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Analyses of topical policy issues

Do firms react to supply chain disruptions?☆

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ABSTRACT

Since the outbreak of the Covid-19 pandemic, the disruption of supply chains has become a major concern for global firms. This article 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 from which they source their input 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.

1. Introduction

The Covid-19 pandemic turned supply chain disruptions from a firm- and location-specific concern to a global and economy-wide concern. The shutdown of factories in China and the confinement measures adopted by many countries made firms aware that halting production processes due to lack of input could become a real possibility. The concern about supply chain disruptions continued to increase 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

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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, companies can increase their inventory of components and finished products to maintain safety stocks. Third, firms can repatriate previously offshored activities. Fourth, firms can shorten their supply chain by relocating previously offshored activities to a neighboring country of the home country: nearshoring. Finally, firms can relocate production to trusted countries to reduce disruption risks due to trade-policy and geopolitical tensions. This strategy is called friendshoring.

This paper explores whether firms have implemented any of the strategies mentioned above in response to increasing concerns 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 socioeconomic shocks and geopolitical tensions are restructuring and reconfiguring them.

We find that Spanish manufacturers participating in GVCs have not implemented significant diversification, nearshoring, or friendshoring strategies as a response to rising concerns about supply chain disruptions from 2020 onward. We do not observe any 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 permanent strategy.

We examine heterogeneity in the implementation of strategies in 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) 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 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 in Baldwin and Freeman (2022), the niche expertise needed to manage specific value chains makes the buyer–supplier networks sticky. Therefore, the relocation of offshored production processes 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 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 perceived as permanent for 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 increasing stocks, which offer a buffer against short-term 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. An additional factor that might contribute to the relocation 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). Therefore, recent disruptions may accelerate already existing trends in 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 Tōhoku 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 imports

[1] Javorcik et al. (2022) found that friendshoring provides insurance against extreme disruptions and secures the supply of 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.

of automobile and electronics from Japan did not diversify their suppliers, switched to geographically close suppliers, or re-shored production after the 2011 earthquake. Shingal and Agarwal (2020) examined how Asian countries' GVC-based imports responded to previous epidemic outbreaks such as SARS and MERS. They found no evidence of 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 Covid-19, Khanna et al. (2022) found that Indian firms more exposed to the pandemic diversified toward geographically close, larger and well-connected suppliers. Lafrogne-Joussier et al. (2023) concluded that French exporters that had a more geographically diversified pool of suppliers experienced the same Covid-19-related disruption than less diversified exporters. Di Stefano et al. (2022) showed that Covid-19 did not generate large waves of re-shoring in Italian multinational firms. In summary, 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 a firm can implement to respond to supply chain disruptions. This enables us to identify whether there is a dominant strategy to cope with supply chain disruptions or firms combine different strategies.[3] We found that firms have only implemented a rise-in-stocks strategy to respond to the growing concerns about supply chain disruptions.

Second, our data set 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 data set enables us to analyze supply chain disruptions in the aftermath of Covid-19 and the Russian invasion of Ukraine. Additionally, firms need time to implement 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. In addition, by covering a three-year period before the pandemic, we can also detect whether recent supply chain disruptions have led firms to adopt novel strategies or 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 the characteristics of the supplier, intermediate, geography, firm, and industry. 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 continuously imported and exported during 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 confidential microdata 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) classification.[4] Countries or territories with a population below 1 million in 2017 are excluded. Some shipments are also excluded from this data collection. Within 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 previous year exceeds the threshold of 400,000 euros. For exports outside the EU all flows are recorded, unless their value is less than 1,000 euros or one ton. These 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 2012 to 2022.

A second source of information is a balance-sheet dataset called Bureau Van Dick SABI (Iberian Balance Sheet Analysis System,). In addition to 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 the following steps. First, we select from the AEAT-Customs database all regular two-way traders, that is, firms that export and import every year over the period 2017–2022.

[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.

[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).

Following previous literature (Antràs and Chor, 2022; Lafrogne-Joussier et al., 2023), 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. 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 pairs of firm-product for each 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 represents 42% of total exports and 38% of total intermediate imports in 2017. When we consider only exports and imports from manufacturing firms, our sample represents 81% of total exports and 62% of total imports in 2017. The data set also accounts for 45% and 59% of employment and production 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 the supplier, input, geography, firm, and industry characteristics.

3.1. Evolution

Fig. 1 shows whether firms implement diversification, nearshoring, friendshoring, reshoring, or stock-accumulation strategies. We define a firm as diversifying if it increases the number of countries from which it imports a particular intermediate. 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 decreased in 2020, the year of Covid-19. Firms increased the number of suppliers in 2021 and 2022, reaching a figure of 2.3 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 increased to 2 for the remainder of the period.[6] The evolution of the mean and median indicates 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 the value 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 did not observe a major change in the way 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 higher value denotes a more distant supplier, we have titled panel C "Farshoring" instead of "Nearshoring". In 2017, the average distance of a supplier was 3,106 km, similar to the road distance between Madrid and Stockholm. There is an increase in the average supplier distance in the period 2017–2022. This indicates that companies did not move to geographically closer suppliers in response to the growing concern about 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 Resolution ES-11/1 of the UN General Assembly "Aggression against Ukraine" (2 March 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 also do not find that concerns about supply chain disruptions led manufacturers to increase sourcing from countries that are friends of Spain from 2020 onward.

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

[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 developed 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 IPS goods (intermediate processed specific) as intermediate goods that are more likely to participate in GVC.

[6] For example, Khan et al. (2023) found that firms that created supply chain redundancy by adding new suppliers performed better during supply chain disruptions. See also Khan et al. (2022).

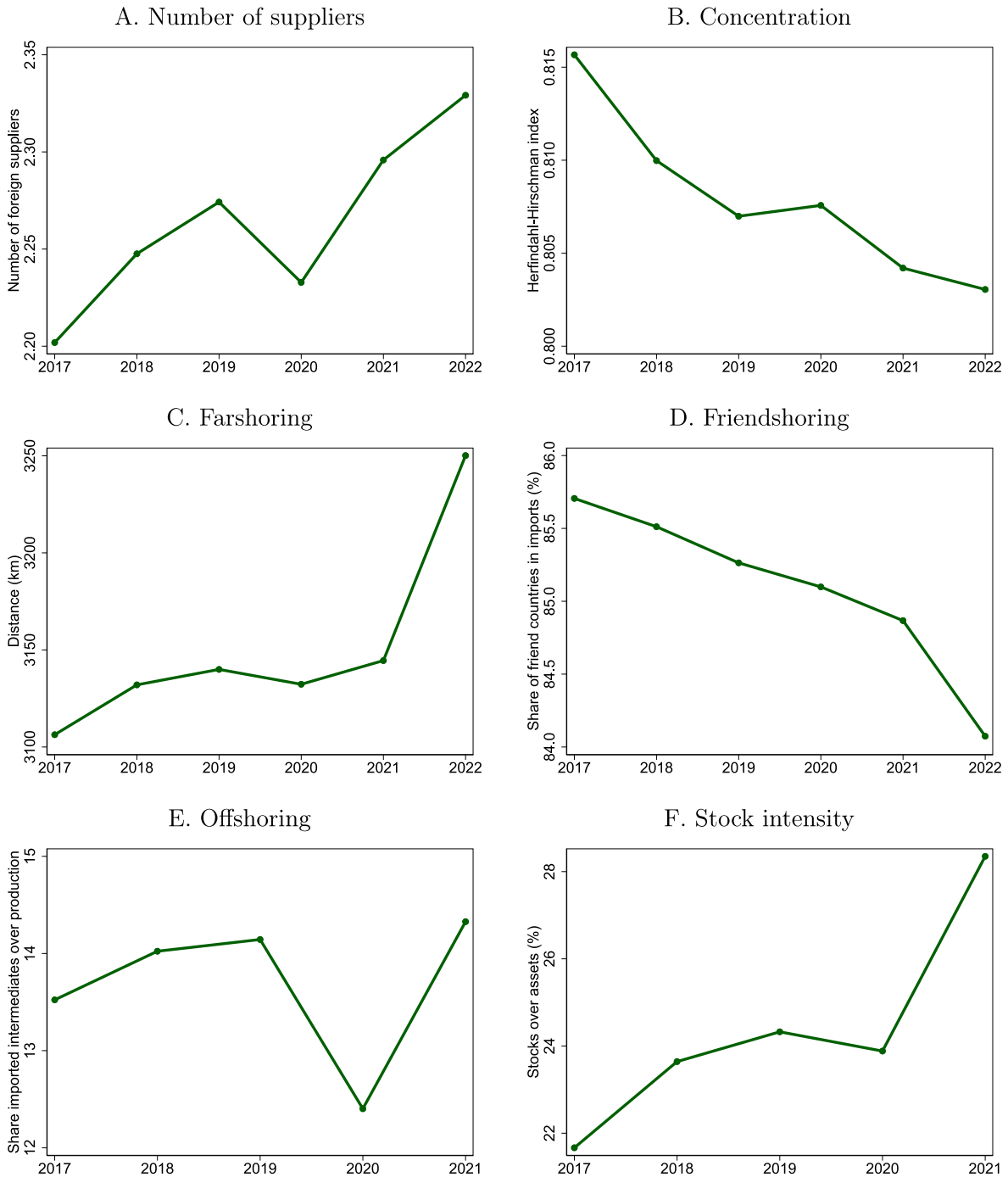

Fig. 1. Implementation of strategies to respond to supply chain disruptions.
Note: Each figure plots the yearly average of the variable. Panel A plots the number of countries per firm×intermediate combination. Panel B plots the Herfindahl–Hirschman index of the value of imports by supplier in a firm×intermediate 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 production. 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.

Panel E presents the evolution of the share of imported intermediates in total production. A rise 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.[7] The offshoring trend in the new sample, which captures firms that have decided to reshore their intermediate imports since 2020, is very similar to the one shown in panel E of Fig. 1.[8]

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 following two ratios:

$$\frac{Imported\ intermediates}{Output} = \frac{Imported\ intermediates}{All\ intermediates} \times \frac{All\ intermediates}{Output} \tag{1}$$

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 in production during the period 2017–2021. The information from these two panels suggests that the substitution of foreign intermediates into domestic ones was only temporary and was reversed in 2021. We observe no substitution of imported or domestic intermediates for production at the firm level.

Panel F plots the average share of stocks in total assets, denoted as stock intensity, among Spanish manufacturers participating in GVC.[9] We observe a clear increase in stock intensity after Covid: the share of stocks in total assets was 4 percentage points higher in 2021 than in 2019. This result suggests that firms have responded to growing concerns about supply chain disruptions by increasing their stocks of intermediates and final products and moving from just-in-time to just-in-case supply chain management systems (Jiang et al., 2022). Such a response would be consistent with available empirical evidence that shows that firms with large inventory stocks are less sensitive to disruptions in input supply than those with relatively low inventories (IMF, 2022; Lafrogne-Joussier et al., 2023). However, we should take our result with care, as 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.

In summary, 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. Therefore, contrary to widespread expectations (De Backer et al., 2018; Lagarde, 2022; UNCTAD, 2022), we do not observe that companies are making profound changes in their supply chain strategies by prioritizing safety over efficiency. They are not rebalancing globalization and regionalization, either, shifting suppliers to geographically closer and friendly countries. The lack of changes in how firms organize their value chains is related to the high costs of offshoring and the sunk nature of these costs. 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 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 Fig. 1 assuming that all EU members belong to the same country.[10] 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 the grouping of EU countries leads to a change in the absolute value of the variables, their evolution is very similar to that presented in Fig. 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 growing concerns about supply chain disruptions. However, this lack of action can conceal differences in implementation between subgroups. In this subsection, we explore the heterogeneity in the implementation of strategies across supplier, intermediate, geography, firm, and industry characteristics.

For each dimension analyzed, we separate the firm×imported intermediate combinations in two groups. For example, an exercise separates the firm×imported intermediate combinations in which China was the main supplier in 2017 from

[7] 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.

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

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

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

those in which it was not. For each group, we estimate the following equation:

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

where y_{fkt} is a variable that captures 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. Therefore, the coefficients β_t 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 from those in 2019. We identify heterogeneity by comparing the trend of the β_t coefficients in one group with that in the alternative group.

Fig. 2 analyzes the 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.[11] 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". Therefore, 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 the figure) will be more intense than in the blue-line one.[12] 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. On the contrary, there is a reduction in the number of suppliers in the >1-supplier group. Therefore, 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 appear to be the result of increasing 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 providing the firm with an intermediate that is well suited to its needs. This makes the relationship more sticky and the supplier difficult to replace (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.[13]

We analyze heterogeneity in two additional supplier 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 stronger relationships with their suppliers if the country where the supplier is located is also a major export destination for the firm. There are two reasons that explain this relationship. First, having a local supplier enables firms to react more quickly to changes in demand preferences. 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 is more than one supplier country. Following Martin et al. (2021), we consider that the quality of the 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 the diversification for this class of intermediate imports to be lower than for other intermediate imports. Panel A5 confirms our expectation.

[11] Table A.8 in the appendix A shows that, on average, every year, most firms 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 increase 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 do not repeat the supplier country (0.7%).

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

[13] 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.

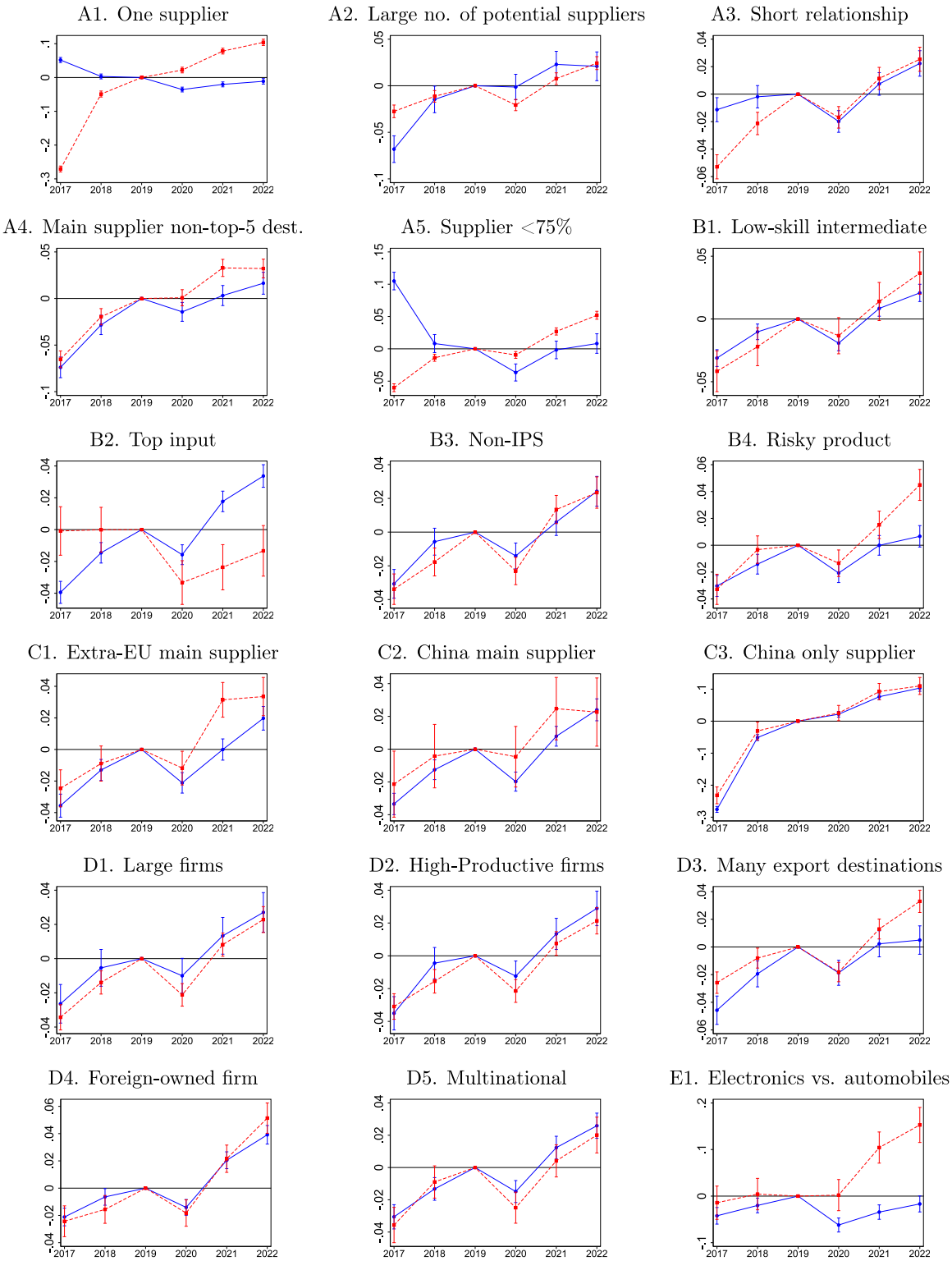

Fig. 2. Heterogeneity. Number of suppliers.
Note: Each panel plots the point values and the 95% confidence intervals estimated with Eq. (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

Next, we explore heterogeneity along the intermediates' characteristics. We analyze whether diversification in low-skill/low-technology intermediates has been more intense than in high-skill/high-technology ones.[14] Substitutability between suppliers is much easier when intermediates are intensive in low-skilled labor, have a low technological content, and are standardized. On the contrary, it is more difficult and costly to find alternative suppliers for highly complex and custom 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 expectations. 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 rest of intermediates. The first group covers 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 chain disruptions may be higher in some intermediates than in others. We use the list of high-risk products developed by Reiter and Stehrer (2023) 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 sourced outside the EU, as 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.[15]

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 look for suppliers in other countries after the Covid-19 pandemic.[16] 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 toward a China + 1 strategy, the diversification effort is similar to that followed by firms that only had one supplier per intermediate.[17]

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).[18] These results are contrary to our expectations. We predicted that large and highly productive companies would 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.[19] Our expectation is that firms exporting to many markets can gather more information about potential suppliers than firms selling in few markets.[20] In line with this prediction, we find that firms exporting to many destinations diversified their suppliers more after 2019.

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

15 We get the same results when we perform the analysis for the top input.

16 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.

17 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, next year. Among these pairs of "China + 1", 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 is an OECD developed country (19.6%), with the United States 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, the Philippines, and Malaysia appear as additional suppliers but with a very low frequency.

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

19 We use the median number of export destinations to define the two groups.

20 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).

In addition, we analyze diversification in Spanish firms whose capital was controlled by foreign companies in 2017 and Spanish firms that had foreign subsidiaries in 2017.[21] In both cases, we expect greater diversification, as 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 investment in relationships and low substitutability, because parts and components are customized and must comply with safety and other regulatory standards (Freund et al., 2022). In response to a shock, we expect the number of supplier countries to increase more in electronics than in automobiles, since the potential number of supplier countries is larger in the former than in the latter. Panel E1 confirms our expectations.

Fig. 3 explores the heterogeneity in farshoring.[22] It has the same structure and includes the same dimensions as Fig. 2. We only observe a significant difference in 2022-point estimates between groups in 6 of the 18 dimensions. A process of nearshoring occurs 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 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 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). Nearshoring occurs 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.[23] 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 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.

Fig. 4 explores the heterogeneity in friendshoring. We observe a significant difference between groups in 2022-point estimates in six 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 supplier 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 away 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 in which the main supplier was also more than 9,000 km 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. Therefore, in this case, friendshoring is not the result of a mechanical effect.

Figs. 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.

Fig. 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. Fig. 6 shows that the increase in stocks was greater in high-productive than low-productive firms, and in domestic firms than in foreign companies 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 the results are robust to grouping all EU members into a single country (see Tables B4-B6 in Appendix B). The results confirm that diversification is more intense among firms that import

[21] 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 a Spanish firm as a multinational if it controls more than 50% of the capital of a foreign firm. Data come from SABI.

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

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

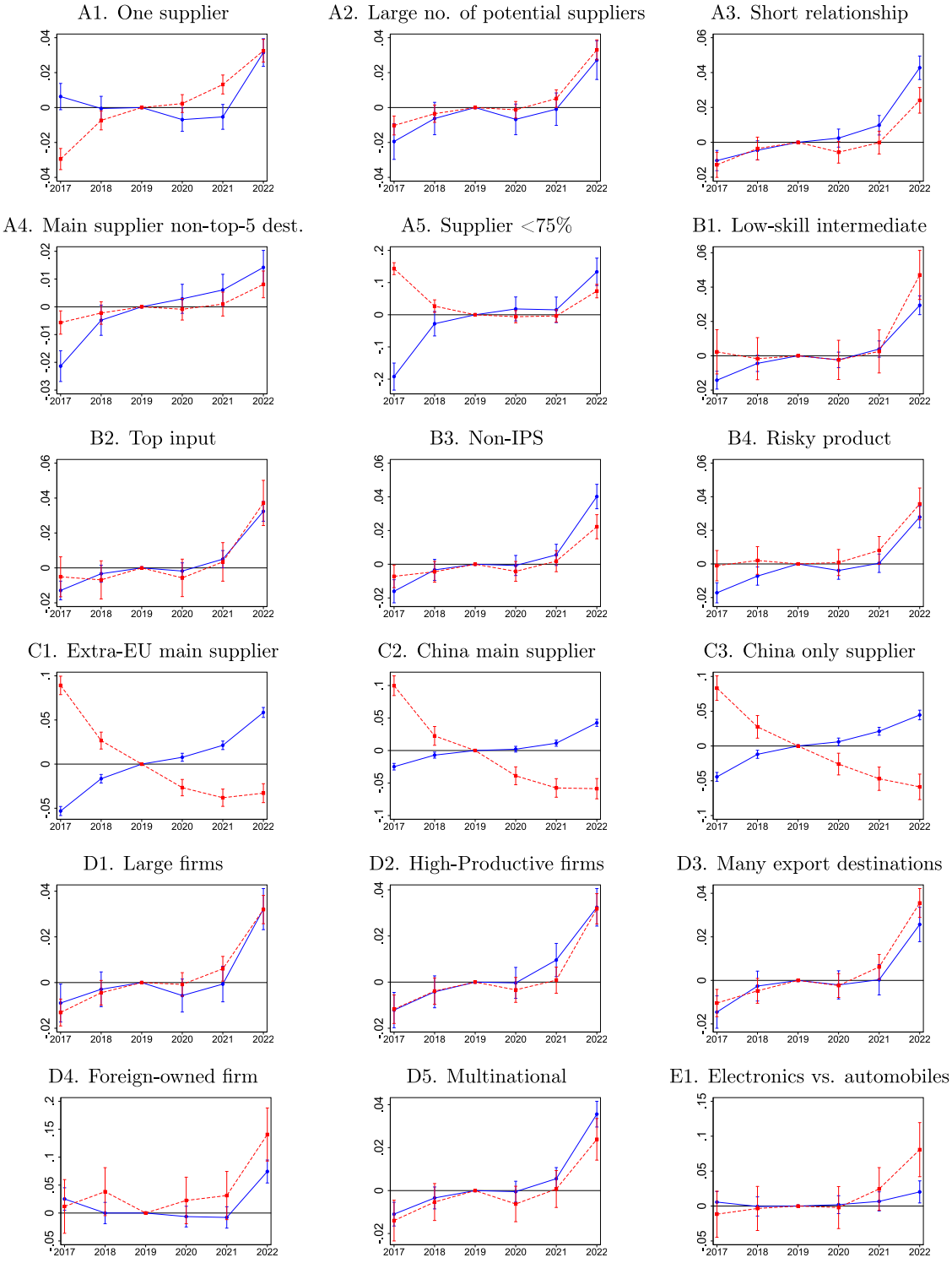

Fig. 3. Heterogeneity. Farshoring.
Note: Each panel plots the point values and the 95% confidence intervals estimated with Eq. (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

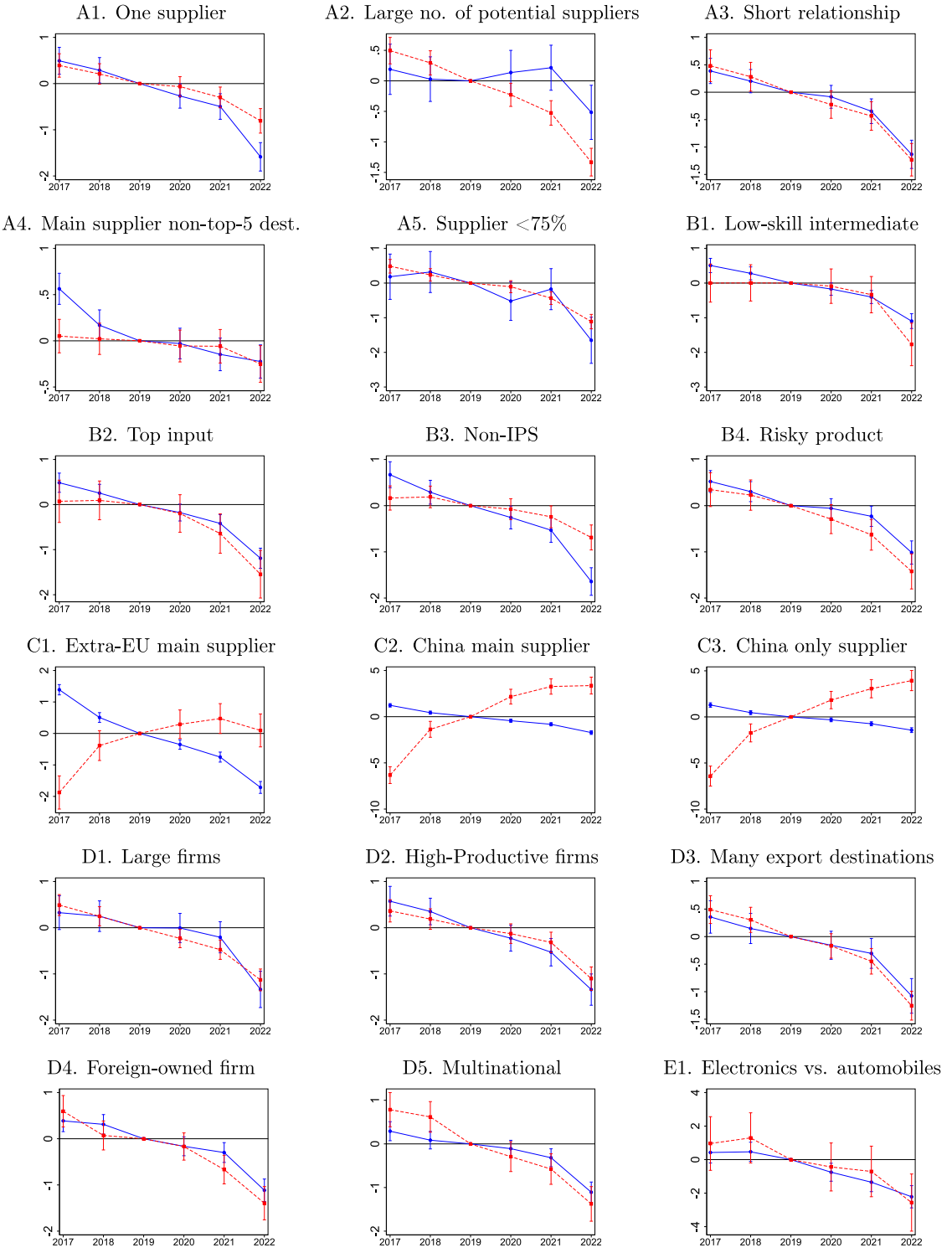

Fig. 4. Heterogeneity. Friendshoring.
Note: Each panel plots the point values and the 95% confidence intervals estimated with Eq. (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

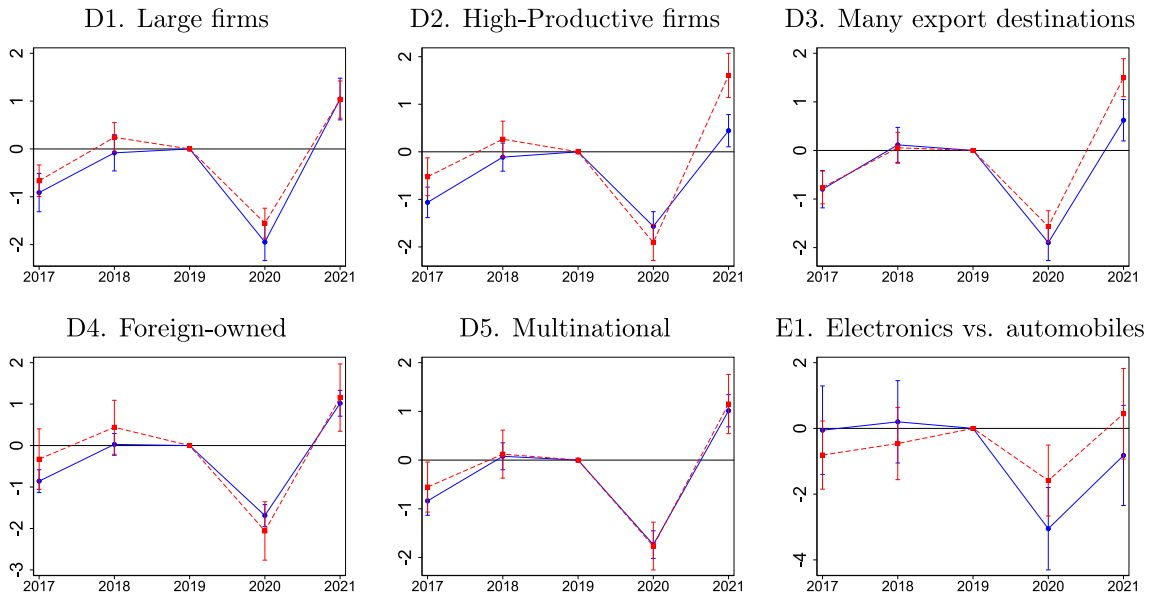

Fig. 5. Heterogeneity. Offshoring.
Note: Each panel plots the point values and the 95% confidence intervals estimated with Eq. (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

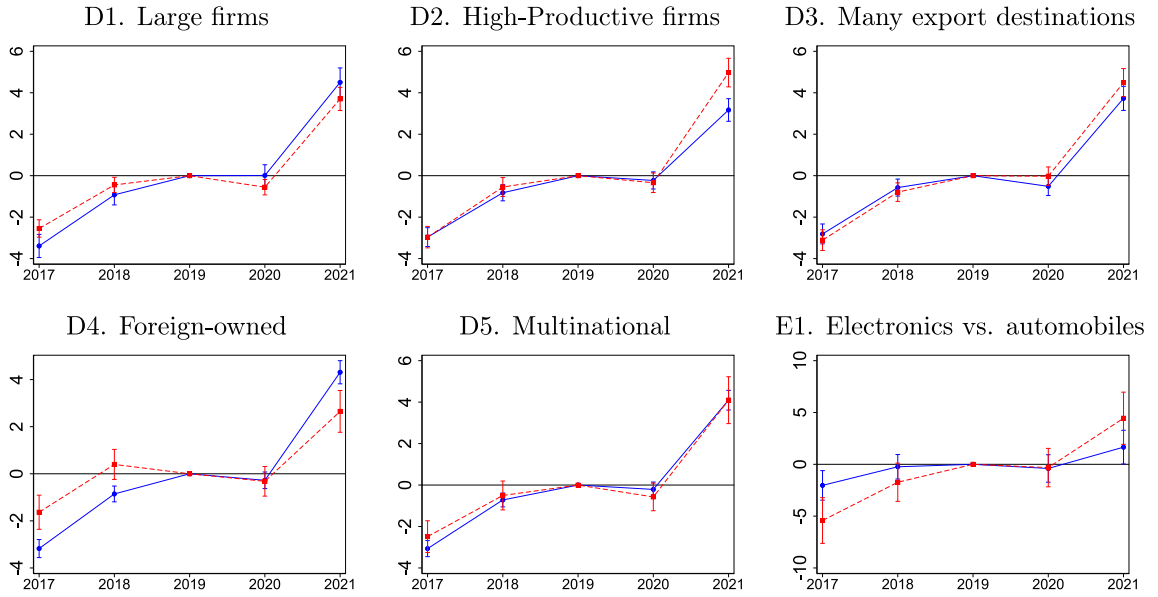

Fig. 6. Heterogeneity. Stock intensity.
Note: Each panel plots the point values and the 95% confidence intervals estimated with Eq. (2). The red-dashed line links the point estimates of the group identified in the title of the panel and the blue line the ones of the alternative group.

intermediates from one supplier and intermediates that are more likely to experience disruption in the value-added chain. However, we also now find 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 in the new sample for friedshoring.

4. Conclusion

This paper has examined whether Spanish manufacturers participating in GVC have implemented any strategy in response to growing 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 strategies listed above: 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 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 precedes 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 is to increase the inventories of companies to maintain safety stocks. The remaining strategies are more difficult and costly to implement because they involve an alteration of 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 who use intermediates that have a higher risk of supply chain disruptions. Nearshoring and friendshoring are supply chain reorganization strategies with higher fixed costs. This explains why these strategies are only adopted by firms whose main supplier is geographically distant. Reshoring is the most expensive strategy because it involves 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 diversification, 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, 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 factors might contribute to the reconfiguration of GVCs, this process could take longer than initially expected.

Policy makers are increasingly concerned about GVC disruptions resulting from socioeconomic shocks or geopolitical tensions. So far, there has been no evidence of a change in global firms' supply strategies, suggesting that firms' competitiveness and efficiency have prevailed over security. Therefore, to promote the resilience of GVCs, policy makers might consider initiatives such as analyzing and monitoring supply chain risks; improving risk management capabilities; developing contingency plans; investing in high-quality infrastructure to foster trade among reliable partners; developing more secure international trade technologies (e.g., Blockchain); and encouraging international cooperation and dispute resolution institutions.

Appendix

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.eap.2023.07.004.

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