estructuraeconòmica
ECONOMÍA APLICADA II

Do firms react to supply-chain disruptions?

by

Juan de Lucio

Carmen Díaz-Mora

Raúl Mínguez

Asier Minondo

and

Francisco Requena

Working Papers in Applied Economics

WPAE-2023-2306

ECONOMÍA APLICADA II

VNIVERSITAT DE VALÈNCIA

Departamento de Estructura Económica (Economía Aplicada II), Facultad de Economía, Universitat de València
Avda dels Tarongers, s/n, 46022 – Valencia, Spain
Phone +34 96 382 83 49 / Fax +34 96 382 83 54
http://www.estructuraeconomica.es
e-mail: investigacion.estructura@uv.es

ISSN 2172-3036

Do firms react to supply-chain disruptions?*

Juan de Lucio[†] Carmen Díaz-Mora[‡] Raúl Mínguez[§]

Asier Minondo[¶] Francisco Requena[‖]

This version: April 18, 2023

Abstract

Since the outbreak of the Covid-19 pandemic, the disruption of supply chains has become a major concern for global firms. This paper uses a representative sample of Spanish manufacturers that participate in global value chains to analyze whether firms are implementing strategies to respond to this concern. Using data for the period 2017-2022, we find that, on average, manufacturers have not increased the number of countries they source their inputs from since the Covid-19 pandemic. Firms have not either shifted their imports to countries that are geographically and geopolitically close to Spain, and have not reshored imports. However, firms have significantly increased the stock of intermediates. Firms only diversify when they have one supplier, export to many destinations, and the imported input has a high risk of experiencing a supply-chain disruption. Firms nearshore and friendshore when their main supplier is geographically distant.

JEL: F10, F14

Keywords: supply-chain disruptions, diversification, nearshoring, friendshoring, reshoring, stocks, Spain.

*We thank the Department of Customs and Excise of the Spanish Tax Agency (AEAT) for providing Customs data and Aitor Garmendia for providing Spanish firms' balance sheet data. This research was conducted as part of the Project PID2021-122133NB-I00 financed by MCIN/AEI/10.13039/501100011033/FEDER, EU. We also gratefully acknowledge financial support from the Basque Government Department of Education (IT1429-22).

[†]de Lucio: Universidad de Alcalá. Pza. San Diego, s/n, 28801, Alcalá de Henares (Spain). Email:juan.delucio@uah.es.

[‡]Díaz-Mora: Universidad de Castilla-La Mancha, Cobertizo de San Pedro Mártir, s/n, 45071 Toledo (Spain). Email: carmen.diazmora@uclm.es

[§]Mínguez: Universidad Antonio de Nebrija. Calle de Santa Cruz de Marcenado, 27, 28015, Madrid (Spain). Email:rminguez@nebrija.es.

[¶]Minondo: Corresponding author. Deusto Business School, University of Deusto, Camino de Mundaiz 50, 20012 Donostia - San Sebastián (Spain). Email: aminondo@deusto.es

[‖]Requena: Department of Economic Structure, University of Valencia, Avda. dels Tarongers s/n, 46022 Valencia (Spain). Email: francisco.requena@uv.es

1 Introduction

The Covid-19 pandemic turned supply-chain disruptions from a firm and location-specific concern to an economy-wide and global preoccupation. The shutdown of factories in China and the confinement measures adopted by many countries made firms aware that the halt of production processes due to a lack of inputs could become a real possibility. The concern about supply-chain disruptions continued rising even when the more stringent Covid-related measures had been lifted. The shift in demand from services to durable goods, capacity constraints in some maritime routes, and labor shortages generated supply-chain disruptions in a wide range of industries. Finally, the Russian invasion of Ukraine, and its repercussions on the supply of energy and some primary products, made firms aware that systemic shocks to supply chains were not unusual. As shown by EBRD (2022), these events led global firms to rank supply-chain disruptions as their second most important risk in the first quarter of 2022.

Firms can use different strategies to cope with supply-chain disruptions. First, they can diversify the pool of suppliers. If disruptions do not occur simultaneously in all suppliers, diversification enables firms to substitute the input of an affected supplier with the input of a non-affected supplier. Second, firms can increase their inventory of components and finished products to hold safety stocks. Third, firms can repatriate previously offshored activities. Fourth, firms can shorten their supply chain relocating previously offshored activities to a neighboring country of the home country: nearshoring. Finally, firms may relocate production to trusted countries to reduce the disruption risks due to trade-policy and geopolitical tensions. This strategy is denoted as friendshoring.

This paper explores whether firms have implemented any of the above-mentioned strategies in response to the rising concern about supply-chain disruptions. We combine a representative sample of Spanish manufacturers that participate in global value chains (GVCs) with a database that covers the universe of import transactions in intermediate products between 2017 and 2022. We focus on firms involved in GVCs because their participation in cross-border production sharing puts them at risk of experiencing supply-chain disruptions and, consequently, are more prone to use strategies to cope with them. Moreover, in a world where GVCs are the prevalent model for global production and trade, we want to know whether economic shocks and geopolitical tensions are restructuring and reconfiguring them.

We find that Spanish manufacturers participating in GVCs have not implemented any significant diversification, nearshoring, or friendshoring strategies as a response to the rising concerns about supply-chain disruptions from 2020 onward. We observe no reshoring of intermediates either. However, we find that firms significantly increased their stocks in 2021. In any case, we would need data for later years to confirm that

stock-pilling has become a permanents strategy.

We examine heterogeneity in the implementation of strategies across several dimensions. We discover that firms diversify the countries they import intermediates from when (i) they have one supplier; (ii) have more than one supplier and none of them is significantly more important than the others; (iii) have many export destinations; (iv) the imported intermediate has more risks of experiencing supply-chain disruptions; and (v) if the firm operates in the electronics industry.

We find that Spanish manufacturers only nearshore when the main supplier is outside the EU or in China. However, this is a mechanical effect that occurs for all firm×intermediate combinations in which the main supplier is distant from Spain. Since the main supplier is already far from Spain, if the firm adds, or shifts to, a random new supplier, this will tend to be closer to Spain, leading to a mechanical nearshoring process. We find that firms increase the share of imports from countries that are friends of Spain if their main supplier is outside the EU or in China. Furthermore, we confirm that this friendshoring process is not the result of a mechanical effect. Friendshoring is also more intense in firm×intermediate combinations that initially had one supplier or a small number of potential suppliers. Finally, we find that stocks have raised more in high-productive firms and firms controlled by domestic capital.

The lack of a widespread use of strategies to cope with supply-chain disruptions can be explained by the hysteresis and the stickiness of offshoring decisions (Antràs, 2020; Antràs and Chor, 2022). The fixed costs associated with offshoring, such as the gathering of information about suitable providers (search costs), relationship-specific investments, or the learning about bureaucratic procedures and contracts in a different legal environment, are nontrivial and sunk in nature. Furthermore, as noted by Baldwin and Freeman (2022), the niche expertise needed to manage specific value chains makes buyer-supplier networks sticky. Therefore, the relocation of production processes that were offshored is likely to require large additional fixed costs. This would explain the persistence of firms' decisions on how to organize their value chains globally.[1] As demonstrated during the Great Recession, GVCs are remarkably resilient to shocks when they are perceived to be transitory (Behrens et al., 2013). The lack of diversification, reshoring, nearshoring, or friendshoring strategies documented by our study suggests that recent disruptions have not been either perceived as permanent to firms participating in GVCs. Consequently, firms have been reluctant to introduce profound changes in their supply chain.[2] They have only introduced policies, such as the increase in stocks, which offer a buffer to short-term

[1] Javorcik et al. (2022) found that friendshoring provides insurance against extreme disruptions and secures the supply for vital inputs. However, in the medium-run, friendshoring leads to real output losses globally.

[2] Minondo (2021) found that the decrease in Spanish exports during the Covid-19 pandemic was explained by the intensive margin. This suggests that customer-supplier relationships were also resilient to the Covid crisis.

disruptions in GVCs.

The nearshoring and friendshoring in firms whose main supplier was outside the EU or, specifically, in China, can be related to strategies that began to be adopted before the outbreak of the Covid pandemic. These strategies would be motivated by the reduction in labor cost differentials between China and closer countries, and the uncertainty about trade policy due to trade tensions between the United States and China that shows no signs of easing. An additional factor that might contribute to the relocation away from China is the series of abrupt and unanticipated regulatory and policy changes adopted by Chinese authorities during 2021, the so-called regulatory storm (Xia and Lorente-Salabarria, 2023). Hence, the recent disruptions might be accelerating already existing trends of supply-chain rationalization, as demonstrated by Antràs (2020) and Bacchetta et al. (2021) for Covid-19.

This paper contributes to the literature on supply-chain disruptions. Carvalho et al. (2021) and Boehm et al. (2019) used the 2011 T$\bar{o}$hoku earthquake to analyze how a supply-chain disruption affected the production of other firms in Japan and Japanese affiliates in the US. Freund et al. (2022) showed that countries more dependent on auto and electronics imports from Japan did not diversify their suppliers, switched to geographically-close suppliers, or reshored production after the 2011 earthquake. Shingal and Agarwal (2020) examined how Asian countries' GVC-based imports responded to prior epidemic outbreaks such as SARS and MERS. They found no evidence for reshoring, some evidence of nearshoring for SARS, and some evidence of geographical diversification for MERS. Some evidence of nearshoring was observed after the 2009 trade collapse for the European Union (EU) as a whole (Stöllinger et al., 2018; Chidlow et al., 2020; Bontadini et al., 2022) and Spain (Díaz-Mora et al., 2020), but restricted to the 2012-2014 period. Related to the Covid-19, Khanna et al. (2022) found that Indian firms more exposed to the pandemic diversified towards geographically-close, larger, and well-connected suppliers. Lafrogne-Joussier et al. (2022) concluded that French exporters that had a more geographically-diversified pool of suppliers experienced the same Covid-19-related disruption than the less-diversified exporters. Di Stefano et al. (2022) showed that Covid-19 did not spur large waves of reshoring in Italian multinational firms. In sum, the empirical evidence on reshoring, nearshoring, and friendshoring highlights that firms have not implemented these strategies widely in the most recent years (Marvasi, 2022).

We make three contributions to the literature. First, instead of focusing on a particular strategy, we explore a pool of strategies firm can implement to respond to supply-chain disruptions. This enables us to identify whether firms use a dominant strategy to cope with supply-chain disruptions or they combine different strategies.[3] We found that firms

[3]For example, using a survey of 113 major firms participating in GVCs, McKinsey (2022) concluded that most of them apply some combination of inventory increases, dual sourcing, and regionalization to boost the resilience of their supply chains.

have only implemented a rise-in-stocks strategy to respond to the growing concerns about supply-chain disruptions.

Second, our dataset covers a period that includes the outbreak-of-Covid year and two additional years. In contrast to the above-mentioned studies, the longer time span of our dataset enables us to analyze the supply-chain disruptions in the aftermath of Covid-19 and those related to the Russian invasion of Ukraine. Furthermore, firms need time to implement the strategies to respond to supply-chain disruptions. The longer time-span of our dataset relative to previous studies enables us to capture the lag in the implementation of strategies. On top of that, by covering a three-year period before the pandemic, we can also detect whether the recent supply-chain disruptions have led firms to adopt novel strategies or they are simply accelerating supply-chain-rationalization strategies that began to be implemented before the pandemic. Despite using a longer time span, we do not observe any significant change in firms' diversification, nearshoring, friendshoring, and reshoring strategies. We find that nearshoring and friendshoring processes implemented by firms whose main supplier was outside the EU or in China had already begun before the Covid-19 outbreak.

Third, we contribute to the literature showing that there is heterogeneity in the implementation of strategies depending on supplier, intermediate, geographical, firm, and industry characteristics. We discover that diversification strategies are only implemented when firms have one supplier, have more than one supplier and none of them is significantly more important than the others, export to many destinations, the imported product has a high risk of experiencing a supply-chain disruption, and the intermediate is imported by the electronics industry. Firms nearshore and friendshore when their main supplier is geographically distant.

The remainder of the paper is organized as follows. The next section explains our data sources and how we combine them to build our dataset. Section 3 analyzes whether manufacturers participating in GVCs adopted strategies to respond to the growing concern about supply-chain disruptions since the Covid-19 pandemic. This section also explores whether the implementation of strategies varied across supplier, input, geography, firm, and industry dimensions. The last section concludes.

2 Data

Our data set is a large sample of Spanish manufacturing firms with 10 or more employees that imported and exported continuously over the period 2017-2022. The sample of firms is obtained after combining the information from two different sources. Our primary source is the Spanish Customs' records. It is a confidential micro data made available to us by the Customs and Excise Department of the Spanish Tax Agency (AEAT-Customs),

which reports the value (in euros) of exports and imports for each firm, by product, country of destination or origin, and year. Products are defined according to the eight-digit combined nomenclature (CN 8-digit).[4] Countries or territories with a population below 1 million in 2017 are excluded. Some shipments are excluded as well from this data collection. Inside the EU, firms are required to report their shipments by product and country (of origin/destination) only if their annual trade value in the current or the previous year exceeds the threshold of 240,000 euros. For exports outside the EU all flows are recorded, unless their value is smaller than 1,000 euros or one ton. Those thresholds only eliminate a very small proportion of the total value of exports and imports (less than 3%). The period for which we have data is from 2012 to 2022.

A second source of information is a balance-sheet dataset called Bureau Van Dick SABI (Iberian Balance Sheet Analysis System, `sabi.bvdinfo.com`). In addition to the annual accounts, this database provides other relevant firm-level information, such as employment, capital ownership, and sector of main activity. The period for which we have data is from 2017 to 2021.

The final data set is the result of merging both databases after applying the following steps. First, we select from the AEAT-Customs database all the regular two-way traders, that is, firms that export and import every year over the period 2017-2022. Following previous literature (Antràs and Chor, 2022; Lafrogne-Joussier et al., 2022), we define that a firm participates in GVCs if it exports and imports. Second, we consider only those imported products that are classified as intermediate goods. Out of 8,292 CN-8 digit products in the AEAT-Customs database, the total number of intermediate goods is 4,671 after excluding tobacco (CN 24) and petroleum oils (CN 27).[5] Third, we use SABI to identify firms whose main activity is manufacturing and have at least 10 workers between 2017 and 2022.

Our data set contains 3,939 firms, 3,156 imported intermediates, and 26,122 firm-product pairs for every year between 2017 and 2022. The total number of countries of origin in the sample is 147. The total number of firm-product-country triplets in 2017 is 57,530 and reaches 60,028 in 2022. According to the AEAT-Customs database, our sample accounts for 42% of total exports and 38% of total intermediate imports in 2017. When we consider only exports and imports by manufacturing firms, our sample accounts for 81% of total exports and 62% of total imports in 2017. The dataset also accounts

[4]Since the CN 8-digit is revised annually, we ensure a consistent concordance across the CN 8-digit products over time following Van Beveren et al. (2012).

[5]In order to select the intermediate products, first we converted the Combined Nomenclature eight-digit codes to Harmonized System 6-digit 1992 classification. Next, we identified the list of Harmonized System 6-digit 1992 classification codes that belong to the category of intermediate goods according to the Broad Economic Categories, rev.5 classification (BEC). The list was elaborated using the Concordance HS1992-BEC tables built by the United Nations (UNSD — Classifications on economic statistics). We also use the BEC rev. 5 to identify the IPS goods (Intermediate Processed Specific) as the intermediate goods that are more likely to participate in GVCs.

for 45% and 59% of employment and output in manufacturing in 2017, respectively. Appendix A describes the construction of the data set in detail and provides additional descriptive analyses.

3 Firm-level strategies to cope with supply-chain disruptions

We divide this section into two subsections. First, we describe whether Spanish manufacturing firms participating in GVCs are adopting diversification, nearshoring, friendshoring, reshoring, and stock-increasing strategies in response to the growing concern about supply-chain disruptions. Second, we analyze whether the implementation of these strategies varies depending on supplier, input, geography, firm, and industry characteristics.

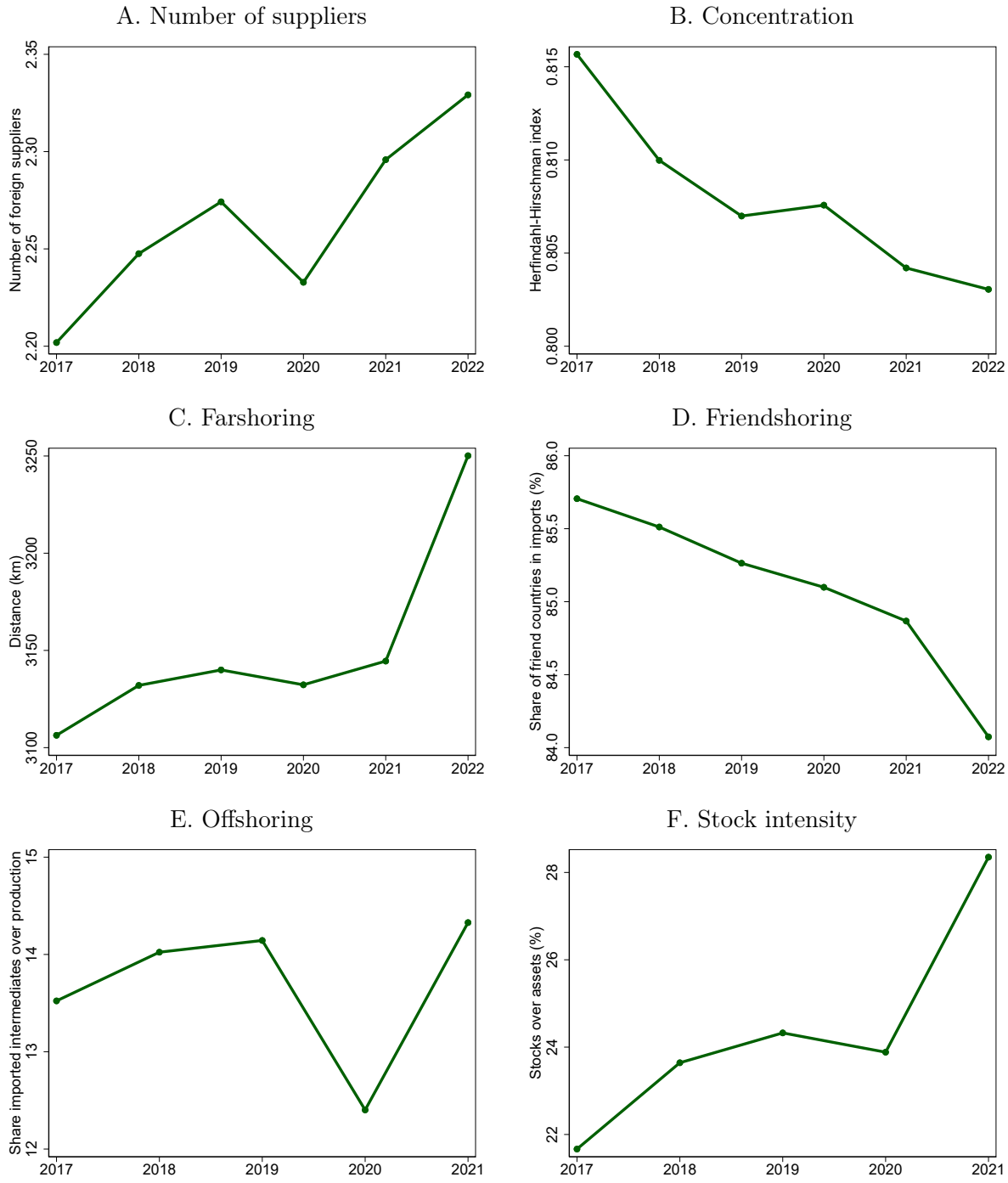
3.1 Evolution

Figure 1 shows whether firms are implementing diversification, nearshoring, friendshoring, reshoring, or stock-accumulation strategies. We define that a firm diversifies if it increases the number of countries it imports a particular intermediate from. Panel A plots the average number of countries supplying a firm×intermediate combination during the period 2017-2022. On average, a firm imported an intermediate from 2.2 countries in 2017. This number increased between 2017 and 2019, but it decreased in 2020, the Covid-19 year. Firms increased the number of suppliers in 2021 and 2022, reaching a 2.3 figure in the latter year. The figure indicates that, except for 2020, there is a modest upward trend in the number of suppliers. The median number of suppliers was 1 in 2017 and rose to 2 for the rest of the period. The evolution of the mean and the median indicate that firms have not significantly increased their number of suppliers in response to the growing concerns about supply-chain disruptions from 2020 onward.

Next, we calculate the Herfindahl-Hirschman concentration index of imports by supplier country in each firm×intermediate combination and plot the yearly average (panel B). We observe a reduction in concentration, only interrupted by the Covid-19 pandemic. Overall, we do not observe a major change in how Spanish exporters distribute their purchases across importers from 2020 onward.

To analyze whether firms are switching to geographically closer suppliers, we calculate the value-weighted distance of the suppliers in each firm×intermediate combination and compute the yearly average. Since a larger value denotes a more distant supplier, we have titled panel C "Farshoring" instead of "Nearshoring". In 2017, the average supplier was at 3,106 km, similar to the road distance between Madrid and Stockholm. There is an increase in the average distance of the supplier in the period 2017-2022. This indicates

Figure 1: Implementation of strategies to respond to supply-chain disruptions



Note: Each figure plots the yearly average of the variable. Panel A plots the number of countries per firm×intermediate combination. Panel B plots the Herfindahl-Hirschman index of the value of imports by supplier in a firm×intermediate combination. Panel C plots the import-value weighted distance of suppliers in a firm×intermediate combination. Panel D plots the share of imports that originate in countries that are friends of Spain in a firm×intermediate combination. A country is a friend of Spain if it voted "Yes" in the UN General Assembly's Resolution ES-11/1 "Aggression against Ukraine" (March 2, 2022). Panel E plots the share of imported intermediates in a firm's total. Panel F plots the stocks/total assets ratio. Data in panels A to D is at the firm×intermediate level and at the firm level in panels E and F.

that firms did not shift to geographically-closer suppliers in response to the rising concern about the disruption of supply chains from 2020 onward.

Panel D plots the average share of the import value that originates from countries that are friends of Spain. Following Javorcik et al. (2022), we identify a supplier country as a friend of Spain if it voted "Yes" in the UN General Assembly's Resolution ES-11/1 "Aggression against Ukraine" (March 2, 2022). We define that a firm friendshores if it increases the share of imports that originates in friend countries. There is a steady decrease in the share of imports that originate from friend countries between 2017 and 2021, and this trend accelerates in 2022. Therefore, we do not find either that the concern about supply-chain disruptions led manufacturers to increase the sourcing from countries that are friends of Spain from 2020 onward.

Panels E and F analyze the evolution of reshoring and stocks. Contrary to the previous panels where data was at the firm×intermediate level, in these latter panels data is at the firm level. This data comes from SABI, which reports the information about firms' annual accounts with a lag. At the moment of writing this paper, the latest data available was for 2021, so we had to shorten the time span of the analysis to the period 2017-2021 for panels E and F.

Panel E presents the evolution of the share of imported intermediates over total output. A raise in this ratio indicates offshoring and a decrease shows reshoring. After a decline in 2020, the ratio in 2021 recovers its pre-Covid level. Therefore, we find no reshoring by Spanish manufacturers participating in GVCs after the 2020 pandemic.

Our data set, by construction, forces firm×intermediate combinations to be alive in all years during the period 2017-2022. It might be the case that since the Covid-19 crisis, some firms decided to stop importing intermediates and procure them domestically. Our data set does not capture these cases and, hence, it might underestimate firms' reshoring activities. To address this concern, we build a new data set where firm×intermediate combinations have to be alive only between 2017 and 2019.[6] The offshoring trend in the new sample, which captures firms that decided to reshore their intermediate imports since 2020, is very similar to the one shown in panel E of Figure 1.[7]

Reshoring can be the result of two strategies: (i) the substitution of imported intermediates by production in the firm; or (ii) the substitution of imported intermediates by intermediates manufactured by domestic firms. To understand the mechanism driving the evolution of offshoring, we decompose the imported intermediates/output ratio in the

[6]The number of firms is 4,356 and the number of combinations is 37,017 compared to 3,939 firms and 26,139 combinations in the main sample. See Table A.11 in Appendix A.

[7]To save on space, the figure is not reported in the paper. It can be requested from the authors.

following two ratios:

$$\frac{Imported\ intermediates}{Output} = \frac{Imported\ intermediates}{All\ intermediates} \times \frac{All\ intermediates}{Output} \quad (1)$$

Panel A of Figure B.1 in Appendix B shows that the evolution of the share of imported intermediates over total intermediates is very similar to the share of imported intermediates over production. Panel B shows no major changes in the share of intermediates over production during the period 2017-2021. Information from these two panels suggests that the substitution away from foreign intermediates toward domestic ones was only temporary and it was reversed in 2021. We observe no substitution of imported or domestic intermediates by production at the firm level.

Panel F plots the average share of stocks over total assets, denoted as stock intensity, across Spanish manufacturers participating in GVCs.[8] We observe a clear increase in stock intensity after Covid: the share of stocks over total assets was 4 percentage points larger in 2021 than in 2019. This result suggests that firms have responded to the rising concerns about supply-chain disruptions increasing their stocks of intermediates and final products and shifting from just-in-time to just-in-case supply chain management systems (Jiang et al., 2022). Such a response would be in line with available empirical evidence which shows that firms with large inventory stocks are less sensitive to input supply disruptions than those with relatively low inventories (IMF, 2022; Lafrogne-Joussier et al., 2022). However, we should take our result with care, since we only have data for one year after the Covid-19 pandemic. Hence, we cannot determine whether the increase in stocks has become a permanent strategy.

To sum up, we find that Spanish manufacturers participating in GVCs have not implemented any diversification, nearshoring, friendshoring, or reshoring strategies in response to the growing concern about the disruption of supply chains since the outburst of the Covid-19 pandemic. We only observe that firms have increased their stock of intermediates. Hence, contrary to widespread expectations (De Backer et al., 2018; Lagarde, 2022; UNCTAD, 2022), we do not observe that firms are introducing profound changes in their supply-chain strategies by prioritizing safety over efficiency. They are not either rebalancing globalization and regionalization shifting suppliers to geographically closer and friendly countries. The lack of changes in how firms organize their value chains are related to the high costs of offshoring and their sunk nature. These reasons lead to hysteresis in offshoring decisions and make buyer-supplier networks sticky. Firms only increase their stocks, since this strategy offers a less costly way to respond to short-term disruptions in GVCs.

Since there is a single market for goods in the EU, Spanish firms may consider imports

[8] Results are robust to using a stock/output ratio instead of a stock/total assets one.

from different EU countries as if they originated from the same country. For example, it is unlikely that a Spanish firm would consider the substitution of a supplier in Sweden with a supplier in Germany as nearshoring. As an additional robustness check, in Figure B.2 in Appendix B, we reproduce panels A to D of Figure 1 assuming that all EU members belong to the same country.[9] We can only perform this robustness analysis for the variables that are calculated using data from AEAT-Customs, because this database provides information about the origin of intermediates. Although grouping EU countries leads to a change in the absolute value of the variables, their evolution is very similar to that presented in Figure 1.

3.2 Heterogeneity in the implementation of strategies

In the previous subsection, we concluded that Spanish manufacturers participating in GVCs have not implemented any diversification, nearshoring, friendshoring, or reshoring strategies to cope with the rising concerns about supply-chain disruptions. However, this lack of action may conceal differences in implementation across sub-groups. In this subsection, we explore the heterogeneity in the implementation of strategies across supplier, intermediate, geography, firm, and industry characteristics.

For each analyzed dimension, we separate the firm×imported intermediate combinations in two groups. For example, one exercise separates the firm×imported intermediate combinations in which China was the main supplier in 2017 from those in which it was not. For each group, we estimate the following equation:

$$y_{fkt} = \sum_{t=2017}^{t=2022} \beta_t D_t + \gamma_{fk} + \epsilon_{fkt} \tag{2}$$

where y_{fkt} is a variable capturing the implementation of a strategy (diversification, nearshoring, friendshoring) by firm f in intermediate k in year t. For strategies whose variable is measured at the firm level, reshoring and high inventories, the dependent variable is defined as y_{ft}. D_t is an indicator variable that turns one if the observation belongs to year t. γ_{fk} is a firm×intermediate fixed effect. It controls for all time-invariant factors at the firm-intermediate level that affect the intensity at which any of the analyzed strategies is implemented. ϵ_{fkt} is the disturbance term. We select 2019, the year before the Covid-19 pandemic, as the reference year. Hence, the β_t coefficients capture whether the dependent variable in year t was smaller or larger than in 2019. In particular, we want to analyze whether the coefficients for 2020, 2021, and 2022 were significantly different to that in 2019. We identify heterogeneity comparing the trend of the β_t coefficients in

[9] Although the UK officially left the EU in 2020, we consider it as an EU member for the whole 2017-2022 period.

one group with that in the alternative group.

Figure 2 analyzes heterogeneity in the number of suppliers. Panel A1 compares the evolution of the number of suppliers in a group of firm×intermediate combinations that had only one supplier in 2017 with another group that had >1 supplier in 2017.[10] The red-dashed line links the point values of the group that appears in the title of the panel. For example, the title of panel A1 is "One supplier". Hence, the red-dashed line links the point estimates of the one-supplier group. The blue line plots the point estimates of the >1-supplier group. We also plot the 95% confidence interval of each point estimate. In all dimensions, our expectation is that, from 2020 onward, diversification in the red-dashed-line group (the title of figure) to be more intense than in the blue-line one.[11] For example, we expect diversification to be more intense in the one-supplier group than in the >1-supplier group, since the former does not have the option to shift to another incumbent supplier if there is a disruption in the supply chain. The one-supplier group (red-dashed line) has an ascending trend before 2019 and continues to increase after that year. By contrast, there is a reduction in the number of suppliers in the >1-supplier group. Hence, in line with expectations, we find that the diversification effort was more intense among the one-supplier group than in the >1-supplier one since 2020. However, the diversification process in the one-supplier group had already begun before the Covid-19 pandemic and, therefore, does not seem to be the result of the rising concerns about supply-chain disruptions.

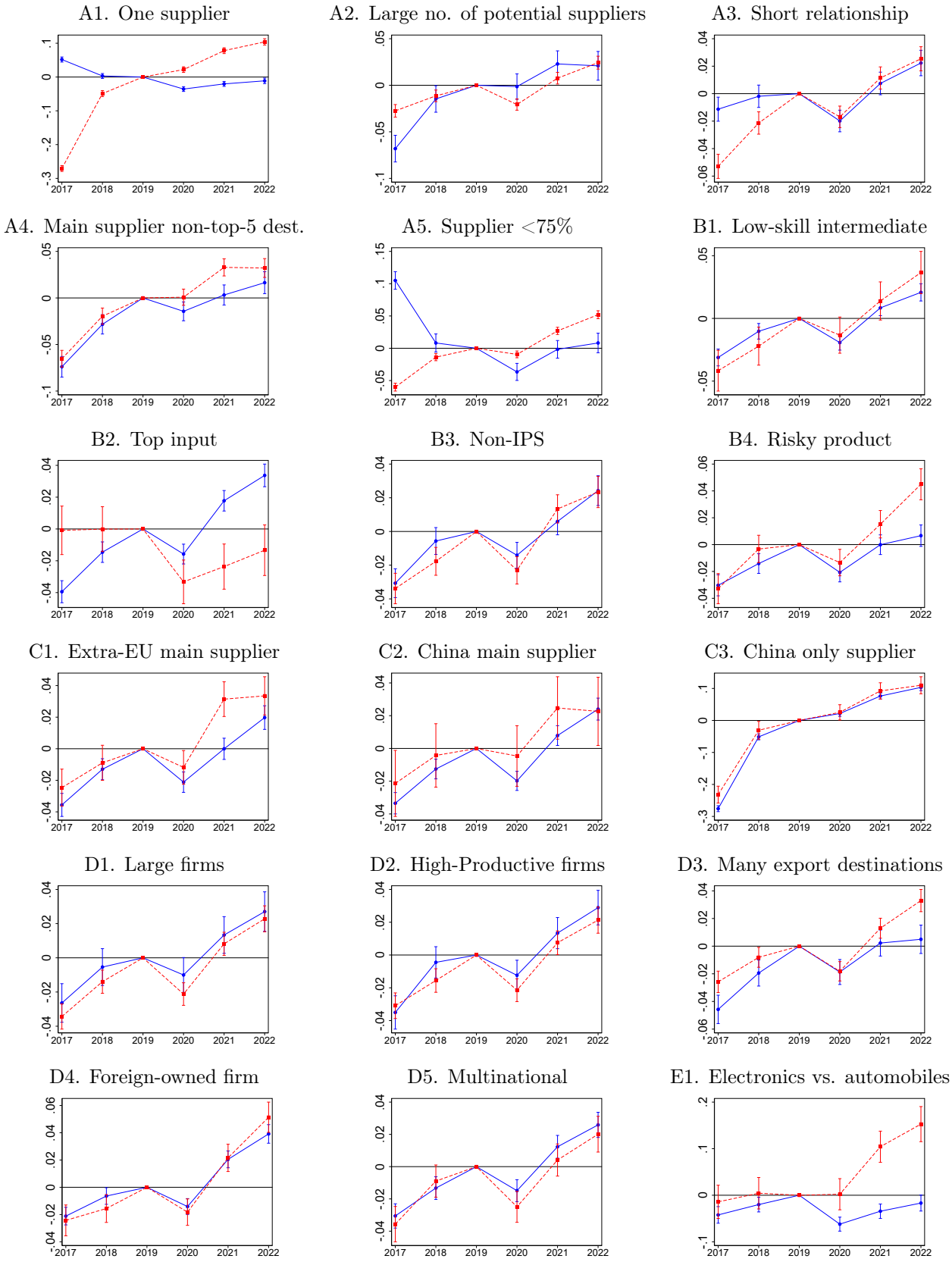
Panel A2 compares firm×intermediate combinations that had a large number of potential suppliers in 2017 with those that had a small number of potential suppliers. We measure the number of potential suppliers counting the countries that supplied the intermediate to Spain in 2017. We use the median as a threshold. Because they have more options to diversify, we expect the high-potential-suppliers' group to diversify more than the low-potential-suppliers one from 2020 onward. Contrary to our expectation, we do not observe any difference between the two groups.

Panel A3 analyzes the duration of the relationship between the firm and the supplier country. For each firm×intermediate combination, we select the period 2012-2016 and compute the number of years a firm imported from each country. Then, we calculate the import-value-weighted average duration of a relationship at the firm-intermediate level. We use the median as a threshold. A long relationship suggests that the supplier is

[10] Table A.8 in Appendix A shows that, on average, every year, most firm-intermediate combinations with only one supplier country at the beginning of the period have the same supplier at the end of the period (78.4%), a small percentage have a different supplier country (2.9%), and the rest increases the number of supplier countries (18.7%). For the group that expands the number of supplier countries, the majority have two supplier countries and one of them is the same supplier the firm had the previous year (14.0%). Only a small fraction of firms does not repeat the supplier country (0.7%).

[11] Tables A.12 and A.13 in Appendix A presents descriptive statistics of the dimensions analyzed in this section.

Figure 2: Heterogeneity. Number of suppliers



Note: Each panel plots the point values and the 95% confidence intervals estimated with Equation (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

providing the firm with an intermediate that is well suited to its needs. This makes the relationship more sticky and the supplier difficult to substitute (Antràs, 2020; Martin et al., 2021). Hence, we expect a firm to diversify less if its relationship is long. Contrary to expectations, we observe a similar trend after 2019 for long and short relationships.[12]

We analyzed heterogeneity in two additional supplier's dimensions. First, in each firm×intermediate combination, we selected the one corresponding to the country that was the most important supplier in 2017. Then, we analyzed whether that supplier was among the top-5 export destinations of the firm in 2017. Following Stöllinger et al. (2018), we expect firms to have stickier relationships with their suppliers if the country in which the supplier is located is also a major export destination for the firm. There are two reasons explaining this relationship. First, having a local supplier enables firms to react more swiftly to changes in preferences in demand. Second, some countries may require some local content to allow the import of goods. Contrary to our expectations, we find that the diversification trend for firm×intermediate combinations in which the main supplier was among the top-5 destinations of the firm was similar to those in which the main supplier was not among the top-5 destinations (panel A4).

Second, we focus on firm×intermediate combinations in which there are more than one supplier country. Following Martin et al. (2021), we consider that the quality of a supplier-customer matching increases with the value of the transaction. We define that the quality of a matching is high if the supplier accounts for 75% or more of a firm's intermediate imports. We expect diversification for this class of intermediate imports to be lower than for other intermediate imports. Panel A5 confirms our expectations.

Next, we explore heterogeneity along intermediates' characteristics. We analyze whether diversification in low-skill/low-technology intermediates has been more intense than in high-skill/high-technology ones.[13] Substitutability between suppliers is much easier when intermediates are intensive in low-skilled labor, have a low technological content, and they are standardized. In contrast, it is more difficult and costly to find alternative suppliers for highly complex and customized inputs (IMF, 2022). Contrary to our expectations, we find no statistically-significant differences between groups (panel B1).

In panel B2, we focus on firms that import more than one intermediate and identify their top intermediate. We find an increase in diversification in the non-top group and a reduction in diversification in the top group from 2019 onward. This result is contrary to our expectation. We predicted that a firm would put more effort into diversifying the suppliers of its top input than in the non-top ones.

The BEC discriminates between processed and specific intermediates (IPS) and the

[12]Results are qualitatively similar when we compare a group whose duration is below the 25th percentile with another whose duration is above the 75th percentile.

[13]We use the low-skill/low-technology classification in Basu and Das (2011).

rest of intermediates. The first group encompasses intermediates used in GVCs. Since firm-supplier relationships tend to be stickier in GVCs (Antràs, 2020; Martin et al., 2021), similar to Panel A3, we expect less diversification in IPS than in non-IPS from 2019 onward. Contrary to our expectations, both groups follow a similar trend (panel B3).

The risk of supply-chains disruptions may be higher in some intermediates than others. We use the list of high-risk products developed by Reiter and Stehrer (2022) to classify intermediates as risky or non-risky. If firms are concerned about supply-chain disruptions, we expect them to prioritize diversification in intermediates belonging to the risky group. Panel B4 confirms this expectation.

Panels C explore the heterogeneity in the response due to the geographical location of the supplier. Panel C1 analyzes the evolution of diversification when the most important supplier is outside or within the EU. We expect diversification to be stronger after 2019 in intermediates that are sourced outside the EU, since a Spanish firm is likely to perceive a higher risk of disruption if the main supplier is in that region. Contrary to our expectations, we observe that the trends are similar for intermediates whose main supplier is outside the EU or within the EU.[14]

Panel C2 explores whether diversification efforts were stronger for firms whose main supplier was in China. We expect diversification efforts to be stronger for this group, because Covid-related social distancing measures lasted longer in China than in other countries. Contrary to our expectations, we find that having the main supplier in China did not lead to a more intense diversification effort. China's industrial clusters with highly specialized suppliers of low-cost intermediates would explain why this country continues to be an important supplier of certain components (Xia and Lorente-Salabarria, 2023).

We further explore diversification from China focusing on firm×intermediate combinations in which China was the only supplier in 2017. Some media analyses contend that firms that had all their suppliers in China began to seek suppliers in other countries after the Covid-19 pandemic.[15] This strategy is denoted as China+1. We built a sub-sample of firm×intermediate combinations that only had one supplier country in 2017. Panel C3 compares the evolution of diversification for China-only-supplier combinations with that of other single-supplier combinations. There is a diversification process in the China-only-supplier group. However, there is an identical process in the other group. Although the results point towards a China+1 strategy, the diversification effort is similar to that followed by firms that only had one supplier per intermediate.[16]

[14] We get the same results when we perform the analysis for the top input.

[15] See, for example, the Financial Times analysis about Apple's dependence on China published on January 17, 2023: https://www.ft.com/content/d5a80891-b27d-4110-90c9-561b7836f11b.

[16] Each year there are about 1,500 firm-intermediate combinations with China as the unique supplier (Table A.9 in Appendix A). About 200 of them expand the number of suppliers to two including China the next year. Among these "China+1" pairs, the most frequent new supplier is an EU28 country (41%), with Germany the first choice in the group (Table A.10 in Appendix A). The second most frequent supplier

Panels D explore heterogeneity among firms' dimensions. First, we find that diversification efforts after 2019 were similar for large and small firms, and for high-productive and low-productive firms in 2017 (panels D1 and D2).[17] These results are contrary to our expectations. We predicted large and high-productive firms to have more resources to overcome the barriers to identify suitable suppliers in new countries. Panel D3 analyzes whether diversification has been more intense in firms that had many export destinations in 2017 than in those that had few export destinations.[18] Our expectation is that firms exporting to many markets can gather more information about potential suppliers than firms selling to few markets.[19] In line with this prediction, we find that firms exporting to many destinations diversified more their suppliers after 2019.

In addition, we analyze diversification in Spanish firms whose capital was controlled by foreign firms in 2017 and Spanish firms that had foreign affiliates in 2017.[20] In both cases, we expect a larger diversification, since these firms have more information to identify alternative foreign suppliers. Contrary to our expectations, we find no significant differences between foreign-owned and domestically-owned firms (panel D4), and multinational and non-multinational firms (panel D5).

Finally, we analyze heterogeneity across industries. Specifically, we compare the strategies of two major GVC industries: electronics and automobiles. The former is characterized by GVCs which are centered in Asia and rely less on customized inputs. The latter is characterized by large relationship-specific investments and low substitutability, because parts and components are customized and need to abide by safety and other regulatory standards (Freund et al., 2022). In response to a shock, we expect the number of supplier countries to raise more in electronics than in automobiles, since the potential number of supplier countries is larger in the former than the latter. Panel E1 confirms our expectations.

Figure 3 explores heterogeneity in farshoring.[21] It has the same structure and includes the same dimensions as Figure 2. We only observe a significant difference in 2022-point estimates between groups in 6 out of the 18 dimensions. A process of nearshoring occurs

is an OECD developed country (19.6%), with USA the first choice in this group. Hong-Kong represents 12.3%, followed by India, Turkey, and Mexico. Other Asian countries such as Vietnam, Indonesia, Thailand, Philippines, and Malaysia appear as additional suppliers but with a very low frequency.

[17] The size and productivity of firms is measured with employment and labor productivity, respectively. We use the median as a threshold. Results are similar if we compare the above-75th-percentile group with the below-25th-percentile one.

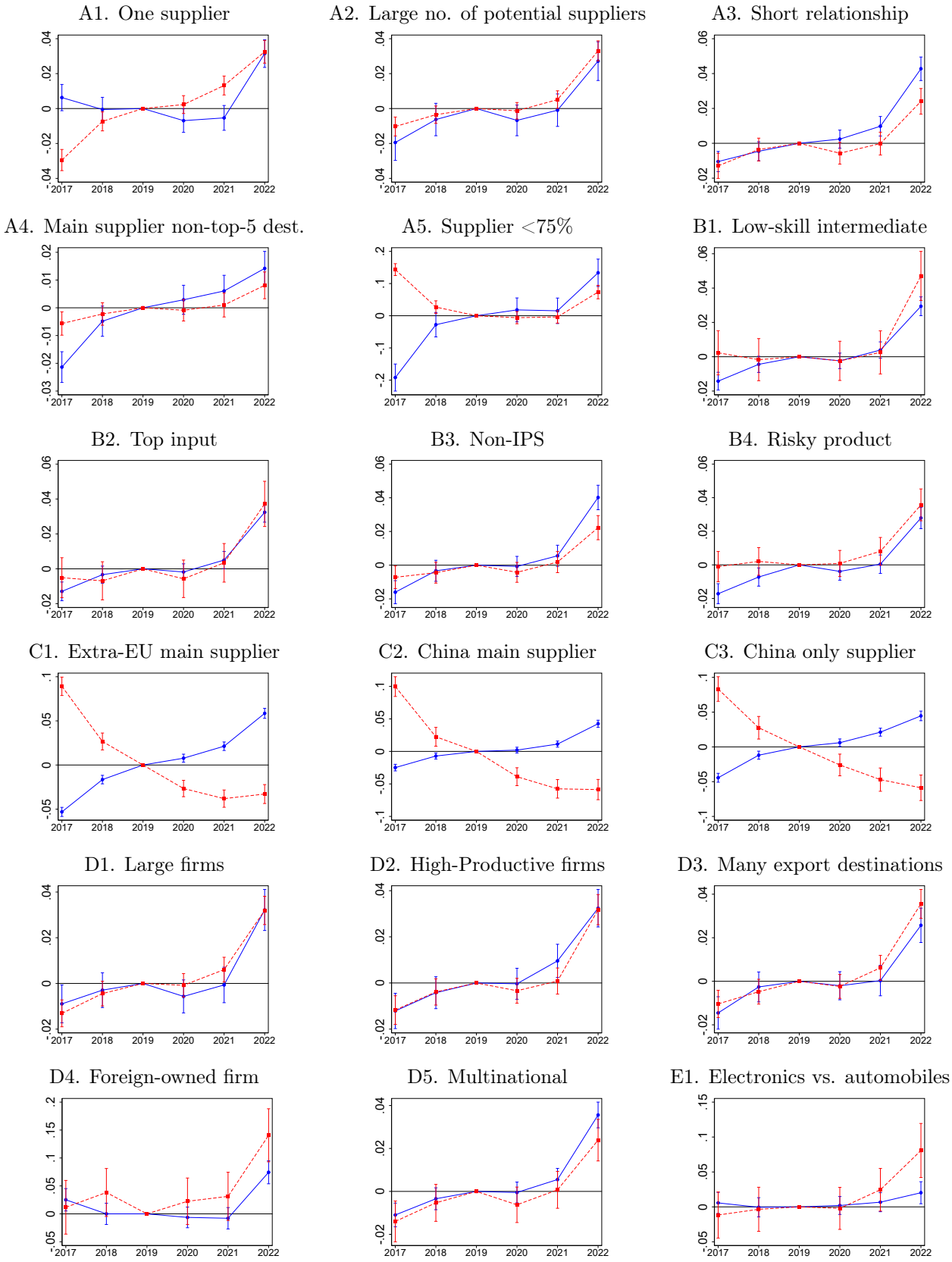
[18] We use the median number of export destinations to define the two groups.

[19] A positive correlation between export and import activity due to operational costs complementarities was modeled by Kasahara and Lapham (2013), Bernard et al. (2018), and Albornoz and Garcia-Lembergman (2019).

[20] We define that a Spanish firm is controlled by a foreign firm if the latter has more than 50% of the capital of the former. We define that a Spanish firm is a multinational if it controls more than 50% of the capital of a foreign firm. Data comes from SABI.

[21] We do not present the figures for concentration, since the trends are qualitatively similar to those reported in Figure 2. These figures can be requested from the authors.

Figure 3: Heterogeneity. Farshoring



Note: Each panel plots the point values and the 95% confidence intervals estimated with Equation (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

for firm×intermediate combinations where the main supplier was outside the EU, in China, or the only supplier was in China in 2017 (panels C). However, in all cases, the downward trend begins in 2017 and it does not accelerate from 2019 onward. Furthermore, the nearshoring processes may reflect a reversion to the mean: it is easier to reduce a firm's distance to its suppliers if its most important supplier is already distant. To test this hypothesis, we built a sub-sample of firm×intermediate combinations where the main supplier was located at more than 9,000 km (flight distance) from Spain. Panel A of Figure B.3 in Appendix B compares the nearshoring process when the main supplier was in China (red-dashed line) or another distant country (blue line). The nearshoring process happens in both groups. We obtain a similar result when we compare firm×intermediate combinations whose only supplier is in China with those whose only supplier is also in a distant country in 2017.[22] These results indicate that the nearshoring processes observed in panels C are the result of a mechanical effect.

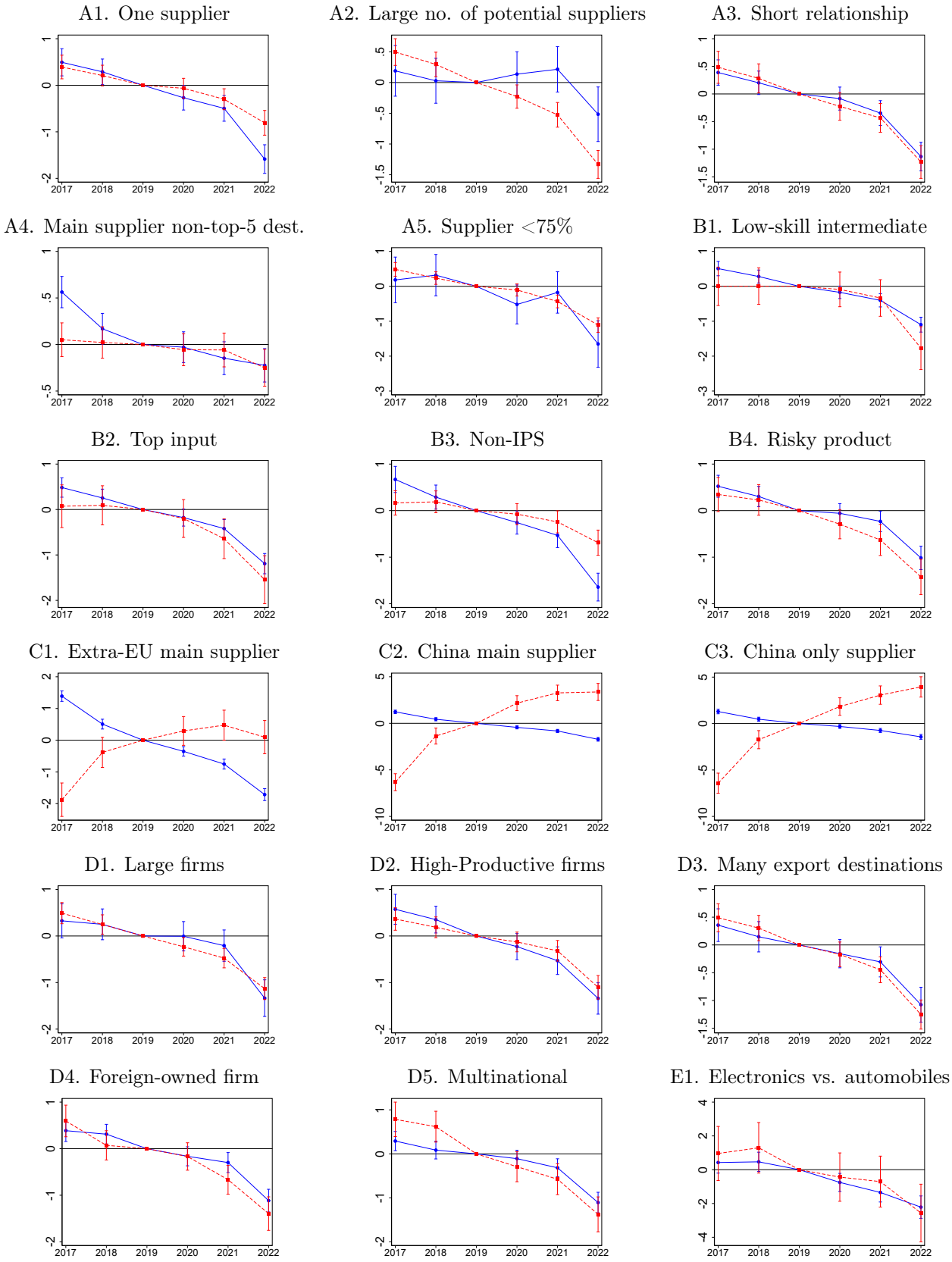
We also find that farshoring was less intense in short-term relationships (panel A3) and non-IPS (panel B2). This is against our expectations since both characteristics are connected to less-sticky supplier-customer relationships. Finally, we find that farshoring was more intense in the electronics than in the automobile industry (panel E1). This is in line with expectations, since value chains are global in electronics and regional in automobiles.

Figure 4 explores heterogeneity in friendshoring. We observe a significant difference between groups in 2022-point estimates in 6 out of 18 dimensions. Friendshoring decreases less among firm×intermediate combinations that had one supplier or a small number of potential suppliers in 2017 (red-dashed line in panel A1 and blue line in panel A2). This result is in line with our expectations: having a small number of actual or potential suppliers makes manufacturers less likely to substitute a friendly with an unfriendly supplier than firms that had many actual or potential suppliers. Friendshoring decreases less in non-IPS than in IPS from 2020 onward (panel B2). This is against our expectations. We predicted a lower reduction in friendshoring for IPS, since they are characterized by longer and more sticky customer-supplier relationships.

There is friendshoring for inputs whose main supplier was outside the EU, in China, or the only supplier was in China in 2017. This result is in line with our expectations: firms diversify towards friend countries if their supplies originate from non-friend countries. If countries that are not friends of Spain are farther and firms having distant suppliers diversify to closer suppliers, the friendshoring processes observed in panels C could be the result of a mechanical process. To rule out this possibility, we compare the friendshoring process in firm×intermediate combination in which China was the main supplier with other combinations where the main supplier was also more than 9,000 km

[22] To save on space, we do not report this figure. It can be requested from the authors.

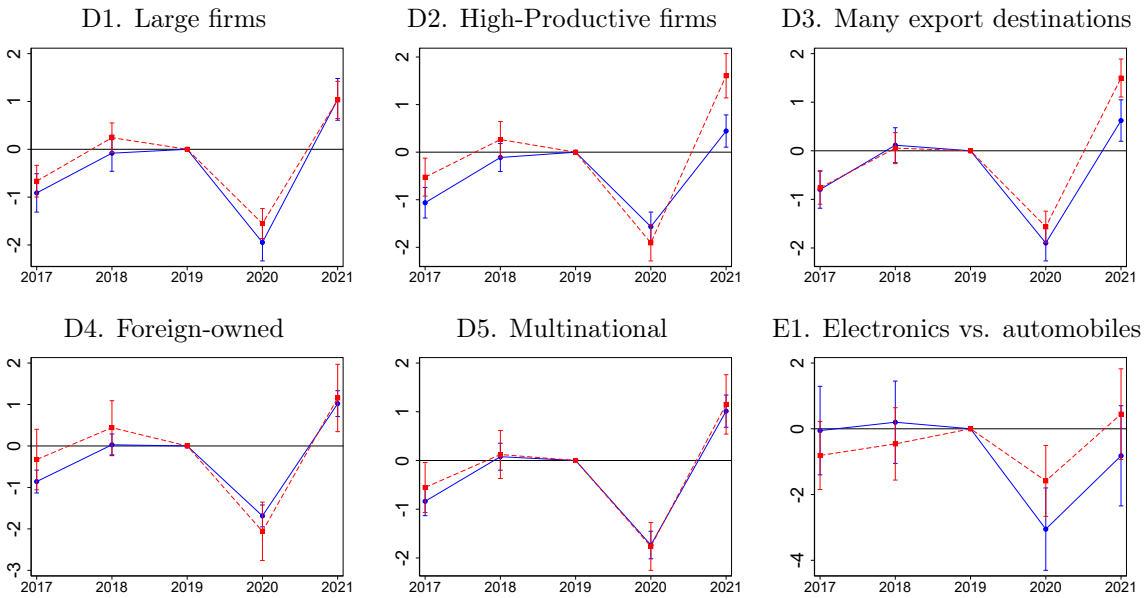
Figure 4: Heterogeneity. Friendshoring



Note: Each panel plots the point values and the 95% confidence intervals estimated with Equation (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

away from Spain. Panel B of Figure B.3 in Appendix B shows a friendshoring process for combinations whose main supplier was in China, but not for combinations whose main supplier was in another distant country. Hence, in this case, the friendshoring process is not the result of a mechanical effect.

Figure 5: Heterogeneity. Offshoring



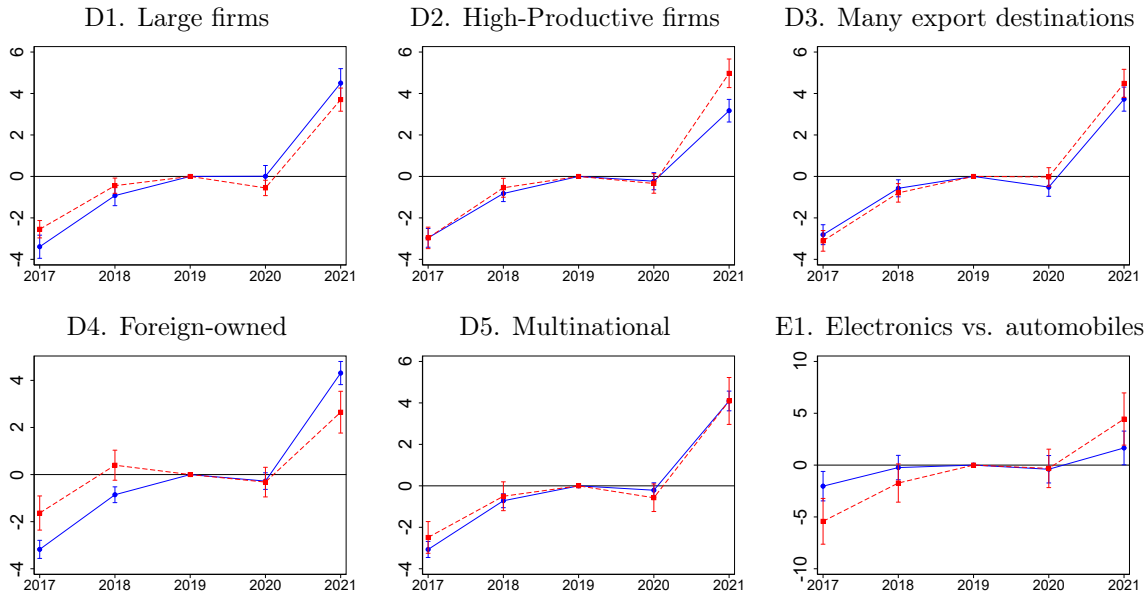
Note: Each panel plots the point values and the 95% confidence intervals estimated with Equation (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

Figures 5 and 6 present the heterogeneity analyses for offshoring and stock intensity. Since these indicators are calculated at the firm level, all heterogeneity analyses are performed on firm-level variables: employment, productivity, number of export destinations, foreign-owned, multinational, and industry at which the firm operates.

Figure 5 shows that the foreign intermediates/production ratio increased more among high-productive firms and manufacturers that had many export destinations after 2020. We observe similar trends for large and small firms, foreign-owned and domestic firms, multinational and non-multinational firms, and firms operating in the electronics and automobile industries. Figure 6 shows that the increase in stocks was larger in high-productive than low-productive firms, and in domestic than in foreign-owned firms since 2020. We observe no significant differences in trends between large and small firms, firms with many or few export destinations, multinational and non-multinational firms, and firms operating in the electronics and automobile industries.

As in the previous subsection, we investigate whether results are robust to grouping all EU members into a single country. Results confirm that diversification is more intense among firms that import intermediates from one supplier and intermediates that have

Figure 6: Heterogeneity. Stock intensity



Note: Each panel plots the point values and the 95% confidence intervals estimated with Equation (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

a higher risk of experiencing a disruption in the value-added chain. However, we also find now that there is more diversification when the input is sourced within the EU or China is the main supplier. When we consider all EU members as part of a single country, it is less likely that a non-EU country will remain as the main supplier. If it remains, it may indicate that the supplier is more difficult to substitute and, hence, less diversification occurs. We also find that diversification is similar for firms that had few or many export destinations in 2017. We still find that farshoring is less intense for intermediates whose main supplier is outside the EU or in China. However, there are no longer differences between IPS and the rest of intermediates, and between the electronics and the automobile industry. Finally, we also find similar results in the baseline and the new sample for friedshoring.

4 Conclusion

This paper has examined whether Spanish manufacturers participating in GVCs have implemented any strategy in response to the rising concern about supply-chain disruptions since the outbreak of the Covid-19 pandemic. We analyzed six strategies a firm can implement to smooth the effect of a supply-chain disruption: (i) increase the number of supplier countries; (ii) reduce the dependence on some suppliers; (iii) substitute geographically-distant suppliers by close ones; (iv) substitute suppliers from countries

that do not share some core values with countries that share them; (v) substitute imports by domestic production; and (vi) increase the level of stocks.

We find that despite a growing concern about supply-chain disruptions since 2020, Spanish firms have only adopted one of the above-listed strategies: the increase in stocks. We also discover that firms have adopted diversification strategies in some particular cases: when they have one supplier, have more than one supplier and none of them is significantly more important than the others, export to many destinations, or the intermediate has a high risk of experiencing a supply-chain disruption. Diversification is also more intense in the electronics than in the automobile industry. Firms switch imports to countries that are geographically and geopolitically close to Spain when their main supplier is geographically distant. However, this trend predates the Covid-19 pandemic.

Our results indicate that there is a high level of stability in GVCs. This happens because there are costs associated with reconfiguring GVCs. The easiest and least-cost strategy seems to be increasing firms' inventories to hold safety stocks. The remaining strategies are more difficult and costly to implement because they involve an alteration of the firms' supply-chains. The design of these supply-chains is based on production efficiency and they tend to be sticky due to the trust and reliability that is built between customers and suppliers. This creates a hysteresis effect in offshoring decisions. Among these strategies, diversification seems to be a less costly way to reduce exposure to supply-chain disruptions. Consequently, it is more intensively adopted by firms with a higher supplier concentration and which use intermediates that have a higher risk of supply-chain disruptions. Nearshoring and friendshoring are supply-chain reorganization strategies that bear higher fixed costs. This explains why these strategies are only adopted by firms whose main supplier is geographically distant. Reshoring is the highest-cost strategy, since it entails the reversion of previous offshoring decisions. This explains why we do not observe any reshoring strategy among Spanish firms.

Hence, contrary to widespread expectations, we do not observe systemic changes in how firms organize their supply chains since the outbreak of the Covid-19 pandemic. Our results suggest that recent disruptions have not been perceived as severe and permanent enough to justify the adoption of reshoring, nearshoring, and friendshoring strategies. Moreover, the trends observed in some particular cases towards greater diversification, reshoring, and friendshoring began to be adopted before the outbreak of the Covid pandemic. That is, the recent disruption events seem to be accelerating already existing trends of supply-chain rationalization motivated by the reduction in labor cost differentials between China and closer countries, and the uncertainty about trade policy. Although increasing geopolitical tensions, technological factors, and sustainability reasons might contribute to the reconfiguration of GVCs, this process could take longer than initially expected.

References

Albornoz, F. and Garcia-Lembergman, E. (2019). Importing after exporting. *University of Nottingham-GEP Discussion Paper 2019-11*.

Antràs, P. (2020). De-globalisation? Global value chains in the post-COVID-19 age. *NBER Working Paper 28115*.

Antràs, P. and Chor, D. (2022). Global value chains. In Gopinath, G., Helpman, E., and Rogoff, K., editors, *Handbook of International Economics: International Trade, Volume 5*, pages 297–376. Elsevier.

Bacchetta, M., Bekkers, E., Piermartini, R., Rubinova, S., Stolzenburg, V., and Xu, A. (2021). Covid-19 and global value chains. *World Trade Organisation*.

Baldwin, R. and Freeman, R. (2022). Risks and global supply chains: What we know and what we need to know. *Annual Review of Economics*, 14:153–180.

Basu, S. R. and Das, M. (2011). *Export structure and economic performance in developing countries: Evidence from nonparametric methodology*. United Nations.

Behrens, K., Corcos, G., and Mion, G. (2013). Trade crisis? What trade crisis? *The Review of Economics and Statistics*, 95(2):702–709.

Bernard, A. B., Jensen, J. B., Redding, S. J., and Schott, P. K. (2018). Global firms. *Journal of Economic Literature*, 56(2):565–619.

Boehm, C. E., Flaaen, A., and Pandalai-Nayar, N. (2019). Input linkages and the transmission of shocks: Firm-level evidence from the 2011 Tohoku earthquake. *The Review of Economics and Statistics*, 101(1):60–75.

Bontadini, F., Evangelista, R., Meliciani, V., and Savona, M. (2022). Patterns of integration in global value chains and the changing structure of employment in Europe. *Industrial and Corporate Change*, 31(3):811–837.

Carvalho, V. M., Nirei, M., Saito, Y. U., and Tahbaz-Salehi, A. (2021). Supply Chain Disruptions: Evidence from the Great East Japan Earthquake. *The Quarterly Journal of Economics*, 136(2):1255–1321.

Chidlow, A., Pegoraro, D., and De Propris, L. (2020). De-globalisation value chains and reshoring. In *Industry 4.0 and Regional Transformations*. Routledge.

De Backer, K., DeStefano, T., Menon, C., and Suh, J. R. (2018). Industrial robotics and the global organisation of production. *OECD Science, Technology and Industry Working Papers, 2018/03*.

Di Stefano, E., Giovannetti, G., Mancini, M., Marvasi, E., and Vannelli, G. (2022). Reshoring and plant closures in Covid-19 times: Evidence from Italian MNEs. *International Economics*, 172:255–277.

Díaz-Mora, C., Gandoy-Juste, R., and González-Díaz, B. (2020). El momento de las cadenas regionales de valor: La integración comercial en la Península Ibérica. *Información Comercial Española. Cuadernos de Economía*, (100):11–33.

EBRD (2022). Transition Report 2022-2023. Business as Unusual. European Bank for Reconstruction and Development.

Freund, C., Mattoo, A., Mulabdic, A., and Ruta, M. (2022). Natural disasters and the reshaping of global value chains. *IMF Economic Review*, 70(3):590–623.

IMF (2022). World Economic Outlook: War sets back the global recovery. *IMF*.

Javorcik, B. S., Kitzmueller, L., Schweiger, H., and Yıldırım, M. A. (2022). Economic costs of friend-shoring. *EBRD Working Paper No. 274, European Bank for Reconstruction and Development*.

Jiang, B., Rigobon, D., and Rigobon, R. (2022). From just-in-time, to just-in-case, to just-in-worst-case: Simple models of a global supply chain under uncertain aggregate shocks. *IMF Economic Review*, 70(1):141–184.

Kasahara, H. and Lapham, B. (2013). Productivity and the decision to import and export: Theory and evidence. *Journal of International Economics*, 89(2):297–316.

Khanna, G., Morales, N., and Pandalai-Nayar, N. (2022). Supply chain resilience: Evidence from Indian firms. *NBER Working Paper 30689*. National Bureau of Economic Research.

Lafrogne-Joussier, R., Martin, J., and Mejean, I. (2022). Supply shocks in supply chains: Evidence from the early lockdown in China. *IMF Economic Review*, pages 1–46.

Lagarde, C. (2022). A new global map: European resilience in a changing world. *Presentation at Peterson Institute for International Economics, Washington DC*.

Martin, J., Mejean, I., and Parenti, M. (2021). Relationship stickiness and economic uncertainty. *CEPR Discussion Paper 15609*.

Marvasi, E. (2022). *Global Value Chain resilience and reshoring during Covid-19: challenges in a post-covid world*. Dipartimento di Economia, Università degli Studi Roma Tre.

McKinsey (2022). Taking the pulse of shifting supply chain. Available at https://www.mckinsey.com/capabilities/operations/our-insights/taking-the-pulse-of-shifting-supply-chains.

Minondo, A. (2021). Impact of COVID-19 on the trade of goods and services in Spain. *Applied Economic Analysis*, 29(85):58–76.

Reiter, O. and Stehrer, R. (2022). Assessing the importance of risky products in international trade and global value chains. *Empirica*.

Shingal, A. and Agarwal, P. (2020). How did trade in GVC-based products respond to previous health shocks? Lessons for COVID-19. Technical report, European University Institute.

Stöllinger, R., Hanzl-Weiss, D., Leitner, S. M., and Stehrer, R. (2018). *Global and regional value chains: How important, how different?* Vienna Institute for International Economic Studies Vienna.

UNCTAD (2022). Impact of the Covid-19 pandemic on trade and development: Lessons learned.

Van Beveren, I., Bernard, A. B., and Vandenbussche, H. (2012). Concording EU trade and production data over time. *NBER Working Paper No. 18604*, National Bureau of Economic Research.

Xia, L. and Lorente-Salabarria, J. (2023). Which economies are to benefit from China's industry relocation? *BBVA Research, Industry, Note March 10, 2023*.

Appendix A Data, variables, and descriptives

We construct our data set as follows. First, we select all firms in the AEAT-Customs database in 2017 that import at least one product from one country of origin (column 1 of Table A.1). There are 85,306 importing firms, buying 8,292 different products from 222 countries (or territories) for a value of 298 billion euros. The number of firm-product pairs (fp) is 591,729 and the number of firm-product-country (fpc) triplets is 845,885. The average value of imports per firm-product is 504 thousand euros and the median value is 16 thousand euros. Second, we select only intermediate imported products and countries with more than 1 million population (column 2 of Table A.1). There are 48,690 importing firms, buying 4,671 different intermediates from 152 countries for a value of 170 billion euros (column 3 of Table A.1). Third, we select only firm-product pairs that regularly show positive imports six consecutive years. There are 20,135 firms, 88,330 firm-product pairs, and 180,509 firm-product-country triplets (column 3 of Table A.1). Fourth, we select manufacturing firms with 10 or more employees over the sample period. There are 4,348 firms, 27,391 firm-product pairs, and 59,685 firm-product-country triplets (column 4 of Table A.1). Fifth and last, we identify firms exporting and importing simultaneously over the sample period. The sample contains 3,939 firms importing 3,156 intermediates from 138 countries. The final number of firm-product pairs in 2017 is 26,139 and the final number of firm-product-country triplets is 57,555 (column 5 of Table A.1).

Table A.1: Construction of sample

	Customs ⇒	Intermediates ⇒	Regular ⇒	Manuf10 ⇒	Twoway
Observations	845885	403710	180509	59685	57555
Firms (f)	85306	48150	20135	4348	3939
Products (p)	8292	4667	3993	3196	3156
Countries	222	152	147	139	138
Value(bn eur)	298	170	113	55	54
fp pairs	591729	276317	89330	27391	26139
Mean(th eur)	504	618	1265	2020	2091
P50(th eur)	16	19	95	123	125

Notes: Intermediates stands for products classified as intermediate goods according to BEC rev 5 classification. Regular stands for firms importing six consecutive years the same intermediate product. Manuf10 stands for firms whose main activity is manufactures and employ 10 or more employees over six years. Twoway stands for firms exporting and importing simultaneously over the six years.

Table A.2 shows the evolution of the number of firm-product-country triplets. The number of triplets is 57,530 in 2017 and 60,859 in 2022, exhibiting an average yearly growth rate of 1.1% over the six-year period.

Figure A.1 shows the distribution of the 3,939 firms by manufacturing sector (NACE 2 digits). The sectors with the largest proportion of firms are metal products (438 firms), mechanical machinery (419), chemistry (402), and food (400). The industries of tobacco (NACE 12) and petroleum (NACE 19) are excluded.

Table A.2: Sample descriptives

	2017	2018	2019	2020	2021	2022	2017-22
Firms(f)	3939	3939	3939	3939	3939	3939	3939
Products(p)	3156	3156	3156	3156	3156	3156	3156
Countries(c)	138	136	132	139	135	132	147
fp pairs	26139	26139	26139	26139	26139	26139	26139
fpc triplets	57555	58749	59445	58364	60011	60882	355006

Table A.3 shows the distribution of firm-product pairs by number of countries of origin. Half of the firm-product pairs have only one country of origin in 2017 (50.7%), accounting for 42.6% of the import value. Six years later, the participation is slightly smaller in number (48.4%), but larger in import value (45.9%).

Figure A.1: Distribution of firms by manufacturing sector

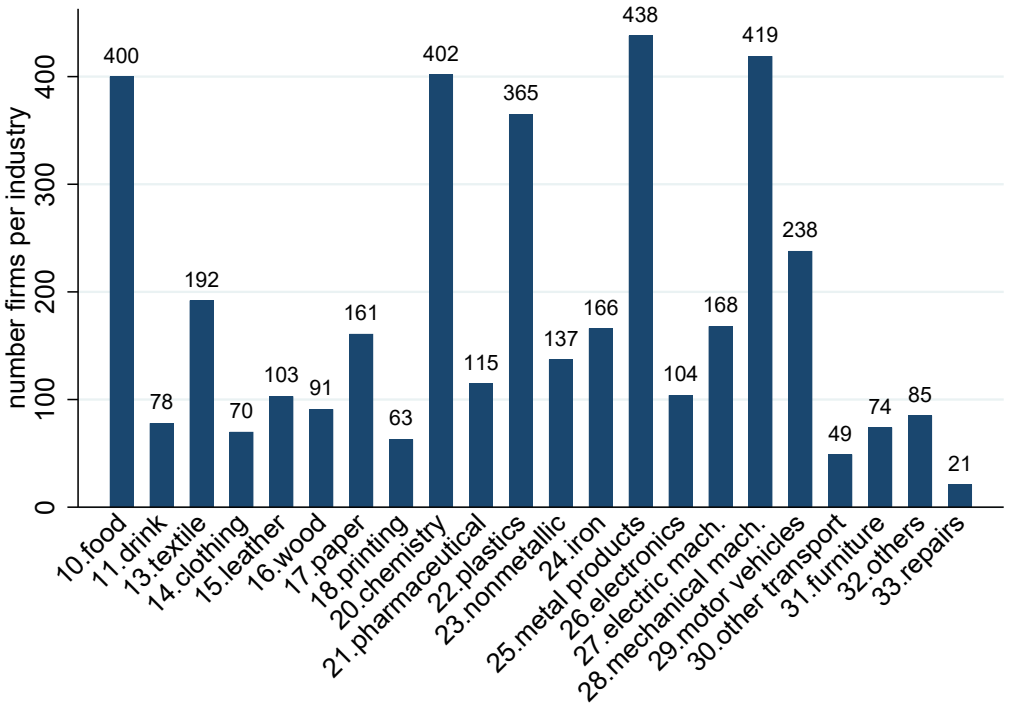


Table A.4 shows the ranking of the top-15 countries of origin among all firm-intermediate-country of origin triplets. In 2017, the most frequent country of origin is Germany (17.5%), followed by Italy (11.8%), and France (11.4%). The ranking is different when we sort countries according to the value of imports. France occupies the first position (17.8%), followed by Germany (17.0%) and Italy (6.5%). The fourth position in the ranking is occupied by China, which has increased its participation steadily over the entire period both in terms of frequency (from 7.6% in 2017 to 8.5% in 2022) and of import

Table A.3: Firm-intermediate pairs by number of countries of origin and year

	Year 2017		Year 2022	
Number of suppliers	% pairs	% import value	% pairs	% import value
1	50.7	42.6	48.4	45.9
2	23.3	23.4	23.1	22.9
3	10.9	8.7	11.4	8.8
4	5.5	5.7	6.3	7.2
5	3.3	6.8	3.5	4.4
6	1.9	5.7	2.3	2.5
7	1.2	4.6	1.6	3.9
8	0.8	2.1	0.9	1.6
9	0.6	1.3	0.5	0.6
10 o more	1.3	3.9	1.7	2.2
Total	100.0	100.0	100.0	100.0

Note: The number of firm-intermediate pairs is the same every year: 26,122.

value (from 4.0% in 2017 to 6.3% in 2022).

Table A.5 presents the transition matrix of the number of countries a firm imports an intermediate from. When a firm imports an intermediate from one destination, the probability to buy from one country of origin again is 81%; and the chances that the number of countries of origin increases from 1 to 2 is 14%. As the initial number of countries of origin per firm-intermediate increases, the likelihood of changing the number of countries of origin the next year increases. When the country portfolio is greater than one, the likelihood of entry is smaller than the one of exit.

Table A.4: Firm-intermediate-country triplets by top-15 countries of origin and year

	Year 2017		Year 2022	
Country of origin	% triplets	% imports	% triplets	% imports
Germany	17.57	17.02	16.54	14.57
Italy	11.84	6.59	11.81	6.42
France	11.43	17.86	10.68	15.31
China	7.58	4.02	8.55	6.32
Netherlands	5.26	3.24	5.30	3.28
United Kingdom	5.11	4.70	3.00	4.82
Portugal	4.85	4.37	4.91	4.58
United States	4.07	4.08	4.15	5.14
Belgium	3.99	2.02	3.92	2.04
India	1.99	1.17	2.26	1.39
Poland	1.95	2.89	2.36	2.07
Turkey	1.82	1.29	2.22	2.14
Austria	1.66	0.89	1.81	0.81
Czech Republic	1.60	1.89	1.72	1.79
Sweden	1.46	0.72	1.37	0.93
Total	100.00	100.00	100.00	100.00

Note: The number of firm-intermediate-country triplets is 57,555 in 2017 and 60,882 in 2022.

The sample contains 3,156 intermediate imported products. Table A.6 presents the list of the top-30 intermediate products imported by Spanish manufacturers in 2017. The most important product is "Parts and accessories for the industrial assembly of motor vehicles", which represents 7.96% of total intermediate imports in 2017. Six years later,

Table A.5: Transition matrix of number of country of origin a firm-intermediate buys from, year-to-year, 2017-2022

	Number of origins in t-1				
	1	2	3	4	5
+5 or more countries	0.001	0.003	0.005	0.006	0.016
+4 countries	0.002	0.004	0.005	0.007	0.015
+3 countries	0.008	0.010	0.016	0.022	0.032
+2 countries	0.029	0.041	0.050	0.058	0.067
+1 countries	0.147	0.152	0.145	0.144	0.141
No change	**0.813**	**0.494**	**0.358**	**0.306**	**0.209**
-1 country		0.297	0.305	0.266	0.212
-2 countries			0.117	0.144	0.146
-3 countries				0.047	0.080
-4 countries					0.043
-5 o more countries					0.040
Total entries	0.19	0.21	0.22	0.24	0.27
Total exits		0.30	0.42	0.46	0.52

it is still the most important product. The main supplier is France in both years. The ranking of intermediates changes over time as does the main supplier for 12 of the top-30 products.

Additionally, Table A.7 presents the top imported intermediate in each sector over the period 2017-2022. The main imported intermediate in some sectors represents a quite substantial share in the total imports of intermediates of the sector. For example, "33021040-Mixtures of odoriferous substances and mixtures" accounts for 48.32% of all intermediate imports in the beverages sector and "30049000-Medicaments consisting of mixed or unmixed products for therapeutic use" accounts for 41.98% in the pharmaceutical sector.

Table A.6: Top 30 intermediate imports

CN8 code	Description code	Share 2017	Main supplier	Share 2022	Main supplier
87089912	Parts and accessories for the industrial assembly of motor vehicles	7.96	France	4.62	France
30049000	Medicaments consisting of mixed or unmixed products for therapeutic use	4.36	Switzerland	3.32	Germany
26030000	Copper ores and concentrates	2.77	Chile	2.42	Chile
87090000	Parts and accessories for tractors, motor vehicles for the transport	2.48	Germany	3.46	France
87084048	Gear boxes and parts thereof, for the industrial assembly of motor vehicles	2.33	Germany	2.13	Germany
84082056	Compression-ignition internal combustion piston engine diesel	1.90	France	0.86	Germany
84073488	Spark-ignition reciprocating piston engine, of a kind used for vehicles	1.85	Germany	0.59	Turkey
87082992	Parts and accessories for the industrial assembly of bodies, nes	1.77	Germany	1.36	Germany
85443000	Ignition wiring sets and other wiring sets for vehicles, aircraft	1.06	Morocco	0.62	Morocco
33021040	Mixtures of odoriferous substances and mixtures, incl. alcohol	0.72	Ireland	0.54	Ireland
87089432	Steering wheels, steering columns and steering boxes, and parts	0.72	Germany	0.38	Germany
73269096	Sintered articles of iron or steel, n.e.s.	0.66	Germany	0.01	United States
84099904	Parts suitable for use solely or principally with compression-ignition	0.66	Germany	0.44	Germany
85371088	Numerical control panels with built-in automatic data-processing	0.63	Morocco	0.18	Morocco
87082912	Parts and accessories for the industrial assembly of bodies	0.63	Germany	0.58	Germany
9011100	Coffee (excl. roasted and decaffeinated)	0.57	Vietnam	0.77	Brazil
26011100	Non-agglomerated iron ores and concentrates (excl. roasted iron)	0.55	Brazil	0.49	Brazil
84119104	Parts of turbojets or turbopropellers, n.e.s.	0.53	Japan	0.49	United States
87087048	Road wheels and parts and accessories thereof, for the industrial vehicles	0.53	France	0.26	Morocco
85371096	Touch screens for electric control, without display capabilities	0.53	China	0.60	Germany
87084016	Brakes and servo-brakes and their parts, for tractors, motor vehicles	0.51	Japan	0.34	France
39269096	Articles made from plastic sheet, n.e.s.	0.50	Germany	0.54	Germany
40111000	New pneumatic tyres, of rubber, of a kind used for motor cars	0.50	Italy	0.29	Italy
12019000	Soya beans, whether or not broken (excl. seed for sowing)	0.50	Brazil	0.49	Brazil
72042112	Waste and scrap of stainless steel, containing by weight >= 8%	0.49	Netherlands	0.40	Germany
72104896	Flat-rolled products of iron or non-alloy steel, of a width of >=5%	0.49	Italy	0.66	Turkey
72044992	Waste and scrap of iron or steel, not fragmentised “shredded”	0.48	Portugal	0.31	Portugal
84073496	Spark-ignition reciprocating piston engine, of a kind used for vehicles	0.47	Germany	1.15	Germany
85122000	Electrical lighting or visual signaling equipment for motor vehicles	0.44	Slovakia	0.56	Morocco
87085032	Drive-axles with differential, whether or not provided with other pieces	0.44	Italy	0.24	Italy

Table A.7: Top intermediate input by sector

Industry	CN8 code	Description code	share 2017-2022
10	09011100	Coffee (excl. roasted and decaffeinated)	9.81
11	33021040	Mixtures of odoriferous substances and mixtures	48.32
13	55032000	Staple fibers of polyesters, not carded, combed	10.80
14	60041000	Knitted or crocheted fabrics, of a width of > 30 cm	13.55
15	41041160	Full grains, unsplit and grain splits, in the wet state	8.47
16	44101112	Particle board of wood, whether or not agglomerated with resins	10.75
17	47032900	Semi-bleached or bleached non-coniferous chemical wood pulp, soda	10.32
18	85285208	Cathode-ray tube monitors "CRT" (excl. computer monitors)	12.81
20	29173600	Terephthalic acid and its salts	3.75
21	30049000	Medicaments consisting of mixed or unmixed products for therapeutic use	41.98
22	40111000	New pneumatic tyres, of rubber, of a kind used for motor cars	9.25
23	69101000	Ceramic sinks, washbasins, washbasin pedestals, baths, bidets	7.58
24	26030000	Copper ores and concentrates	22.22
25	87089992	Parts and accessories of closed-die forged steel, for motor vehicles	6.01
26	85443000	Ignition wiring sets and other wiring sets for vehicles, aircrafts	37.83
27	85389096	Electronic assemblies for electrical apparatus for switching	7.81
28	84159000	Parts of air conditioning machines, comprising a motor-driven fan	7.77
29	87089912	Parts and accessories for the industrial assembly of motor vehicles	22.76
30	84119104	Parts of turbojets or turbopropellers, n.e.s.	18.59
31	39205100	Plates, sheets, film, foil and strip, of non-cellular polymethyl	13.78
32	38220000	Diagnostic or laboratory reagents on a backing, prepared diagnostics	14.89
33	88033000	Parts of aeroplanes or helicopters, n.e.s. (excl. those for gliders)	29.41

Table A.8: Frequency of change of supplier among firm-intermediate pairs with one initial supplier

	#fp with one supplier	next year one supplier same supplier	one supplier diff supplier	two suppliers repeat supplier	two suppliers diff suppliers	next year three or more
2017-2022	64,322	50,446	1,859	8,996	433	2,588
%	100.0	78.4	2.9	14.0	0.7	4.0

Table A.9: China+1: Changing China when China is initial unique supplier

		1 supplier: China	2 suppliers	%
2017	2018	1,549	206	13.2
2018	2019	1,509	186	12.3
2019	2020	1,514	205	13.5
2020	2021	1,525	223	14.6
2021	2022	1,488	190	12.7

Table A.10: China+1: new suppliers replacing China

New supplier	Frequency	%	% accum.
EU28	426	41.0	41.0
OECD-non UE28	204	19.6	60.6
Hong Kong	128	12.3	72.9
India	85	8.2	81.1
Turkey	62	6.0	87.0
Mexico	16	1.5	88.6
Vietnam	13	1.3	89.8
Morocco	9	0.9	90.7
Indonesia	7	0.7	91.3
Thailand	6	0.6	91.9
Philippines	6	0.6	92.5
Pakistan	5	0.5	93.0
Malaysia	5	0.5	93.5
Peru	4	0.4	93.8
Colombia	4	0.4	94.2
Rest	30	5.8	100.0

Note: OECD-non UE28 includes USA, Canada, Japan, Australia, New Zealand, Switzerland and Norway.

Table A.11: Firms and firm-intermediates regular 2017-2019 and interrupted after

Sample	All firms	Regular firms	% firm attrition	All fp	# fp regulars	% fp attrition
Customs	27891	20135	27.8	137515	89330	35.0
Sample	4356	3939	9.6	37017	26139	29.4

Table A.12: Descriptives on heterogeneity dimensions, firm-intermediate level, 2017

	Observations		Num. suppliers		Farshoring		Friendshoring	
	Red	*Blue*	*Red*	*Blue*	*Red*	*Blue*	*Red*	*Blue*
Heterogeneity suppliers								
A1	13,272	12,867	1.0	3.4	3,005.1	3,210.7	85.0	86.5
A2	20,509	5,630	2.4	1.6	3,385.5	2,089.5	83.8	92.8
A3	13,579	12,560	1.8	2.6	3,440.7	2,744.8	83.3	88.3
A4	3,891	665	1.4	1.5	8,064.5	6,556.4	39.0	68.9
A5	3,775	22,364	3.8	1.9	4,469.0	2,876.3	75.6	87.4
Heterogeneity inputs								
B1	26,139	26,139	2.2	2.2	3,106.3	3,106.3	85.7	85.7
B2	3,045	22,200	3.4	2.0	3,310.3	3,060.2	82.7	86.4
B3	13,834	12,315	2.2	2.2	3,318.9	2,871.8	83.2	88.5
B4	8,048	16,282	2.4	2.1	3,434.5	2,949.7	82.6	87.1
Heterogeneity geography								
C1	6,719	19,420	2.3	2.2	7,651.8	1,533.7	47.6	98.9
C2	2,674	23,465	1.9	2.2	9,230.2	2,408.5	7.4	94.6
C3	1,549	18,016	1.0	1.6	9,689.0	1,861.7	0.0	97.5
Heterogeneity firm								
D1	18,456	7,683	2.3	1.9	2,930.3	3,529.1	88.1	79.9
D2	16,474	9,665	2.3	2.0	3,013.1	3,265.3	87.0	83.5
D3	15,922	10,217	2.3	2.0	3,293.0	2,815.5	84.0	88.4
D4	6,947	19,192	2.4	2.1	2,629.1	3,279.1	92.3	83.3
D5	7,981	18,158	2.5	2.1	3,278.7	3,030.6	84.3	86.3
Heterogeneity industry								
E1	2,080	714	2.5	3.7	4,021.3	3,649.4	78.4	83.8

Table A.13: Descriptives on heterogeneity dimensions, firm level, 2017

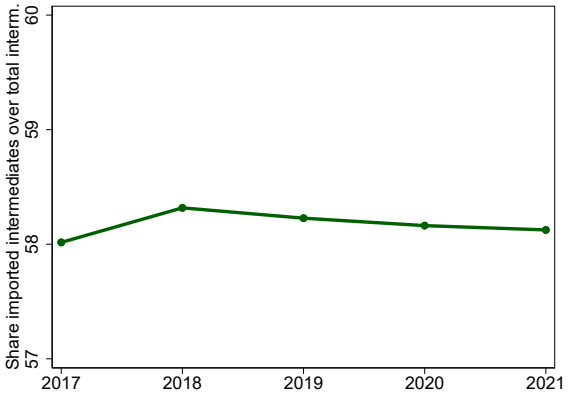
	Observations		Offshoring		Stock intensity	
	Red	*Blue*	*Red*	*Blue*	*Red*	*Blue*
Heterogeneity firm						
D1	1,650	1,556	13.1	13.9	19.9	23.5
D2	1,618	1,588	16.2	10.8	20.9	22.5
D3	1,520	1,686	13.6	13.4	22.9	20.5
D4	471	2,735	18.8	12.6	18.6	22.2
D5	624	2,582	13.2	13.6	19.9	22.1
Heterogeneity industry						
E1	88	184	9.7	17.6	23.5	17.6

Appendix B Additional analyses

Figure B.1: Decomposition of reshoring, 2017-2021

A. Imported intermediates/total intermediates (%)

B. Intermediates/Production (%)

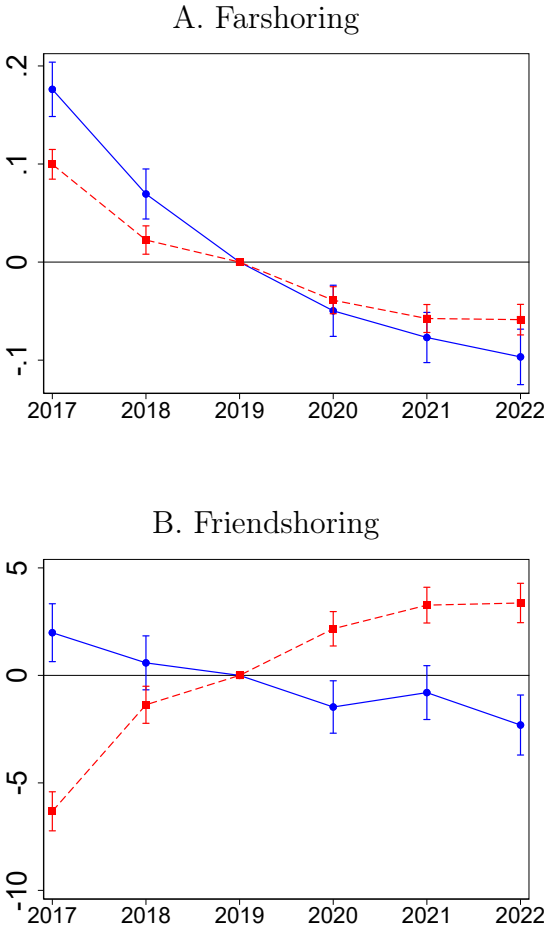


Note: Each figure plots the yearly average of the variable.

Figure B.2: Robustness. EU as a single country. Implementation of strategies to respond to supply-chain disruptions, 2017-2022

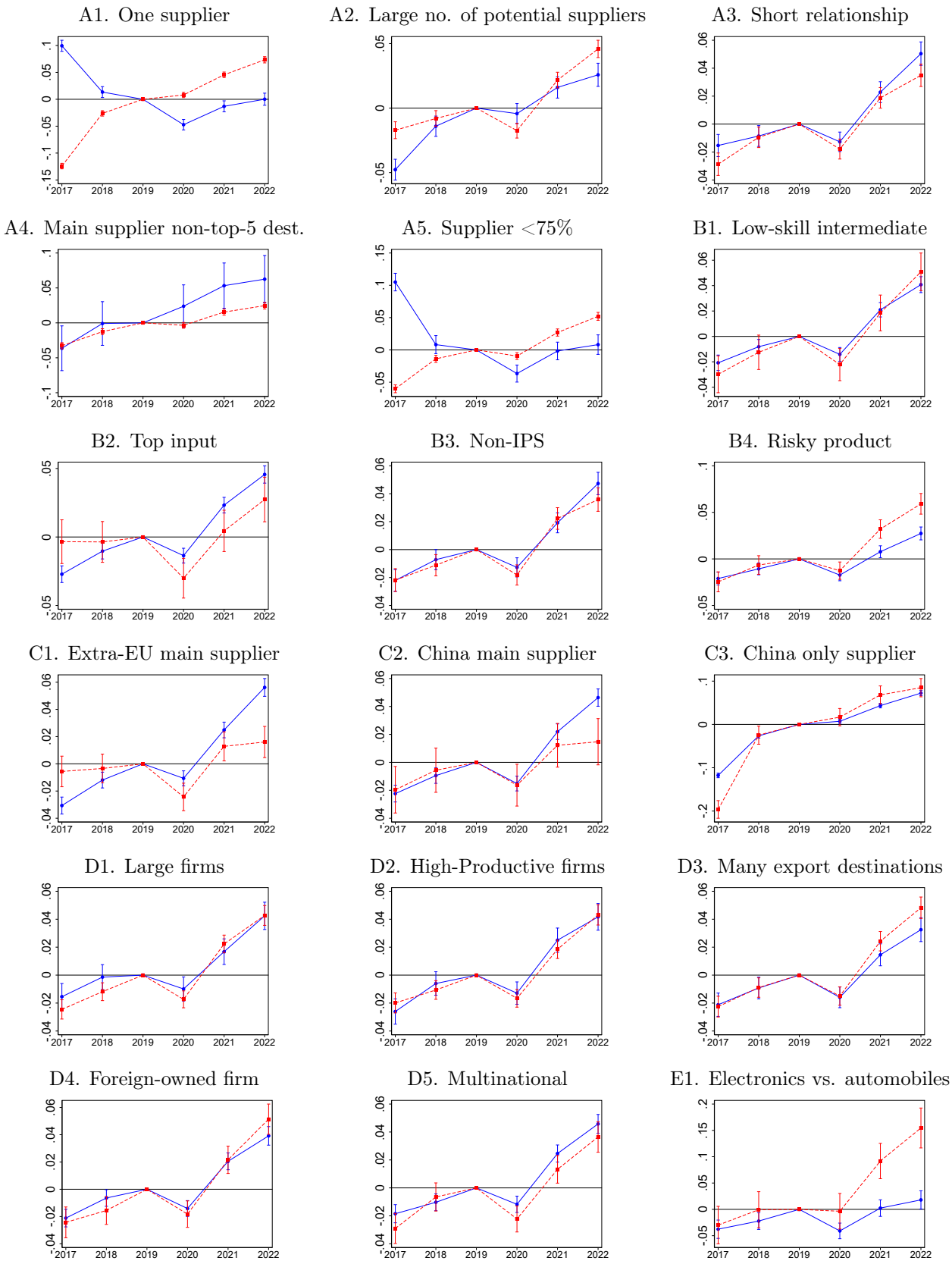
Note: Each figure plots the yearly average of the variable. Panel A plots the number of countries per firm×intermediate combination. Panel B plots the Herfindahl-Hirschman index of the value of imports by supplier in a firm×intermediate combination. Panel C plots the import-value weighted distance of suppliers in a firm×intermediate combination. Panel D plots the share on imports that originate in countries that are friends in Spain in a firm×intermediate combination. A country is a friend of Spain if it voted "Yes" in the UN General Assembly's Resolution ES-11/1 "Aggression against Ukraine" (March 2, 2022). Data in panels A to D is at the firm×intermediate level, whereas in panels E and F is at the firm level.

Figure B.3: China is the main supplier vs. other distant countries are the main suppliers



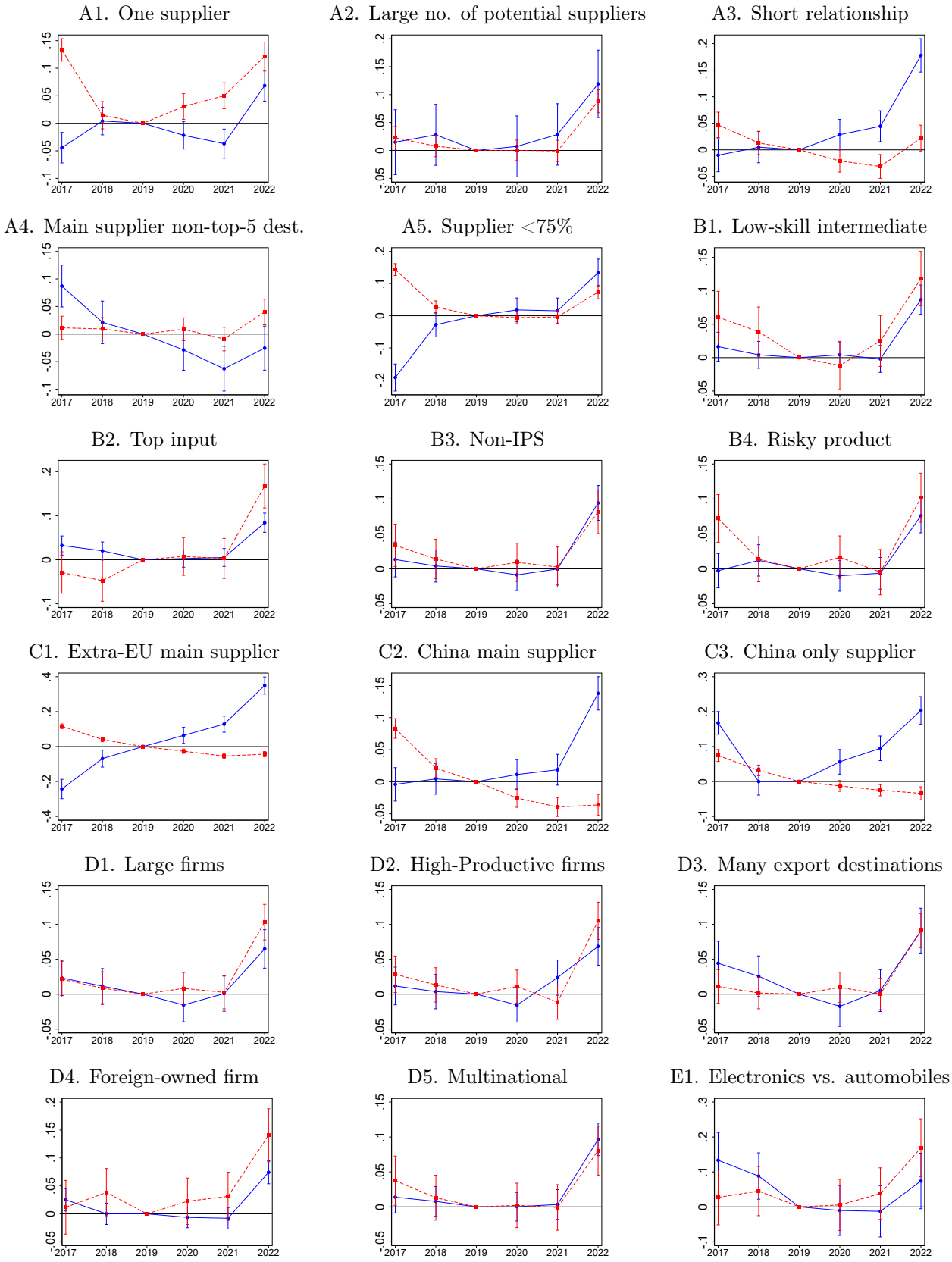
Note: Distant countries are those located at 9,000 km (flight distance) from Spain. Each panel plots the point values and the 95% confidence intervals estimated with Equation (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

Figure B.4: Robustness. Heterogeneity. EU as a single origin. Number of suppliers



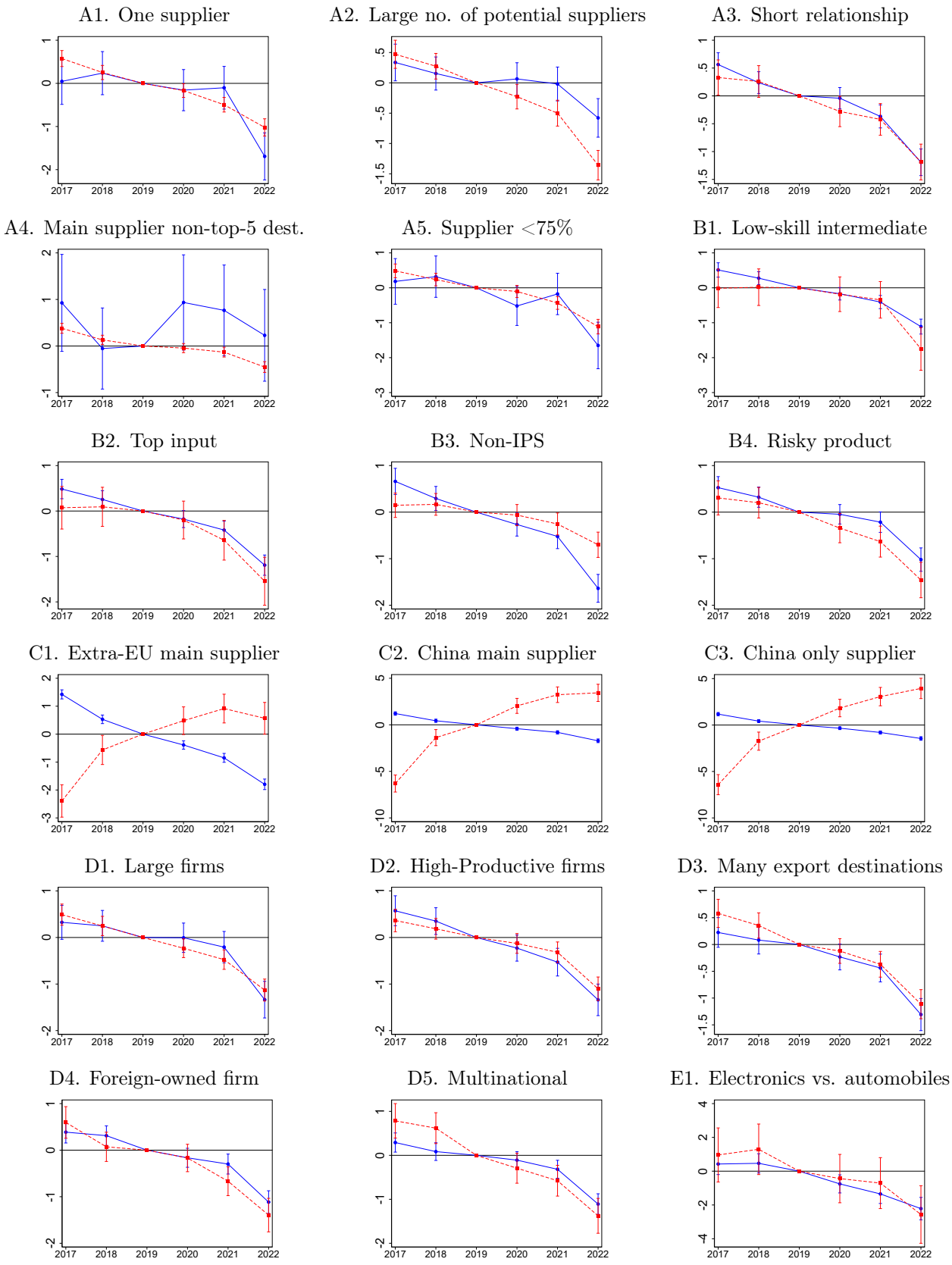
Note: Each panel plots the point values and the 95% confidence intervals estimated with Equation (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

Figure B.5: Robustness. Heterogeneity. EU as a single origin. Farshoring



Note: Each panel plots the point values and the 95% confidence intervals estimated with Equation (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

Figure B.6: Robustness. Heterogeneity. EU as a single origin. Friendshoring



Note: Each panel plots the point values and the 95% confidence intervals estimated with Equation (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.