5.759	3.584	3,954,165
Hadlock & Pierce index	-2.773	0.815	-35.311	1.041	4,589,808
Supply chain link					
Supply chain intensities	0.487	0.151	0.097	0.96	4,611,717
High exposure	0.168	0.374	0	1	4,611,717
Diversification	0.453	0.498	0	1	4,611,717
Distance	0.442	0.497	0	1	4,611,717
Pandemic country characteristics					
Stringency index	18.219	26.593	0	68.09	4,611,717
Stringency index (home)	18.376	27.099	0	69.444	4,611,717
Bank-Firm link					
Bank relationship	1.566	0.941	1	14	576,158

Notes: This table provides summary statistics of all variables used in the empirical analysis. All the variables are constructed over the full sample period. All the firm variables are winsorised at 1th and 99th percentile. See Table A1 for variable definitions.

Table 2: Parallel Trend Tests

	Treated		Control		
Variables	Mean	SD	Mean	SD	ND
Firm assets (Ln)	13.087	2.258	12.692	2.095	0.13
ROA	5.700	17.306	5.586	18.289	0.00
Leverage ratio	0.628	0.619	0.620	0.664	0.01
Solvency ratio	40.459	33.396	40.340	35.447	0.00
Liquidity ratio	0.184	0.221	0.205	0.244	-0.07

Notes: This table shows whether highly exposed firms (treated firms) are significantly different from lowly exposed firms (control firms) before the pandemic. ND represents normalised difference. Imbens and Wooldridge (2009) suggests that a ND of more than 0.25 shows a significant difference between treated and control group. See Table A1 for variable definitions.

Table 3: Baseline result

Dependent variable: Sales growth(%)

	(1)	(2)	(3)	(4)	(5)	(6)
	2018 to 2020	2018 to 2020	2018 & 2020	2018 & 2020	2020-2018	2020-2018
Stringency index	-0.1742***	-0.2765***	-0.2261***	-0.1253***	-0.2261***	-0.1253***
	(0.0034)	(0.0396)	(0.0040)	(0.0466)	(0.0040)	(0.0466)
High exposure×Stringency index	-0.0181***	-0.0090***	-0.0237***	-0.0140***	-0.0237***	-0.0140***
	(0.0033)	(0.0031)	(0.0039)	(0.0037)	(0.0039)	(0.0037)
Ln(assets)		11.9431***		7.7657***		7.7657***
		(0.1140)		(0.1303)		(0.1303)
ROA		0.8608***		0.8201***		0.8201***
		(0.0025)		(0.0032)		(0.0032)
Solvency ratio		-0.2678***		-0.2237***		-0.2237***
		(0.0039)		(0.0047)		(0.0047)
Leverage ratio		11.4354***		12.6420***		12.6420***
		(0.3402)		(0.4214)		(0.4214)
Liquidity ratio		7.8335***		2.1214***		2.1214***
		(0.2571)		(0.3184)		(0.3184)
Stringency at home		0.0881***		-0.0750*		-0.0750*
		(0.0333)		(0.0392)		(0.0392)
Observations	4,611,717	4,611,717	2,888,554	2,888,554	1,444,277	1,444,277
R-Squared	0.3998	0.4516	0.5631	0.6001	0.0330	0.1147
Firm F.E.	Yes	Yes	Yes	Yes	-	-
Industry*Time F.E.	Yes	Yes	Yes	Yes	-	-
Controls	No	Yes	No	Yes	No	Yes
Clustering	Firm	Firm	Firm	Firm	Firm	Firm
Number of firms	1,605,007	1,605,007	1,444,277	1,444,277	1,444,277	1,444,277

Notes: This table shows the estimation results for Equation 3. In column 1 and 2, we show the result from our whole sample. In column 3 and 4, we show the result from the sample for our pre- and post- treatment that is, 2018 and 2020. In column 5 and 6, we show the result of the collapsed difference-in-difference where we take the first difference of all variables between 2020 and 2018. The dependent variable is sales growth (in %). The dummy "High exposure" equals one for firms that belongs to industries whose supply chain intensity exceeds the 75th percentile of all industries within a country. Stringency index is measured as the weighted average of the workplace closure index in the sourcing country. The regression includes firm and home country variables in the model. These include: ln(assets), ROA, solvency ratio, leverage ratio, liquidity ratio, and stringency index at home. See Table A1 for variable definitions. We also include the firm and industry*time fixed effects. Standard errors are in parentheses and clustered at the firm level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 4: Effect of supply chain disruption using a continuous treatment of the GSC

Dependent variable: Sales growth(%)		
	(1)	(2)
Stringency index	-0.1703***	-0.8957***
	(0.0039)	(0.0383)
Supply chain intensity×Stringency index	-0.0375***	-0.0432***
	(0.0043)	(0.0043)
Stringency index (home)		0.6265***
		(0.0326)
Observations	4,611,717	4,611,717
R-Squared	0.3879	0.4435
Firm F.E.	Yes	Yes
Industry F.E.	Yes	Yes
Time F.E.	Yes	Yes
Controls	No	Yes
Clustering	Firm	Firm
Number of firms	1,605,007	1,605,007

Notes: This table shows the estimation results for Equation 3 using a continuous treatment of the supply chain link. The dependent variable is sales growth (in %). Supply chain intensity are the share of total inputs that the home country industry sources from all foreign countries scaled by the total output produced by industry in the home country. Stringency index is measured as the weighted average of the workplace closure index in the sourcing country. The regression includes firm and home country variables in the model. These include: ln(assets), ROA, solvency ratio, leverage ratio, liquidity ratio, and stringency index at home. See Table A1 for variable definitions. We also include the firm, industry and time fixed effects. Standard errors are in parentheses and are clustered at the firm level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 5: The role of external finance

Measurement:	(1) Total leverage	(2) Bank debt	(3) Non-bank debt	(4) Mono relation	(5) Multi relation
External finance	15.7519***	-11.6176***	30.6727***	-9.0511***	-5.6375**
	(0.3560)	(0.4968)	(0.2838)	(1.3630)	(2.7904)
High exposure×External finance	-1.9050***	-4.8073***	5.6728***	-3.5446	-9.8090*
	(0.6010)	(1.1371)	(0.6594)	(3.0010)	(5.4306)
Stringency index	-0.4017***	-0.2971***	-0.1964***	-0.9994***	-0.2742
	(0.0395)	(0.0397)	(0.0395)	(0.1806)	(0.4865)
High exposure×Stringency index	-0.0310***	-0.0101***	-0.0145***	-0.0032	0.0375*
	(0.0044)	(0.0033)	(0.0039)	(0.0085)	(0.0224)
External finance×Stringency index	-0.2034***	-0.1021***	-0.1535***	-0.2633***	-0.2313***
	(0.0025)	(0.0084)	(0.0029)	(0.0242)	(0.0415)
High exposure×External finance×Stringency index	0.0330***	0.0388**	-0.0022	0.0924*	0.1340*
	(0.0061)	(0.0182)	(0.0075)	(0.0546)	(0.0791)
Observations	4,611,717	4,562,758	4,562,758	447,673	91,155
R-Squared	0.4527	0.4521	0.4561	0.4513	0.4251
Firm F.E	Yes	Yes	Yes	Yes	Yes
Industry*Time F.E.	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes
Clustering	Firm	Firm	Firm	Firm	Firm

Notes: This table shows the estimation results for Equation 4. In column 1, we measure the effect of firms' total leverage. In column 2 and 3, we measure the effect of firms that have more and no access to bank loan respectively. In column 4 and 5, we examine the effect of bank relationship for firms that have more access to bank loans. In the last two columns, we have only 10% coverage of the main sample from our firm and bank relationship. The dependent variable is sales growth (in %). The dummy "High exposure" equals one for firms that belongs to industries whose supply chain intensity exceeds the 75th percentile of all industries within a country. Stringency index is measured as the weighted average of the workplace closure index in the sourcing country. The regression includes firm and home country variables in the model. These include: ln(assets), ROA, solvency ratio, leverage ratio, liquidity ratio, and stringency index at home. See Table A1 for variable definitions. We also include the firm and industry*time fixed effects. Standard errors are in parentheses and clustered at the firm level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 6: Firms faced with financial constraint

	(1) constrained firms(K-Z)	(2) unconstrained firms(K-Z)	(3) constrained firms(W-W)	(4) unconstrained firms(W-W)	(5) constrained firms(S-A)	(6) unconstrained firms(S-A)
Bank debt	-8.1176***	-15.7311***	4.6173***	-11.6132***	-13.2372***	-5.5226***
	(0.9012)	(0.7738)	(1.4075)	(0.6212)	(0.8252)	(0.9766)
High exposure×Bank debt	-5.1149**	-7.2358***	-7.2726**	-4.9375***	-3.9311**	-4.1058*
	(2.1098)	(1.8958)	(3.5722)	(1.4664)	(1.9751)	(2.1981)
Stringency index	0.0277	-0.6872***	0.3985**	-0.8099***	-0.5974***	-0.3280***
	(0.0810)	(0.0600)	(0.1973)	(0.0453)	(0.0624)	(0.0772)
High exposure×Stringency index	-0.0038	0.0113**	0.0166	0.0106***	0.0002	0.0260***
	(0.0063)	(0.0049)	(0.0129)	(0.0037)	(0.0049)	(0.0064)
Bank debt×Stringency index	-0.1750***	-0.1005***	-0.1912***	-0.1271***	-0.0944***	-0.1254***
	(0.0148)	(0.0132)	(0.0280)	(0.0100)	(0.0130)	(0.0161)
High exposure×Bank debt×Stringency index	0.1126***	0.0665**	0.1130	0.0411*	0.0368	0.0626*
	(0.0314)	(0.0316)	(0.0693)	(0.0222)	(0.0296)	(0.0339)
Observations	1,477,244	2,478,882	476,912	3,356,440	2,150,346	1,366,367
R-Squared	0.5653	0.4981	0.5890	0.5859	0.5869	0.5179
Firm F.E	Yes	Yes	Yes	Yes	Yes	Yes
Industry*Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Clustering	Firm	Firm	Firm	Firm	Firm	Firm

Notes: This table shows the estimation results for Equation 4 (specifically, bank debt) conditional on whether firms are financially constrained. We split the sample at their median. This implies that constrained firms are those firms whose index exceeds the median measure of the whole sample. Unconstrained firms in contrast, are below this median measure. K-Z index represents the financial constraint measure proposed by Kaplan and Zingales (1997). W-W index represents the financial measure proposed by Whited and Wu (2006). We also use a more conservative measure proposed by Hadlock and Pierce (2010). Our result produce qualitatively similarity when we examine these set of firms in our baseline setting, see Table A3. The dependent variable is sales growth (in %). The dummy "High exposure" equals one for firms that belongs to industries whose supply chain intensity exceeds the 75th percentile of all industries within a country. Stringency index is measured as the weighted average of the workplace closure index in the sourcing country. Bank debt are firms with more access to bank loans. The regression includes firm and home country variables in the model. These include: ln(assets), ROA, solvency ratio, leverage ratio, liquidity ratio, and stringency index at home. See Table A1 for variable definitions. We also include the firm and industry*time fixed effects. Standard errors are in parentheses and clustered at the firm level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 7: Patterns of trade

	(1)	(2)	(3)	(4)	(5)
	Diversification	Distance	Sales growth (%)		
Stringency index	-0.4474***	-0.2906***			
	(0.0405)	(0.0395)			
High exposure×Stringency index	-0.0202***	-0.0003			
	(0.0033)	(0.0043)			
Trade patterns×Stringency index	0.0485***	-0.0201***			
	(0.0028)	(0.0018)			
High exposure×Trade patterns×Stringency index	0.0528***	-0.0277***			
	(0.0071)	(0.0049)			
High exposure×Stringency index China			-0.0045**		
			(0.0023)		
High exposure×Stringency index Russia				-0.0067**	
				(0.0034)	
High exposure×Stringency index USA					-0.0060**
					(0.0030)
Observations	4,611,717	4,611,717	4,611,717	4,611,717	4,611,717
R-Squared	0.4517	0.4517	0.4516	0.4516	0.4516
Firm F.E.	Yes	Yes	Yes	Yes	Yes
Industry*Time F.E.	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes
Clustering	Firm	Firm	Firm	Firm	Firm
Number of firms	1,605,007	1,605,007	1,605,007	1,605,007	1,605,007

Notes: This table shows the estimation results for Equation 3 conditional on the trade patterns of the home country: diversification, distance, and countries that are a strong participant in the supply chain. In column 1, we examine the effect of SCD on diversified firms. In column 2, we examine the effect of SCD on distant partners. In column 3-5, we examine the effect of SCD of major countries that participate in the supply chain. Diversification are firms with HHI of its industry below the median within the country. Distant represents the distance between a sourcing country and the home country. China, Russia, and USA are the three most important countries that provide intermediate goods to the EU. The dependent variable is sales growth (in %). The dummy "High exposure" equals one for firms that belongs to industries whose supply chain intensity exceeds the 75th percentile of all industries within a country. Stringency index is measured as the weighted average of the workplace closure index in the sourcing country. The regression includes firm and home country variables in the model. These include: ln(assets), ROA, solvency ratio, leverage ratio, liquidity ratio, and stringency index at home. See Table A1 for variable definitions. We also include the firm and industry*time fixed effects. Standard errors are in parentheses and are clustered at the firm level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 8: Effect of the disruption on firms' profitability, employment and investment

	(1) Profit margin(%)	(2) Profit margin(%)	(3) ROA(%)	(4) ROA(%)	(5) Employment	(6) Employment	(7) Investment	(8) Investment
Stringency index	-0.0021	0.1125***	0.0011	0.1916***	0.0553***	-0.0425	0.8113***	-2.0790***
	(0.0014)	(0.0128)	(0.0012)	(0.0147)	(0.0041)	(0.0428)	(0.0289)	(0.3345)
High exposure×Stringency index	-0.0051***	-0.0025***	-0.0053***	-0.0134***	-0.0162***	-0.0167***	-0.1514***	-0.1897***
	(0.0012)	(0.0009)	(0.0011)	(0.0011)	(0.0034)	(0.0034)	(0.0257)	(0.0258)
Stringency at home		-0.0945***		-0.1686***		0.0719**		2.2664***
		(0.0107)		(0.0125)		(0.0354)		(0.2817)
Observations	4,401,523	4,401,523	4,611,717	4,611,717	3,105,890	3,105,890	3,771,085	3,771,085
R-Squared	0.6431	0.7783	0.5564	0.6316	0.3457	0.3475	0.3602	0.3685
Firm F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry*Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Clustering	Firm	Firm	Firm	Firm	Firm	Firm	Firm	Firm

Notes: This table shows the estimation results for Equation 3 on other firm outcomes. In column 1 and 2 are the profit margin, column 3 and 4 are the return on total assets (ROA), column 5 and 6 are the employment growth and, column 7 and 8 are the investment. The dummy "High exposure" equals one for firms that belongs to industries whose supply chain intensity exceeds the 75th percentile of all industries within a country. Stringency index is measured as the weighted average of the workplace closure index in the sourcing country. The regression includes firm and home country variables in the model. These include: ln(assets), ROA, solvency ratio, leverage ratio, liquidity ratio, and stringency index at home. See Table A1 for variable definitions. We also include the firm and industry*time fixed effects. Standard errors are in parentheses and clustered at the firm level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 9: Falsification test

Dependent variable: Sales growth(t-1) (%)		
	(1)	(2)
Stringency index	-0.1486***	-0.1666***
	(0.0040)	(0.0499)
High exposure×Stringency index	-0.0003	-0.0051
	(0.0040)	(0.0040)
Stringency index at home		0.0140
		(0.0421)
Observations	2,958,862	2,958,862
R-Squared	0.5025	0.5049
Firm F.E.	Yes	Yes
Industry*Time F.E.	Yes	Yes
Firm controls	No	Yes
Clustering	Firm	Firm
Number of firms	1,479,431	1,479,431

Notes: In this table, we show the falsification test by regressing the sales growth of firms in the home country in period t-1 to our high exposure measure interacted with the stringency index in the current period. The dependent variable is sales growth (t-1) (in %). The dummy "High exposure" equals one for firms that belongs to industries whose supply chain intensity exceeds the 75th percentile of all industries within a country. Stringency index is measured as the weighted average of the workplace closure index in the sourcing country. The regression includes firm and home country variables in the model. These include: ln(assets), ROA, solvency ratio, leverage ratio, liquidity ratio, and stringency index at home. See Table A1 for variable definitions. We also include the firm and industry*time fixed effects. Standard errors are in parentheses and clustered at the firm level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 10: Different measurements of Supply Chain Disruptions

	Dependent variable: Sales growth(%)			
	(1)	(2)	(3)	(4)
Stringency index (home)	-0.1473***	-0.1455***		-0.1465***
	(0.0029)	(0.0028)		(0.0028)
High exposure×Stringency index (home)	-0.0149***	-0.0045		
	(0.0032)	(0.0030)		
High exposure×Year dummy (2020)			1.0744***	-0.3164**
			(0.1704)	(0.1609)
Observations	4,611,717	4,611,717	4,611,717	4,611,717
R-Squared	0.3998	0.4516	0.3992	0.4516
Firm F.E.	Yes	Yes	Yes	Yes
Industry*Time F.E.	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes
Clustering	Firm	Firm	Firm	Firm
Number of firms	1,605,007	1,605,007	1,605,007	1,605,007

Notes: This table shows the estimation results for Equation 3 with different measures of supply chain disruptions. In column 1 and 2, we show the effect of the disruption only at the home country industries. Column 3 and 4 shows the effect of the disruption measured by a yearly dummy (2020). The dependent variable is sales growth (in %). The dummy "High exposure" equals one for firms that belongs to industries whose supply chain intensity exceeds the 75th percentile of all industries within a country. The regression includes firm and home country variables in the model. These include: ln(assets), ROA, solvency ratio, leverage ratio, liquidity ratio, and stringency index at home. See Table A1 for variable definitions. We also include the firm and industry*time fixed effects. Standard errors are in parentheses and are clustered at the firm level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

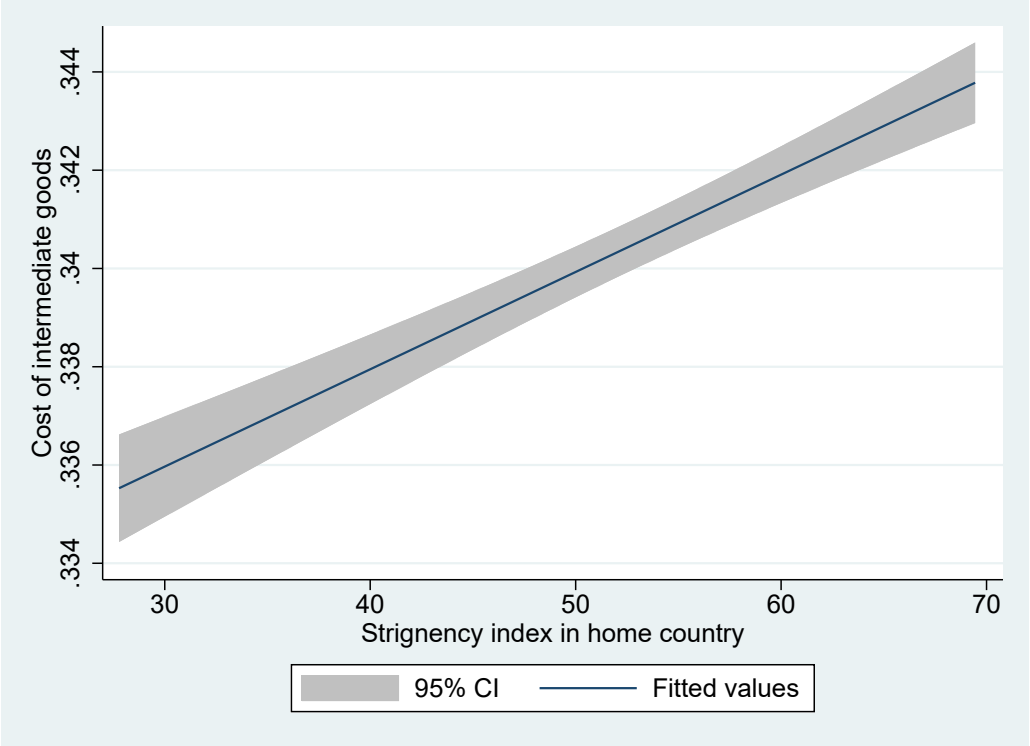
Table 11: Baseline consistent with the maximum level of government stringency

Dependent variable: Sales growth(%)		
	(1)	(2)
Stringency index (max)	-0.3262***	-0.2518***
	(0.0070)	(0.0097)
High exposure×Stringency index(max)	-0.0105***	-0.0100***
	(0.0020)	(0.0019)
Ln(assets)		11.9534***
		(0.1140)
ROA		0.8612***
		(0.0025)
Solvency ratio		-0.2693***
		(0.0039)
Leverage ratio		11.4874***
		(0.3402)
Liquidity ratio		7.9487***
		(0.2571)
Stringency at home		-0.0653***
		(0.0040)
Observations	4,611,717	4,611,717
R-Squared	0.3997	0.4518
Firm F.E.	Yes	Yes
Industry*Time F.E.	Yes	Yes
Controls	No	Yes
Clustering	Firm	Firm
Number of firms	1,605,007	1,605,007

Notes: This table shows the estimation results for Equation 3 with disruption measured by the strictest level of workplace closure stringency index in the sourcing country. The dependent variable is sales growth (in %). The dummy "High exposure" equals one for firms that belongs to industries whose supply chain intensity exceeds the 75th percentile of all industries within a country. The regression includes firm and home country variables in the model. These include: ln(assets), ROA, solvency ratio, leverage ratio, liquidity ratio, and stringency index at home. See Table A1 for variable definitions. We also include the firm and industry*time fixed effects. Standard errors are in parentheses and are clustered at the firm level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

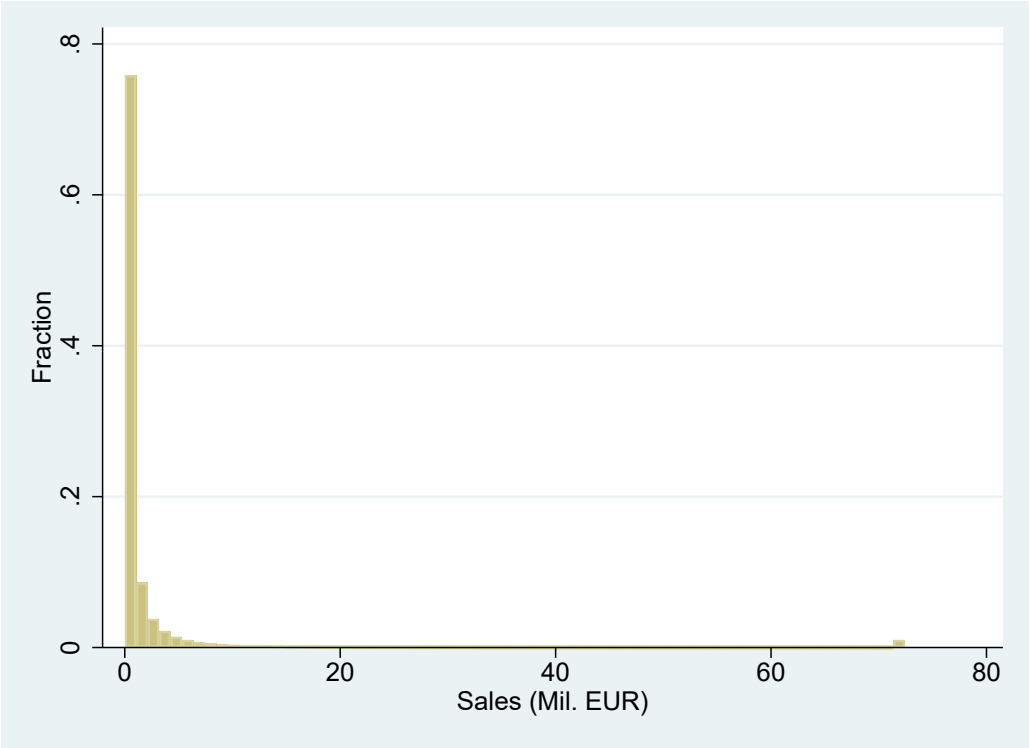
Appendix

Figure A1: Correlation relationship between stringency index in home country and cost of intermediate goods



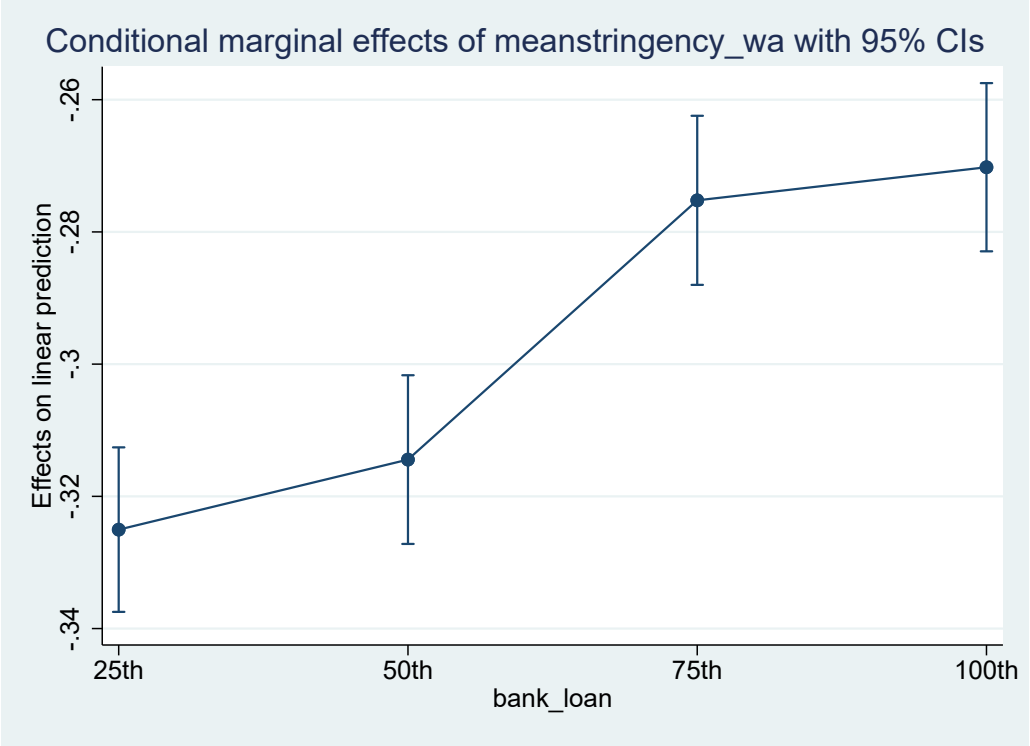
Source: Authors' calculation (2022).
Notes: The cost of intermediate goods are measured at the industry-level and scaled by total assets of the industry. Stringency index is a construct measure based on government stringency towards workplace closures and normalised to a value ranging from 0 to 100 (100 = strictest). A higher score indicates a stricter response (i.e. 100 = strictest response).

Figure A2: Distribution of firm sales in our data



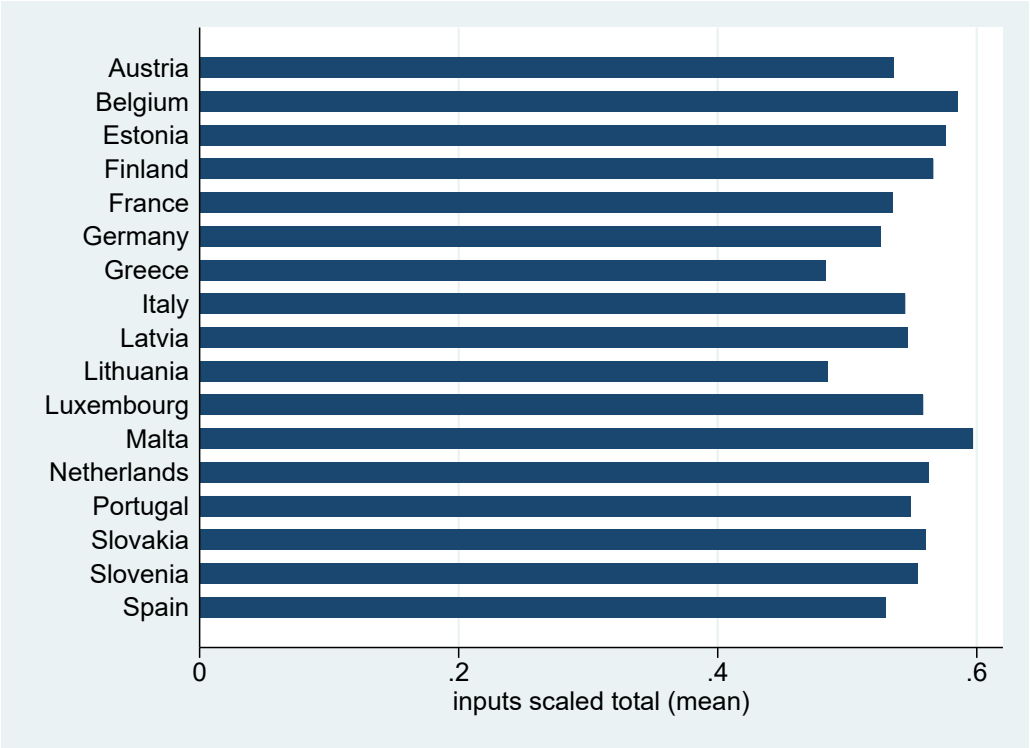
Source: Authors' calculation (2022).
Notes: The figure shows that the distribution of firm sales in our dataset are right skewed.

Figure A3: Conditional marginal plot of firms with access to bank loans during disruption



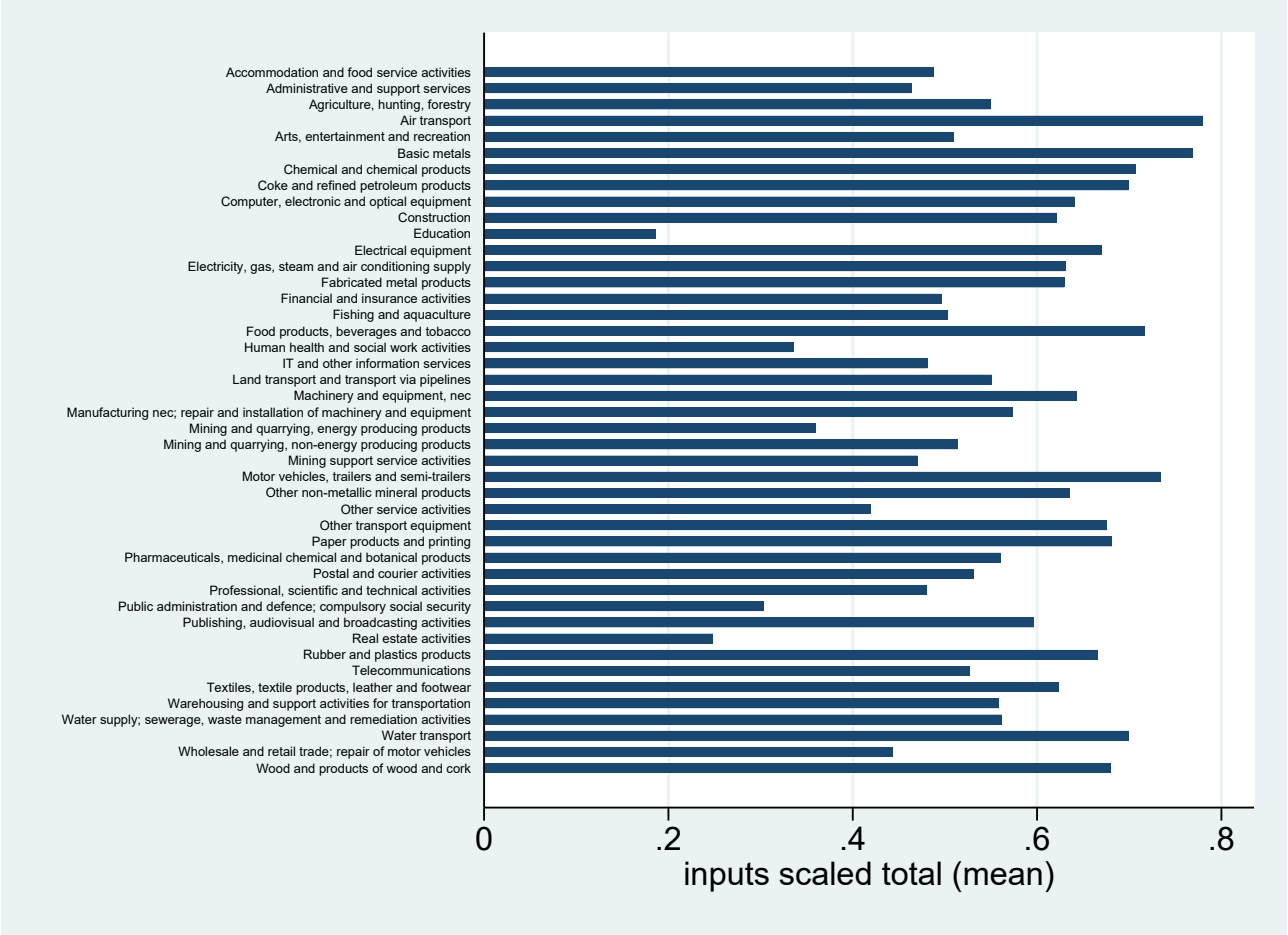
Source: Authors' calculation (2022).
Notes: This shows the marginal effect of firms' access to bank loan on firm sales in a supply disruption. The x-axis shows the level of percentile for each firms' access to bank loans. The y-axis shows the linear prediction obtained from the baseline result.

Figure A4: Amount of inputs by country



Source: Authors' calculation (2022).
Notes: This shows the variation of supply chain intensity across the home countries.

Figure A5: Amount of inputs by industry



Source: Authors' calculation (2022).
Notes: This shows the variation of supply chain intensity across the industries.

Table A1: Variable description

Variable	Description	Source
Dependent variable		
Sales growth	Growth rate of firm sales (%)	Amadeus
Profit margin	Firms profit margin (%)	Amadeus
Employment	The growth in the number of employees for each firm in a given year (%)	Amadeus
Investment	The sum of tangible and intangible assets minus depreciation (%)	Amadeus
Firm characteristics		
Total assets	Natural logarithm of total assets (Mil. EUR)	Amadeus
Leverage ratio	The ratio of the sum of long-term debt and debt in current liabilities to total assets	Amadeus
Solvency ratio	Solvency ratio (%)	Amadeus
ROA	Firms' return on total assets (%)	Amadeus
Liquidity ratio	The ratio of firms' cash and cash equivalent to total assets	Amadeus
Bank debt	The ratio of firms' current liabilities from bank loan scaled by the firms' total assets	Amadeus
Non-bank debt	The ratio of firms' current liabilities other than bank loan e.g. trade credit	Amadeus
Firms' financial constraint		
K-Z index	This represents the financial constraint measure proposed by Kaplan and Zingales (1997).	Amadeus
W-W index	This represents the financial measure proposed by Whited and Wu (2006).	Amadeus
S-A index	This represents the financial measure proposed by Hadlock and Pierce (2010).	Amadeus
Supply chain link		
High exposure	Firms with the ratio of inputs from other countries over total outputs of its industry above the 75th percentile within its country	OECD
Supply chain intensity	Total amount of input from sourcing countries scaled by the total output from each industry in the home country.	OECD
Diversification	Firms with Herfindahl-Hirschman Index (HHI) of its industry below the median within the country.	OECD
Distance	The weighted average of the distance between the home country and the sourcing country using input amount from each country as weights.	GeoDist
Pandemic country characteristics		
Stringency index (sourcing countries)	A constructed measure based on the strictness of government policy towards workplace closure.	OxCGRT
Stringency at home	Government stringency index imposed at the home country	OxCGRT
Bank-Firm link		
Bank relationship	The number of bank relationship for each firm	Amadeus banker

Table A2: Cross-section observation of the number of firms in each country

Country	Number of firms	Country	Number of firms
Austria	3,687	Lithuania	2,116
Belgium	25,516	Luxembourg	1,251
Estonia	24,673	Malta	459
Finland	106,976	Netherlands	1,669
France	193,935	Portugal	152,416
Germany	13,067	Slovakia	38,454
Greece	13,992	Slovenia	32,774
Italy	639,536	Spain	307,935
Latvia	46,551		
Total: 1,605,007			

Table A3: Baseline result based on firms faced with financial constraint

Dependent variable: Sales growth(%)			
	(K-Z)	(W-W)	(S-A)
Stringency index	-0.0795**	0.2984***	0.0225
	(0.0354)	(0.0328)	(0.0350)
High exposure×Stringency index	-0.0107***	0.0305***	-0.0079**
	(0.0033)	(0.0032)	(0.0033)
Ln(assets)	0.0612***	0.5920***	0.1941***
	(0.0107)	(0.0113)	(0.0110)
ROA	0.6092***	0.6009***	0.6374***
	(0.0015)	(0.0015)	(0.0016)
Solvency ratio	-0.1346***	-0.1606***	-0.1416***
	(0.0006)	(0.0007)	(0.0007)
Liquidity ratio	-0.7265***	-2.4194***	-0.8257***
	(0.0918)	(0.0951)	(0.0974)
Stringency at home	-0.0793***	-0.3535***	-0.1582***
	(0.0299)	(0.0277)	(0.0295)
Observations	3,956,126	3,833,352	3,516,713
R-Squared	0.1311	0.1640	0.1344
Firm F.E.	Yes	Yes	Yes
Industry*Time F.E.	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Clustering	Firm	Firm	Firm

Notes: This table shows the estimation results for Equation 3 based on firms' faced with financial constraint. The dependent variable is sales growth (in %). The dummy "High exposure" equals one for firms that belongs to industries whose supply chain intensity exceeds the 75th percentile of all industries within a country. Stringency index is measured as the weighted average of the workplace closure index in the sourcing country. The regression includes firm and home country variables in the model. These include: ln(assets), ROA, solvency ratio, leverage ratio, liquidity ratio, and stringency index at home. See Table A1 for variable definitions. We also include the firm and industry*time fixed effects. Standard errors are in parentheses and are clustered at the firm level. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table A4: List of Countries (sourcing and home) covered in OECD ICIO

S/N	ISO 3	European Economies	Classification	S/N	ISO 3	Non-European Economies	Classification
1.	AUS	Australia	OECD	39.	ARG	Argentina	Non-OECD
2.	AUT	Austria	OECD	40.	BRA	Brazil	Non-OECD
3.	BEL	Belgium	OECD	41.	BRN	Brunei	Non-OECD
4.	CAN	Canada	OECD	42.	BGR	Bulgaria	Non-OECD
5.	CHL	Chile	OECD	43.	KHM	Cambodia	Non-OECD
6.	COL	Colombia	OECD	44.	CHN	China	Non-OECD
7.	CRI	Costa Rica	OECD	45.	HRV	Croatia	Non-OECD
8.	CZE	Czechia	OECD	46.	CYP	Cyprus	Non-OECD
9.	DNK	Denmark	OECD	47.	IND	India	Non-OECD
10.	EST	Estonia	OECD	48.	IDN	Indonesia	Non-OECD
11.	FIN	Finland	OECD	59.	HKG	Hong KOng	Non-OECD
12.	FRA	France	OECD	50.	KAZ	Kazakhstan	Non-OECD
13.	DEU	Germany	OECD	51.	LAO	Laos	Non-OECD
14.	GRC	Greece	OECD	52.	MYS	Malaysia	Non-OECD
15.	HUN	Hungary	OECD	53.	MLT	Malta	Non-OECD
16.	ISL	Iceland	OECD	54.	MAR	Morocco	Non-OECD
17.	IRL	Ireland	OECD	55.	MMR	Myanmar	Non-OECD
18.	ISR	Israel	OECD	56.	PER	Peru	Non-OECD
19.	ITA	Italy	OECD	57.	PHL	Philippines	Non-OECD
20.	JPN	Japan	OECD	58.	ROU	Romania	Non-OECD
21.	KOR	Korea Republic	OECD	59.	RUS	Russia	Non-OECD
22.	LVA	Latvia	OECD	60.	SAU	Saudi Arabia	Non-OECD
23.	LTU	Lithuania	OECD	61.	SGP	Singapore	Non-OECD
24.	LUX	Luxembourg	OECD	62.	ZAF	South Africa	Non-OECD
25.	MEX	Mexico	OECD	63.	TWN	Taiwan	Non-OECD
26.	NLD	Netherlands	OECD	64.	THA	Thailand	Non-OECD
27.	NZL	New Zealand	OECD	65.	TUN	Tunisia	Non-OECD
28.	NOR	Norway	OECD	66.	VNM	Vietnam	Non-OECD
29.	POL	Poland	OECD				
30.	PRT	Portugal	OECD				
31.	SVK	Slovakia	OECD				
32.	SVN	Slovenia	OECD				
33.	ESP	Spain	OECD				
34.	SWE	Sweden	OECD				
35.	CHE	Switzerland	OECD				
36.	TUR	Turkey	OECD				
37.	GBR	United Kingdom	OECD				
38.	USA	United States	OECD				

Source: OECD, ICIO(2021)

Table A5: Sectors covered in OECD ICIO

S/N	Code	Industry	ISIC Rev.4
1.	01T02	Agriculture, hunting, forestry	01, 02, 03
2.	03	Fishing and aquaculture	03
3.	05T06	Mining and quarrying, energy producing products	05, 06
4.	07T08	Mining and quarrying, non-energy producing products	07, 08
5.	09	Mining support service activities	09
6.	10T12	Food products, beverages and tobacco	10, 11, 12
7.	13T15	Textiles, textile products, leather and footwear	13, 14, 15
8.	16	Wood and products of wood and cork	16
9.	17T18	Paper products and printing	17, 18
10.	19	Coke and refined petroleum products	19
11.	20	Chemical and chemical products	20
12.	21	Pharma., med-chemical and botanical products	21
13.	22	Rubber and plastics products	22
14.	23	Other non-metallic mineral products	23
15.	24	Basic metals	24
16.	25	Fabricated metal products	25
17.	26	Computer, electronic and optical equipment	26
18.	27	Electrical equipment	27
19.	28	Machinery and equipment, nec	28
20.	29	Motor vehicles, trailers and semi-trailers	29
21.	30	Other transport equipment	30
22.	31T33	Manufacturing, repairs etc.	31, 32, 33
23.	35	Electricity, gas, steam etc.	35
24.	36T39	Water supply; sewerage etc.	36, 37, 38, 39
25.	41T43	Construction	41, 42, 43
26.	45T47	Wholesale and retail trade; repair of motor vehicles	45, 46, 47
27.	49	Land transport and transport via pipelines	49
28.	50	Water transport	50
29.	51	Air transport	51
30.	52	Warehousing and support activities for transportation	52
31.	53	Postal and courier activities	53
32.	55T56	Accommodation and food service activities	55, 56
33.	58T60	Publishing, audiovisual and broadcasting activities	58, 59, 60
34.	61	Telecommunications	61
35.	62T63	IT and other information services	62, 63
36.	64T66	Financial and insurance activities	64, 65, 66
37.	68	Real estate activities	68
38.	69T75	Professional, scientific and technical activities	69, 70, 71, 72, 73, 74, 75
39.	77T82	Administrative and support services	77, 78, 79, 80, 81, 82
40.	84	Public administration and defence; compulsory social security	84
41.	85	Education	85
42.	86T88	Human health and social work activities	86, 87, 88
43.	90T93	Arts, entertainment and recreation	90, 91, 92, 93
44.	94T96	Other service activities	94, 95, 96
45.	97T98	Activities of households as employers	97, 98

Source: OECD, ICIO(2021)

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