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Abstract

We study how disruptions to the supply of foreign critical inputs (FCIs) —defined as vulnerable inputs and key inputs for the digital and green transition —may affect value-added at different levels of aggregation. Using firm-level customs and balance sheet data for Belgium, France, Italy, Slovenia and Spain, our framework allows us to assess how geoeconomic fragmentation may affect European economies differently. Our baseline calibration suggests that a 50% reduction in imports of FCIs from China and other countries with a similar geopolitical orientation would result in sizable losses with significant heterogeneity across firms, sectors, regions, and countries, driven by the heterogeneous exposure of firms. Our findings highlight that the short-term costs of supply disruptions of FCIs can be substantial, especially when firms cannot easily substitute away from these products.

Keywords: Geoeconomic fragmentation, global value chains, global sourcing, international trade, imported inputs.

JEL Codes: F10, F14, F50, F60.

1 Introduction

Decades of increasing economic integration have led to an unprecedented expansion of global value chains —interconnected networks of production processes across countries. However, in such a globalised economy, recent events such as the COVID-19 pandemic and the Russian invasion of Ukraine have shown that the impact of foreign shocks on domestic production can be large. Many countries are now working to reduce this vulnerability to foreign input sourcing by diversifying supply chains —i.e., increasing the number of suppliers of goods and services deemed "critical" or "strategic" to domestic production —and by bringing production closer to home, both geographically and geopolitically.[1] Policies that undermine integration —what many refer to as "geoeconomic fragmentation" (Aiyar et al., 2023) —could lead to economic losses and inflationary pressures. Against this backdrop, mapping strategic vulnerabilities and quantifying the impact of supply disruptions to such products are key to building resilience.

In this paper, we use firm-level production and trade data for several European countries, namely Belgium, France, Italy, Slovenia and Spain (henceforth "BFISS"), to shed quantitative light on the role played by *firm-level exposure* to foreign risk on manufacturing value-added.[2] We use our micro data to calibrate a tractable yet parsimonious model of supply disruptions that considers firm-level exposure to specific restrictions —those imposed by selected countries on their exports of critical *products*. We then use the model to simulate the economic impact of a sudden reduction in imports of foreign critical inputs (FCIs) from China and other countries with a similar geopolitical orientation (hereafter, China-aligned countries). The use of micro data for five different European Union (EU) countries allows us to retrieve the economic impact at different levels of aggregation —firm-, sectoral-, regional- and aggregate level —with an arguably high degree of external validity.

More in detail, we start by showing that EU firms report being strongly dependent on critical inputs —see footnote 13 for the definition —from China. To this aim, we rely on a survey from the European Central Bank, complemented by a na-

[1]Governments are incentivising firms to diversify and/or re-shore/friend-shore their activities through initiatives such as tax breaks, subsidies, and concessional loans to support new investments, or the imposition of export restrictions. On the former, see, for instance, the "CHIPS and Science Act" and the "Inflation Reduction Act" in the US, the "Dual Circulation Strategy" in China, "Make in India" in India, the "InvestEU", "REPowerEU", and the "Green Deal Industrial Plan" in the EU. On export restrictions, for instance, China's export restrictions on rare-earth minerals used in semiconductor and electric vehicle production followed those on semiconductor sales enforced by the US, Japan, and the Netherlands. See the Financial Times article, "China imposes export curbs on chipmaking metals", 3 July 2023.

[2]We focus on the manufacturing sector given its key role in the production process. However, we also provide results for the whole economy.

tional survey from the Bank of Italy,[3] that focuses on firms sourcing critical inputs from China. We document that 41% of leading European firms report being exposed to China through imports of critical inputs. Importantly, 90% of these firms source critical inputs from China that are hard to substitute —as assessed by the firms themselves.

Motivated by this evidence and with the goal of providing a more complete mapping of foreign dependencies that go beyond China, we subsequently use a dual approach to identifying FCIs at the HS6 level.[4] Similarly to Jaravel and Méjean (2020), we are able to leverage on our detailed customs data to map vulnerabilities at the firm-level. We recover a list of 667 FCIs defined at the HS6 level.[5] Matching our list of FCIs to balance-sheet data on the near universe of Belgium, French, Italian, Slovenian, and Spanish firms, we unravel a series of stylised facts on importers of FCIs: *i)* the share of exposed firms is relatively higher for large firms; *ii)* diversification of sourcing is limited for FCIs and large importers are relatively *less* vulnerable; *iii)* FCIs account for a modest share of firms' total purchases; *iv)* importers of FCIs account for a sizable share of the economy and *v)* are larger and more productive than other firms even within narrowly defined industries. All in all, our facts for BFISS motivate the use of a framework accounting for heterogeneous firm-level exposure to geoeconomic fragmentation.

We thus build a framework in which firms combine labour, capital and intermediates in a Cobb-Douglas fashion to produce an output good. Importantly, intermediates are produced using FCIs and non-FCIs in a constant-elasticity of substitution (CES) fashion.[6] Our baseline scenario consists of halving the supply of FCIs from China-aligned countries.[7] The benefit of using granular data is that this aggregate shock can be combined with firms' heterogeneous exposure to FCIs to generate idiosyncratic shocks. These shift-share shocks are then fed into our model to assess how geopolitical fragmentation may affect firms, sectors, regions and countries. As our model features a CES production function, the impact of firm-level supply disruptions arising from decoupling is governed by the elasticity of substitution be-

[3] The European Central Bank survey focuses on the largest European firms, while Bank of Italy's survey also targets smaller firms.

[4] Our methodology builds on the methodology of the European Commission which typically identifies vulnerable inputs according to three criteria (European Commission, 2021). Inputs for which there are few suppliers, that are mostly imported from extra-EU countries, and that are hard to substitute are classified as vulnerable. We build on the list of Arjona et al. (2023) but also include inputs that are prone to supply disruptions due to their intrinsic characteristics. We prefer to label our list of inputs as "critical" instead of "vulnerable" because it encompasses high-tech products and products that are key for the green transition. More details are provided in Section 3.

[5] China is a major supplier of FCIs (30% of EU FCIs imports).

[6] A similar approach has been recently adopted by Bachmann et al. (2022) to analyse the potential impact of a Russian oil embargo on German value-added.

[7] We build on den Besten et al. (2023) and Capital Economics (2023) to assign countries into different blocs based on four different measures of political alignment. See Section 3 for more details.

tween FCIs and non-FCIs. We offer a range of estimates that are contingent on this parameter,[8] to account for uncertainty surrounding its precise value. Other parameter values needed to calibrate the model —sectoral expenditure shares on capital and labour, and firms' expenditure shares on FCIs —have a direct counterpart in our microdata. We view our framework as appropriate for studying the *short-run* effects of fragmentation scenarios, as factors of production other than FCIs are held constant and the elasticity of substitution between intermediates is assumed to be smaller than one (Peter and Ruane, 2023).

We find that the impact of geopolitical fragmentation is heterogeneous across firms and countries. In fact, on average, larger firms experience *lower* value-added losses, consistent with fact *ii)* according to which they are also relatively *less* exposed to FCI disruptions. Aggregating these firm-level effects using value-added weights, we find that our countries of focus could experience a drop in manufacturing value-added ranging from 2% for Belgium to 3.1% for Italy and Slovenia when FCIs and non-FCIs are perfect complements.[9] We further show that large firms, given their larger weights (Gabaix, 2011), are those driving the aggregate change. Indeed, exposed firms in the top quartile of the value-added distribution account for about 75% of the manufacturing value-added drop in all five countries. We provide a battery of robustness checks and show that our results remain sizable when considering alternative values for the aggregate supply shock, an alternative list of critical inputs, China as the only country at risk, or the whole economy.

Finally, we show that relying on industry-level data —rather than firm-level data —may bias the impact of geopolitical fragmentation if the assumed value of the elasticity of substitution is low enough. The bias stemming from using sector-level data arises for two reasons. First, exposure to FCI disruptions is *mismeasured* with macro data and masks the heterogeneity in firm-level exposure. Second, the *distribution of value-added weights* also contributes to pinning down the size of the bias. Indeed, the aggregate impact obtained by taking a value-added weighted average of firm-level effects yields different results than its counterpart obtained with sectoral data because the weighting scheme may dilute firm-level value-added changes. We find that the impact of geoeconomic fragmentation at the aggregate level may be more costly when using the sectoral rather than firm-level data for Belgium, Italy and Spain when the production function exhibits complementarities. This finding highlights the importance of using micro data to monitor exposure to supply shocks of critical inputs.

We have stressed that our model is tractable in that it can be easily calibrated us-

[8] As detailed below, we simply constrain this elasticity to be smaller than 0.2, consistent with recent evidence (Barrot and Sauvagnat, 2016; Atalay, 2017; Boehm et al., 2019).

[9] Moreover, we show that the effects of geopolitical fragmentation are more muted when the elasticity of substitution is higher and vary substantially across sectors and regions.

ing micro data to account for firms' actual exposure to critical inputs and study how different decoupling scenarios may affect the economy at different levels of aggregation in the short run. It is, however, parsimonious in that it only captures direct exposure and is partial equilibrium and thus does not account for the possibility that factors of production may adjust. For this reason, we view our contribution and that of papers relying on general equilibrium trade models as complementary —see below.

Finally, by providing a firm-level analysis for different European countries, we also show the potential of cross-country collaboration. In a sense, our paper is a first step towards "an alliance to map global supply networks", combining different data sources for different countries, as stressed by Pichler et al. (2023).

Related literature. Our paper contributes to two strands of literature. First, it is related to the literature that uses qualitative information at the firm level (survey-based or micro data) to assess firms' exposure to potential sources of geopolitical fragmentation and the measures planned to mitigate them (Jaravel and Méjean, 2020; Di Stefano et al., 2022; de Lucio et al., 2023; Attinasi et al., 2023b; Baur and Flach, 2023; Crosignani et al., 2024). We add to this literature by taking a step beyond mapping dependencies and vulnerabilities, as we provide a quantitative analysis of the impact of supply disruptions to such inputs at the firm-, sectoral, regional and aggregate level.

We also build on a growing literature interested in quantifying the potential economic impacts of different geoeconomic fragmentation scenarios using general equilibrium (multi-country, multi-sector) trade models.[10,11] Other recent work such as Berthou et al. (2023) maps GVC vulnerabilities using input-output tables and trade data from Comtrade and quantifies the transmission of upstream supply shocks to downstream producers. Our contribution is to precisely identify exposure to disruptions to the supply of HS6 products at the *firm*-level using micro data. This allows us to provide stylised facts on importers of foreign critical inputs and show that there might be a bias associated with using more aggregate data. Moreover, the fact that we conduct our analysis on five different EU countries provides a high degree of external validity.

[10]This literature typically relies on models à la Caliendo and Parro (2015); Allen et al. (2020), Antràs and Chor (2022), or Baqaee and Farhi (2023), to calculate the economic consequences of an increase in trade barriers along geopolitical lines. Examples of such applications include Eppinger et al. (2021), Góes and Bekker (2022), Javorcik et al. (2022), Attinasi et al. (2023a), Borin et al. (2023), Campos et al. (2023), Felbermayr et al. (2023), and Hakobyan et al. (2023).

[11]Other studies use different frameworks, such as large macroeconomic models (the METRO model in OECD (2020) and the World Bank ENVISAGE model in Chepeliev et al. (2022)), Hypothetical Extraction Method (Wu et al., 2021; Giammetti et al., 2021), or computable general equilibrium (CGE) models (Lim et al., 2021).

The rest of the paper is organised as follows. In Section 2, we report survey-based evidence on the exposure to sourcing FCIs from China. Section 3 shows how to identify FCIs and introduces our stylised facts. Section 4 presents our framework while Section 5 introduces our results. Section 6 concludes.

2 Exposure to China: evidence from survey data

In this Section, we rely on the Corporate Telephone Survey (CTS) data collected by the European Central Bank in the summer of 2023 and targeting the largest European firms. The survey focused on global supply chains —see Attinasi et al. (2023b) for a summary of the results, among other things, to shed light on firms' exposure to critical inputs sourced from China and to provide a first assessment of the associated economic risks.[12] The survey included questions on how European firms assess their exposure to critical inputs sourced from non-EU countries, including China, and their strategies to increase the resilience of their supply chain.[13,14]

Exposure to critical inputs from China. About 40% of the largest European firms rely on inputs from China that they deem critical for their activity, as shown in Figure 1. Intra-group imports are the biggest channel of exposure (60%). This is not surprising, since the firms surveyed are multinationals. This result is to be contrasted with other national surveys covering a larger sample of firms, including smaller ones for which intra-firm trade is much more modest.[15] Perhaps not surprisingly given the importance of China in manufacturing, the share of firms importing critical inputs from China is much higher in manufacturing than in services (48% and 26%, respectively).

Substitutability of critical inputs. The CTS further asked firms how difficult it would be to replace their critical inputs from China, as this important piece of information cannot be directly inferred from granular trade data. Figure 2 shows that

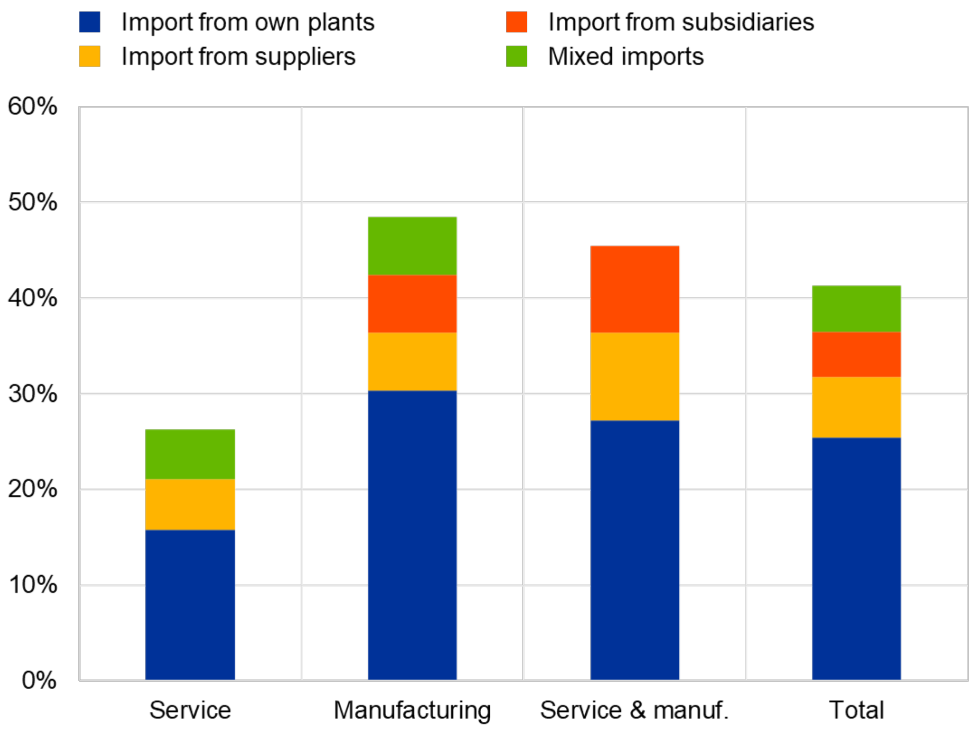
[12]The CTS was sent to companies with which the ECB maintains regular contact as part of its gathering of information on current business trends. A total of 66 responses were received. This is a relatively small sample in terms of the overall number of firms, but the aggregate value added of these firms generated globally is equivalent to around 5% of euro area GDP.

[13]In the survey, "critical" inputs are defined as goods without which a significant part of the business activity could not be completed or would suffer significant delays or the quality of the good or service produced by the firm would significantly decrease.

[14]For comparison, Figure A1 highlights the most exposed manufacturing sectors in terms of value added and employment, using customs and balance sheet data of Belgium, France, Italy, Slovenia and Spain.

[15]The Survey of Industrial and Service Firms (INVIND hereafter) covers 4000 Italian firms. Figure A2 contains mirror results of Figure 1 for Italy.

Figure 1: Critical Inputs from China among Large Euro Area Firms



Source: ECB CTS, Attinasi et al. (2023b) and own elaboration. **Notes:** Responses to the question "Does your company presently source critical inputs which depend (entirely or heavily) on supply from a specific country; and if so, which one(s)?", percentages of firms which answered "yes, China".

the degree of substitution associated with sourcing critical inputs from China is either low or very low for almost 90% of manufacturing firms. The corresponding number remains high (70%) for surveys covering a higher number of companies .[16]

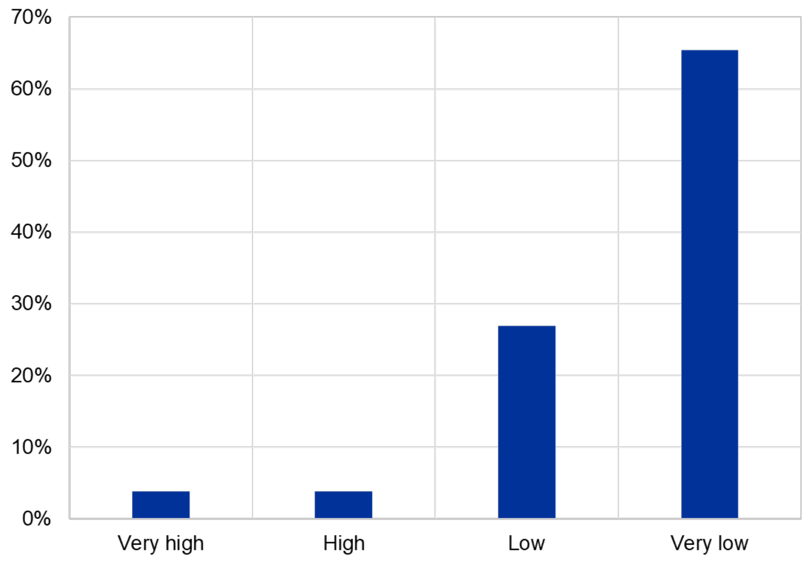
Supply chain reorganization. Firms exposed to China were explicitly asked about their strategies to reduce purchases of critical inputs from there. Figure 3 shows that firms would instead source from non-Chinese suppliers outside the EU (42%), regionalise their supply chain, i.e. substituting Chinese suppliers with EU ones (12%), or both (12%). Other measures mentioned by the firms were dual sourcing/diversification, monitoring risks, increasing stocks, changing production technologies, and downsizing production capacity. Overall, the vast majority of leading European firms plan to act to increase resilience (96%).[17]

Expected impacts on the real economy in the next five years. Most companies do not expect the *strategies* aiming to increase their supply chain resilience to have

[16] See Figure A3 for the corresponding findings based on Italian survey data.

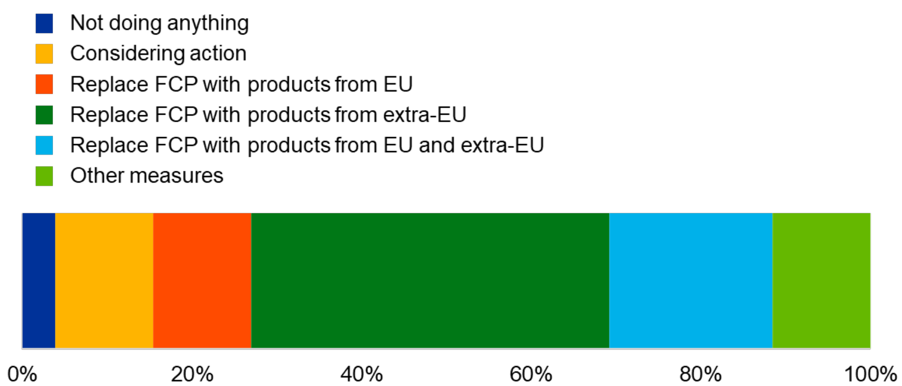
[17] Italian firms surveyed in INVIND report different results, depending on the degree of substitutability of critical inputs. Indeed, as shown in Figure A4, the majority of Italian firms with low substitution possibilities plan to take actions, whereas the converse is true for firms sourcing critical inputs with a high degree of substitutability.

Figure 2: Substitutability of Critical Inputs from China



Source: ECB CTS, Attinasi et al. (2023b) and own elaboration. **Notes:** Responses to the questions "In case these inputs were suddenly no longer available, how easy would it be to substitute them with inputs originating elsewhere?" The percentages of responses refer only to those firms that reported sourcing critical inputs which depended (entirely or heavily) on supply from China.

Figure 3: Strategies to Increase the Resilience of Supply Chains



Source: ECB CTS, Attinasi et al. (2023b) and own elaboration. **Notes:** Responses to the question "Is your firm implementing or is it planning to implement a strategy to reduce exposure to [China]?" The percentages of responses refer only to those firms that reported sourcing critical inputs which depended (entirely or heavily) on supply from China.

any impact on their value added or employment in Europe (Figure A5). A similar number of firms expect their value added to increase or decrease due to the changes mentioned (31%). However, on the employment side, the message is less optimistic: 42% of leading European firms expect a decrease in their number of employees working on their European sites.

Taken together, amidst growing geopolitical tensions, China represents a key source of vulnerability for EU firms.

3 Identifying foreign critical inputs

Given the exposure of firms to China, we detail the methodology used to identify foreign critical inputs and discuss our key stylised facts.

3.1 Data

Our analysis makes use of three types of datasets: i) customs data; ii) balance sheet data; iii) international trade data. We use data for 2019, the last year before the COVID-19 pandemic.

3.1.1 Customs data

Customs data are available at the importing country-firm-product-year level. European firms are required to report all transactions with extra-EU counterparts, indicating the products they trade, the date, the quantity and value of the transaction, as well as the specific product — at the CN8 level, and country of origin or destination. Intra-EU trade flows include the same information if above a country-specific threshold. Product codes are defined at the 8-digit level of the 2019 Combined Nomenclature (CN), the European counterpart of the Harmonized System nomenclature (HS). Unique firm tax identifiers are reported in the customs data, which allows us to merge our customs data with other firm-level datasets.

3.1.2 Balance-sheet data

The balance sheet data provide indicators for the universe of firms in the country (with some country-specific exceptions), including value-added, turnover and intermediate inputs. The database also includes information on the firms' main sector of economic activity (NACE3).

3.1.3 Sources and specificities

Belgium. Belgian customs data according to the national concept (excluding cross-border movements of goods in Belgium between non-resident businesses) are sourced from the "International Trade Dataset" of the National Bank of Belgium. Balance sheet data for non-financial corporations are retrieved from the annual accounts and the VAT declarations provided by the Central Balance Sheet Office (CBSO) of the National Bank of Belgium. We use the VAT declarations, collected by the Belgian tax authority, to complement data on turnover and intermediate inputs for those Belgian firms that do not report them in their annual accounts, because of reporting thresholds. For the number of employees and labour costs, we rely on social security data from *Rijksdienst voor Sociale Zekerheid / Office national de securité sociale (RSZ/ONSS)*.

France. French customs data "Statistiques du Commerce Extérieur" are provided by the Direction générale des douanes et droits indirects. The balance sheet data come from the French National Institute of Statistics and Economic Studies (INSEE).

Italy. Italian customs data come from ISTAT's warehouse for international trade statistics, which is based in turn on the microdata of the Italian Customs and Monopolies Agency (CMA). The balance sheet data come from the Cerved Group; it excludes companies operating in the financial and real estate sectors, as well as companies with no revenues or assets. We complement this database with information contained in Infocamere, which is the Official Business Register of the Italian Chambers of Commerce and further includes demographic information for non-limited liability companies. Lastly, we collect sectoral data from the Frame SBS database provided by ISTAT.[18]

Slovenia. Slovenian customs data come from the Financial Statistics department of the Bank of Slovenia, sourced in turn from the Statistical Office of the Republic of Slovenia (SORS). Balance sheet data come from the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES), which covers all firms registered in Slovenia obliged to report their annual balance sheets and financial statements. The latter is completed with data from the Business Registry of the Republic of Slovenia to provide information on regions and sectors of economic activity.

Spain. The Spanish dataset combines three different sources. Customs data come from the Customs and Excise Department of the Spanish Tax Agency. Balance sheet data come from Bureau Van Dick's SABI (*Sistema de Análisis de Balances Ibéricos*) database, which provides detailed financial and accounting records of Spanish firms that have filed their accounts with the Business Registry. Unfortunately, it is not possible to directly link Customs and SABI due to the lack of a common firm identifier. This limitation is overcome by using a third source, the Directory of Spanish Exporting and Importing Firms (*Directorio*), which is produced by the Chamber of Commerce of Spain. The *Directorio* contains both the customs and tax identifier for a sample of manufacturing firms, which account for almost 90 percent of Spain's total imports in 2019.

[18]This database complements administrative data on business units with survey and balance sheet data and is one of the major sources for national accounts statistics.

3.1.4 Macro trade data

International trade data are recovered through the CEPII BACI dataset, which provides data on bilateral trade flows for 200 countries at the HS6 level.[19] We use BACI to build the list of FCIs.

3.2 Methodology

To define foreign critical inputs, we employ a dual approach. First, we compile a list of inputs susceptible to supply disruptions in a fragmenting global economy due to their intrinsic characteristics. This category encompasses high-tech products and items crucial for the green transition —which major economies are actively seeking to secure and enhance resilience, since they could be used by geopolitical rivals to exert pressure (i.e. weaponization of supply). Second, we draw upon work done by the European Commission to identify foreign dependencies (European Commission, 2021; Arjona et al., 2023).

More specifically, we consider as foreign critical inputs: *i*) inputs included by the US Census in the list of Advanced Technology Products;[20] *ii*) inputs and raw materials key for the green transition —such as lithium, nickel, and photovoltaic cells);[21] *iii*) inputs for which the "EU experiences an important level of foreign dependencies" according to the European Commission (Arjona et al., 2023).[22]

For our baseline scenario, we combine lists *i* to *iii*. However, as a robustness check, we provide results wherein foreign critical inputs are defined based on their intrinsic characteristics only, i.e. items *i* and *ii* above. Our baseline list of FCIs includes 667 HS6 product codes, including products such as Electronic integrated circuits (HS code 854239) or Insulin and its salts (HS code 293712).

3.3 Allocation of countries into blocs

In order to assess from which countries —from the point of our European Union countries —importing FCIs is riskier, we extend upon the approaches based solely

[19] See Gaulier and Zignago (2010).

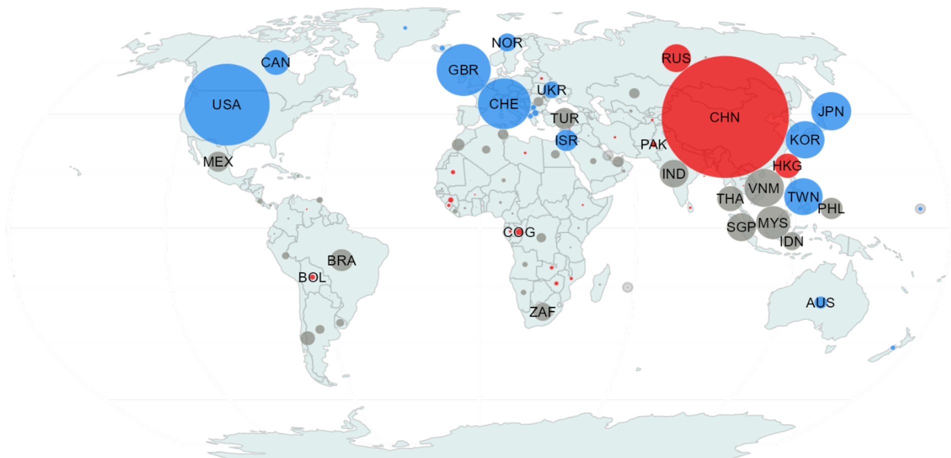
[20] The US Census considers as Advanced Technology Product those items used in the production processes of applications in the following fields: biotechnology, life science, opto-electronics, information & communications, electronics, flexible manufacturing, advanced materials, aerospace, weapons, and nuclear technologies. Such products mostly fall in chapters 29, 30, 84, 85, 88, and 90 of the HS classification.

[21] Compared to the original list of raw materials key for the green transition compiled by the OECD (Kowalski and Legendre, 2023), we restrict the sample by looking only at materials whose exports by extra-EU countries are highly concentrated, i.e. those with an Herfindahl-Hirschman index above 0.4.

[22] Compared to the official list of the European Commission, we restrict the sample only to inputs and capital goods, therefore excluding final products.

on United Nations voting patterns to assess geopolitical alignment —as those recently used in the literature (Campos et al., 2023; Javorcik et al., 2022; Gopinath et al., 2024), by relying on the geopolitical index developed by den Besten et al. (2023). This index is constructed by combining four measures of political alignment between countries over the past decade. These measures include the frequency of sanctions, military import disparities, China's official lending, and voting behaviors on UN resolutions. The final index varies from zero to one, indicating the degree of geopolitical alignment with China and Russia (closer to 1) compared to the United States (closer to 0). Countries with an index below 0.25 are assigned to the US-aligned bloc, while those with an index above 0.75 are instead assigned to the China-aligned one. Other countries are assigned to the "Neutral" bloc. To cover a larger sample of countries compared to the list in den Besten et al. (2023) —which consists of 63 economies —we rely on the allocation provided by Capital Economics (2023) which is based on political and economic alignment, as both measures are conceptually close.[23] As can be seen in Appendix B, the China-aligned bloc consists, among others, of China, Russia, and Pakistan.

Figure 4: Extra-EU Import Share of FCIs by Country and Partner Alignment



Notes: The circles represent the share of each extra-EU country's exports of FCIs in EU imports of FCIs from all extra-EU countries. See Appendix B for the complete list of US-aligned, China-aligned, and neutral countries.

[23] We consider as US-aligned economies those classified as "US allies" in Capital Economics (2023), and China-aligned economies those classified as "China allies". Other economies are considered as Neutral. The overlapping sample between the two classifications is highly correlated, as only three countries (out of 63) are assigned to different blocs. Click here to access the list of Capital Economics (2023).

Foreign critical inputs for the EU. We investigate the main sourcing countries of FCIs for the EU as a whole. As is evident in Figure 4, this sourcing is very concentrated. China represents 30% of extra-EU imports of FCIs and is thus ranked as the most important extra-EU supplier of FCIs to the EU. The US follow with a share of 18% while the United Kingdom's share is 7%. These three countries together account for roughly 55% of imports of FCIs from extra-EU countries, while other countries such as Ukraine or Russia account for 2.5% each.[24]

In terms of sectoral composition (at the NACE-2 level), other transport equipment is the sector with the highest import share of FCIs in extra-EU imports, at about 28%, as highlighted in Figure A7. Pharmaceutical inputs and metallurgy represent the two other most relevant sectors, with shares reaching 13% and 12%, respectively.

3.4 Stylised facts

We now rely on our micro data from BFISS to establish five stylised facts on the characteristics of firms importing FCIs. In our five combined datasets, there are 61,453 importers of FCIs in the manufacturing sector —accounting for 9% of the number of firms in manufacturing.

3.4.1 Exposure to FCI disruptions

Which firms are exposed to FCI disruptions? Across all manufacturing firms, the largest ones are more likely to be exposed to an import cut of FCIs from China-aligned countries. Indeed, 37% of Spanish firms and 61% of Slovenian firms in the top 1% of the corresponding value-added distribution import FCIs from China-aligned countries (Figure 5). The share of exposed firms decreases monotonically for every country along the firm size distribution. As a consequence, large exposed firms account for 70 to 96% of total *exposed* value added (Figure A8).

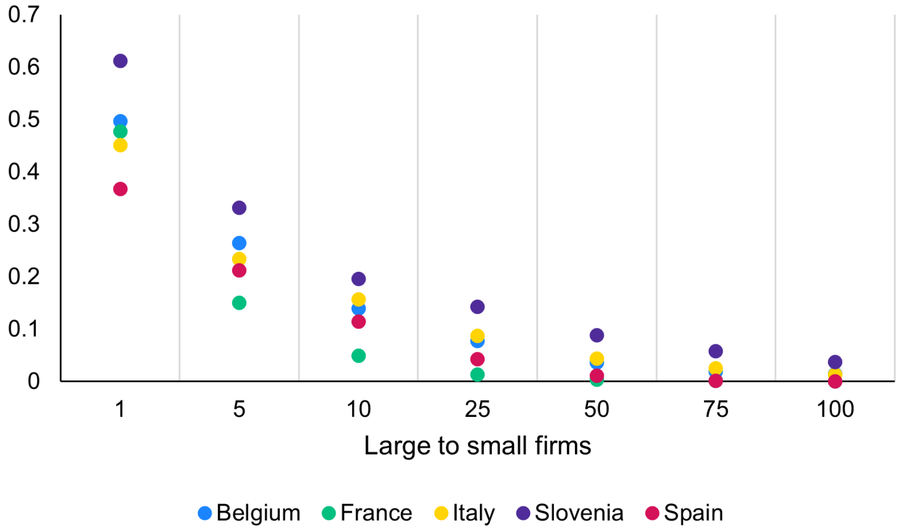
The sur-representation of the largest firms among exposed firms is due to two main factors. First, almost all large firms are importers (from 86% in Spain to 100% in Slovenia).[25] Second, large *importers* are more exposed than small ones as a share of the relevant population (from 42% in Spain to 61% in Slovenia for firms in top 1% of the value-added distribution).[26]

[24]At the extensive margin, China is also the main exporter of FCIs for about 30% of these goods (200 FCIs out of 667); the United States is the most important supplier of 145 FCIs; and Switzerland follows at a distance with 48 product-codes (Figure A6).

[25]See Figure A9.

[26]See Figure A10.

Figure 5: Share of Exposed Firms by Firm Size



Notes: The x-axis shows percentiles, e.g. 1 stands for the 1% largest firms in value added, 5 for the 1 to 5% largest, etc. Exposed firms are firms importing foreign critical inputs from China-aligned countries. The share is computed by dividing the number of exposed firms by the total number of firms (importers and non-importers).

Fact 1: *The share of exposed firms is much higher for large firms and large exposed firms account for about 70 to 96% of total exposed VA. This is driven by two factors: (1) almost all large firms are importers; (2) large importers are more exposed than small ones as a share of the relevant population.*

3.4.2 Sourcing strategy

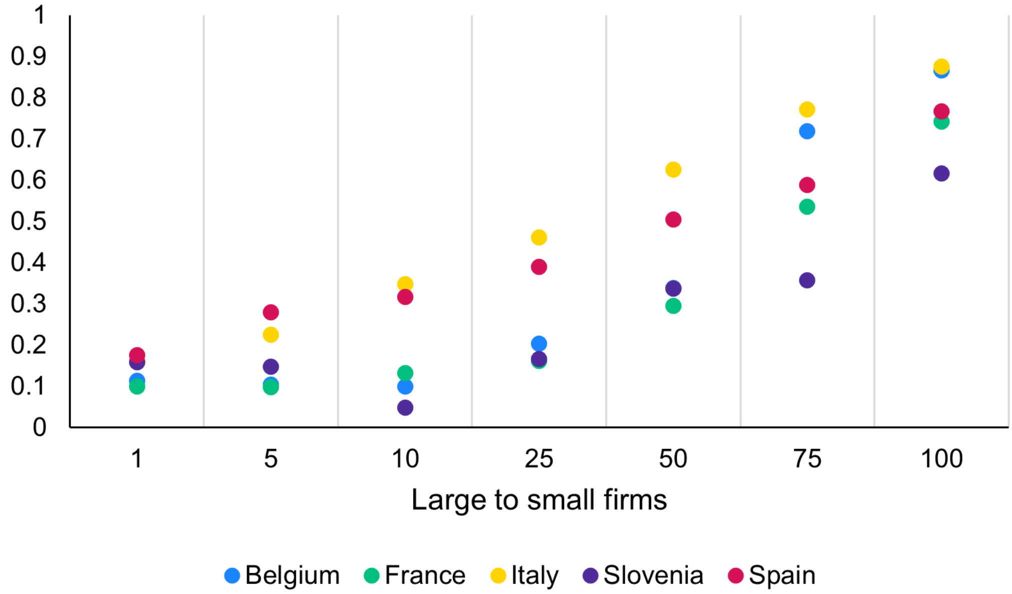
We then dig deeper into firms' sourcing strategies. Firms purchase few different FCIs, 6 on average, compared to 23 non-FCIs. Table A2 shows that the number of FCIs purchased displays a right-skewed distribution, reaching a maximum of 241 FCIs in France.[27] The median number of sourcing countries for each firm-FCI pair is 1, while around 10% of firms purchase the same FCI from at least 2 to 3 different countries. These figures are similar to those observed for non-FCIs.

We then compute the import share of FCIs sourced from China-aligned countries. Figure 6 shows that smaller firms tend to be more heavily exposed to China-aligned countries for their critical inputs, while larger firms face a lower risk in that regard.[28]

[27] See Table A3 for the whole economy.

[28] Figure 6 defines firm size using value added. Alternatively, Figure A11 reproduces the results when measuring firm size by the number of employees.

Figure 6: Import Share of FCIs from China-aligned Countries by Firm Size (Conditional on Exposure)



Notes: The x-axis shows percentiles, e.g. 1 stands for the 1% largest firms in value added, 5 for the 1 to 5% largest, etc. Only firms importing critical inputs from China-aligned countries are considered.

Fact 2: *Diversification of sourcing is limited for FCIs and large importers are relatively less vulnerable.*

3.4.3 Expenditure shares of FCIs

To understand the importance of FCIs for firms, we compute the share of imports of FCIs in firms' total purchases of goods and services. These statistics are described in Table 1 —see Table A4 for the whole economy. On average, FCIs account for about 6% of firms' total purchases (see last panel) with some heterogeneity across countries. The median of this ratio is 1.1% and the 90th percentile is 17%.[29]

However, the risks of supply disruptions are higher when countries have weaker ties and different political stances on key issues —e.g., from the point of view of European countries, diplomatic ties with Switzerland and the US are stronger than those with other countries such as China or Russia. To take this dimension into account, we further distinguish between "China-aligned" and "US-aligned" countries. The following two rows of Table 1 show that the FCI share from China-aligned and US-aligned countries averages 4% and 5%, respectively.[30]

[29]Despite some variation in these shares, the share of foreign critical inputs over total inputs is rather stable along the firm size distribution (Figure A12).

[30]The number of firms reported in the second and third rows need not add up to that reported in the first row as firms may import from both US- and China-aligned countries.

Table 1: Summary Statistics for FCI Importers

		Mean	p10	p50	p90	SD	Obs.
Belgium	FCIs, share of firms' total purchases	4.9	0.03	0.7	13.3	11.4	2748
	FCIs from US-align countries, share of firm's total purchases	4.3	0.02	0.6	10.9	10.7	2422
	FCIs from China-align countries, share of firm's total purchases	3.2	0	0.3	8.0	8.7	975
France	FCIs, share of firms' total purchases	5.9	0.03	1.0	17.0	12.9	8366
	FCIs from US-align countries, share of firm's total purchases	5.3	0.02	0.8	14.8	12.3	7657
	FCIs from China-align countries, share of firm's total purchases	2.8	0.00	0.2	6.6	8.2	3224
Italy	FCIs, share of firms' total purchases	4.6	0.03	0.8	12.8	10.4	15238
	FCIs from US-align countries, share of firm's total purchases	3.9	0.02	0.5	10.4	9.6	12346
	FCIs from China-align countries, share of firm's total purchases	3.4	0.03	0.6	9.3	7.7	6604
Slovenia	FCIs, share of firms' total purchases	6.3	0.06	1.3	18.3	13.2	3570
	FCIs from US-align countries, share of firm's total purchases	5.7	0.06	1.2	15.4	12.3	3490
	FCIs from China-align countries, share of firm's total purchases	4.1	0.01	0.4	10.6	10.7	642
Spain	FCIs, share of firms' total purchases	8.58	0.1	1.6	24.4	17.35	4030
	FCIs from US-align countries, share of firm's total purchases	7.61	0.1	1.3	21.0	16.28	3594
	FCIs from China-align countries, share of firm's total purchases	5.04	0.0	1.0	12.5	11.71	1476
All	FCIs, share of firms' total purchases	6.0	0.044	1.1	17.2	13.1	6790
	FCIs from US-align countries, share of firm's total purchases	5.3	0.036	0.9	14.5	12.2	5902
	FCIs from China-align countries, share of firm's total purchases	3.7	0.016	0.5	9.4	9.4	2584

Notes: The table displays summary statistics for manufacturing firms importing foreign critical inputs in 2019. See Table A4 for the whole economy. The variables are expressed in percentage points. The category "all" refers to a simple average across countries. Intermediate goods refer to expenditures on goods and services. All countries but Spain use the population of importing firms; in the case of Spain, only importers are included in Directorio. Differences between Spain and the other countries are explained by the fact that Directorio excludes the majority of small-size importing firms.

Fact 3: *FCIs, on average, account for a modest share of firms' total purchases. The ratio of imports of FCIs to total costs is relatively constant along the firm size distribution.*

3.4.4 FCIs and size premia

We have seen that the share of exposed firms is higher for large firms but a question remains. How large are importers of FCIs? Figure A13 shows that firms importing FCIs account for 70% of *total BFISS* manufacturing value-added. Firms importing FCIs from China-aligned countries more specifically account for 55% of total BFISS manufacturing value-added.[31]

Fact 4: *Firms importing FCIs account for a sizable share of the economy.*

To assess whether there are significant differences between importers of FCIs and non-importers of such products, we estimate the following regression:

$$\log \mathrm{y}_i = \gamma + \beta \text{Foreign Critical}_i + \delta_s + \varepsilon_i \tag{1}$$

where i is a firm, y_i is employment, turnover, wages or labour productivity measured as the ratio of value-added to the number of employees. Foreign Critical$_i$ is a dummy variable equal to one if firm i imports FCIs. We further control for differ-

[31] As shown in the previous section, China is by far the most relevant source of FCIs. In fact, the value-added produced by firms importing FCIs from China corresponds to 26% of total BFISS value-added, while this figure reaches 35% in the manufacturing sector.

Table 2: FCI Premia

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All firms				Extra-EU importers			
Import FCI	log Employment	log Turnover	log Wages	log Labor Prod.	log Employment	log Turnover	log Wages	log Labor Prod.
Belgium	2.031***	2.465***	0.383***	0.310***	1.319***	1.495***	0.180***	0.167***
	(0.0347)	(0.0382)	(0.0116)	(0.0158)	(0.0465)	(0.0502)	(0.0143)	(0.0221)
Obs.	12343	12343	12343	12343	4071	4071	4071	4071
France	2.399***	2.858***	0.215***	0.242***	1.467***	1.593***	0.0823***	0.0993***
	(0.0195)	(0.0210)	(0.00641)	(0.00819)	(0.0309)	(0.0319)	(0.0114)	(0.0146)
Obs.	92,353	92,353	92,353	92,353	10,722	10,722	10,722	10,722
Italy	1.558***	2.123***	0.305***	0.363***	0.930***	1.137***	0.147***	0.174***
	(0.0123)	(0.0136)	(0.00299)	(0.00556)	(0.0148)	(0.0161)	(0.00362)	(0.00696)
Obs.	107,773	107,773	107,773	107,773	30,642	30,642	30,642	30,642
Slovenia	1.255***	1.637***	0.150***	0.275***	1.168***	1.325***	0.123***	0.148***
	(0.0383)	(0.0425)	(0.00926)	(0.0186)	(0.0852)	(0.0951)	(0.0171)	(0.0369)
Obs.	6,125	6,125	6,125	6,125	2,280	2,280	2,280	2,280
Spain	1.280***	1.681***	0.139***	0.336***	0.927***	1.125***	0.0896***	0.198***
	(0.0271)	(0.0312)	(0.00643)	(0.0115)	(0.0325)	(0.0368)	(0.00773)	(0.0144)
Obs.	10,161	10,161	10,161	10,161	6,060	6,060	6,060	6,060
3-digit industry FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The table reports estimates from eq. (1) in the text. Standard errors clustered at the firm level. * significant at 10%, ** significant at 5%, *** significant at 1%. Manufacture firms only, see Table A5 for the whole economy.

ences in demand or supply that could explain size differences across firms as well as the fact that firms in specific industries may need FCIs for their production process by including three-digit (NACE) sector fixed effects δ_s.

Table 2 presents our results for the manufacturing sector.[32] As shown in columns 1 to 4, firms importing FCIs are larger and more productive than non-importers of FCIs. To fix ideas, columns 1-4 show that importers of FCIs have 250 to 1000% more employment, 410 to 1640% more turnover, give 15 to 47% higher wages and have 27 to 44% higher labour productivity than non-importers of such products. A concern, however, is that these premia mostly reflect size differences across importers and non-importers (Bernard et al., 2007). To address this concern, columns 5 to 8 focus on size differences across firms importing from extra-EU countries —these firms are arguably larger than other types of importers since fixed costs associated with sourcing from outside the EU may be larger. While the point estimates are smaller, they remain highly significant and the size differences remain important: Column 8, for instance, shows that importers of FCIs are 10 to 22% more productive than non-importers of FCIs, conditional on sourcing from extra-EU partners.

Fact 5: *Firms importing FCIs are relatively larger and more productive, even within narrowly defined industries.*

Taken together, Facts 1-5 suggest that importers of FCIs are relatively large and the degree of exposure to disruptions from China-aligned countries varies across firms.

[32]See Table A5 for the whole economy.

This motivates the use of a framework accounting for heterogeneous exposure to geoeconomic fragmentation.

4 Supply shortages of foreign critical inputs

We adopt a stress-test approach, in order to evaluate the effects of a disruption in the availability of FCIs on value-added. We start by outlining our framework before discussing it.

4.1 Model

4.1.1 Environment

Each firm i produces output Y with a Cobb-Douglas technology, by combining labour (L), capital (K), and intermediates goods and services (M):

$$Y_i = A_i K_i^{\alpha_s} L_i^{\beta_s} M_i^{1-\alpha_s-\beta_s}, \tag{2}$$

where α_s and β_s are industry-specific expenditure shares on labour and capital while $1 - \alpha_s - \beta_s$ is the expenditure share of goods and services purchases.

In turn, intermediate goods and services are combined through a firm-specific CES aggregator:[33]

$$M_i = \left[\gamma_i^{\frac{1}{\sigma}} E_i^{\frac{\sigma-1}{\sigma}} + (1-\gamma_i)^{\frac{1}{\sigma}} X_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{3}$$

where γ_i is firms' expenditure share on FCIs E, whereas X is a bundle of non-foreign critical intermediate goods and services. Importantly, σ denotes the elasticity of substitution between FCIs and other intermediates. As usual with this type of production function, FCIs and non-FCIs become perfect complements when $\sigma = 0$ (the Leontief case), while the function becomes Cobb-Douglas when $\sigma = 1$.

4.1.2 Foreign critical input disruption and value-added

We assume that a firm-specific shock ε_i reduces the availability of FCIs E. Normalising its original endowment to 1, expenditures on FCIs after the shock are thus given

[33]This formulation echoes Bachmann et al. (2022)'s approach to studying the effect of cutting energy imports from Russia.

by $E_i = 1 - \varepsilon_i$. After some derivations detailed in Appendix A, we obtain:

$$\Delta \text{va}_i = (1 - \alpha_s - \beta_s) \left[\frac{\left(\gamma_i^{\frac{1}{\sigma}} (1-\varepsilon_i)^{\frac{\sigma-1}{\sigma}} + (1-\gamma_i)^{\frac{1}{\sigma}} \left(\frac{1-\gamma_i}{\gamma_i} \right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}}{\left(\gamma_i^{\frac{1}{\sigma}} + (1-\gamma_i)^{\frac{1}{\sigma}} \left(\frac{1-\gamma_i}{\gamma_i} \right)^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}} - 1 \right]. \quad (4)$$

The change in value-added Δva_i depends on the firm-specific shock ε_i, on the elasticity of substitution σ, on the sectoral parameter $1 - \alpha_s - \beta_s$ and on the firm-specific parameter γ_i.

Aggregation. To derive the effect of disruptions to the supply of FCIs at the sectoral, regional, aggregate level, we calculate the average value-added change as follows:

$$\Delta \text{va} = \sum_i \Delta \text{va}_i \times \omega_i^{va}, \quad (5)$$

where ω_i^{va} is firm i's value-added share in the relevant sample (sector, region, or aggregate). In other words, the aggregate change in value-added is given by a value-added weighted average of changes in firm-level value-added. Importantly, these value-added weights are computed over the entire sample of firms, which includes both exposed and non-exposed firms. We will come back to this point when we discuss the importance of relying on micro data.

4.2 Calibration

We calibrate our model as follows. We recover the γ_i parameters by combining customs data at the firm-product level with balance sheet data for 2019 for BFISS. More specifically, we compute the ratio of the import value of FCIs to expenditures on materials.[34] The sectoral shares $1 - \alpha_s - \beta_s$ are the ratio of expenditures on materials to turnover. To minimize the importance of outliers that could be driven by different definitions of sales across countries, we rely on data from the OECD (Horvát and Webb, 2020). Nonetheless, these Cobb-Douglas parameters are allowed to vary at the country-industry level —an industry being defined at the 3-digit level (NACE3).

In our baseline scenario, we assume that geoeconomic fragmentation would disrupt imports of FCIs sourced from China-aligned countries. Using our customs data, we thus compute the share of FCIs sourced from China-aligned countries in total imports of FCIs (China-aligned share$_i$) and allow this share to change accord-

[34]One recovers the import value of FCIs by aggregating the value of imports of all HS6 FCIs at the firm-year level.

ing to the parameter δ. Therefore, the firm-level shock is:

$$\varepsilon_i = \text{China-aligned share}_i \times \delta \quad (6)$$

In other words, we reduce firm-level endowments of FCIs by a share that is proportional to their imports from China-aligned countries. Our baseline value for δ is 0.5 but we provide robustness checks using alternative values.

We can now make a number of remarks. First, firms that do not import FCIs from China-aligned countries —China-aligned share$_i$ $= 0$ and thus $\varepsilon_i = 0$ —will not experience any value-added change ($\Delta \text{va}_i = 0$). Second, everything else equal, value-added decreases relatively more when the degree of exposure to disruptions to the supply of FCIs from China-aligned countries is higher ($\frac{\partial \text{va}_i}{\partial \varepsilon_i} < 0$). Third, δ not only captures different degrees of disruptions but also the ease of substitution between FCIs from China- and US-aligned/neutral countries.[35]

Finally, given the central role of σ and to reflect the uncertainty about its value, we allow this parameter to vary from 0 to 0.2. However, since our focus is on the *short-run* effects of decoupling, the elasticity of substitution between intermediates is arguably closer to zero (Barrot and Sauvagnat, 2016; Atalay, 2017; Boehm et al., 2019).[36,37]

4.3 Discussion

Despite its limitations —prices and factors of production other than FCIs are held constant and non-directly exposed firms are not affected through indirect importing (Dhyne et al., 2021), we find the framework above to be useful for the following reasons. First, the model can easily be calibrated using micro data which are typically available to researchers. Second, considering alternative decoupling scenarios or using alternative elasticity values is computationally fast as eq. (4) can be readily recovered. Third, our framework can be used to shed light on the role played by firm-level exposure to aggregate geoeconomic shocks affecting the supply of granular *inputs*.

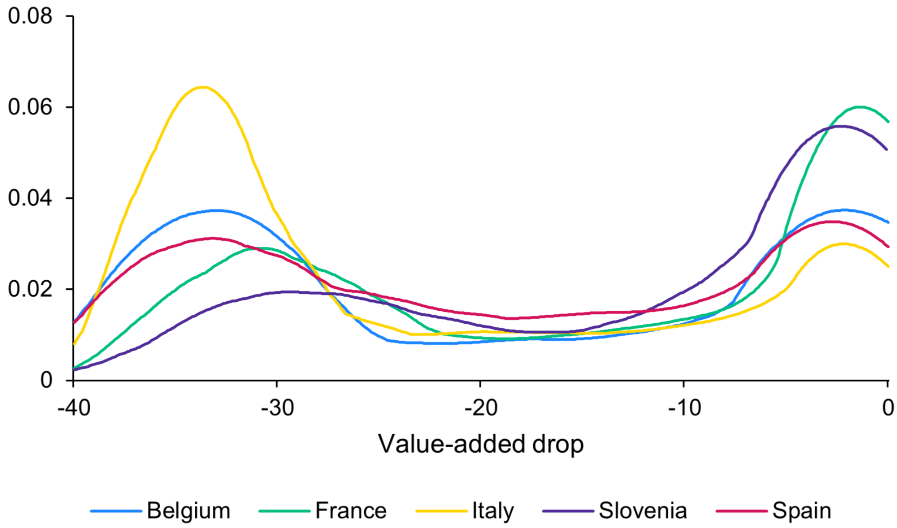
Overall, our framework attempts to assess how shocks affecting different sets of *inputs* may affect firms, sectors, regions, and the economy differently, depending on the underlying exposure of *firms*. Because of its limitations and advantages, we

[35] For instance, $\delta = 0.5$ could result from either a 100% drop in the supply of critical inputs, partially mitigated by substituting 50% of this supply, or from a 50% drop in the supply of critical inputs without any substitution.

[36] Peter and Ruane (2023) find values for the elasticity of substitution between intermediates consistently higher than one. Their estimates, however, are long-run ones in that they focus on India's trade liberalisation episode.

[37] See footnote 52 for the change in value-added in the Leontief case.

Figure 7: Distribution of Value-added Change (in %)



Notes: The figure reports the distribution of value-added changes (in %) due to a 50% cut in FCIs from China-aligned countries when $\sigma = 0$. Only manufacturing firms are included.

consider our framework to be complementary to recent papers relying on Baqaee and Farhi (2023)'s work —see Section 1.

5 Results

We detail our results in this section. To facilitate the exposition, we provide robustness checks along the way.

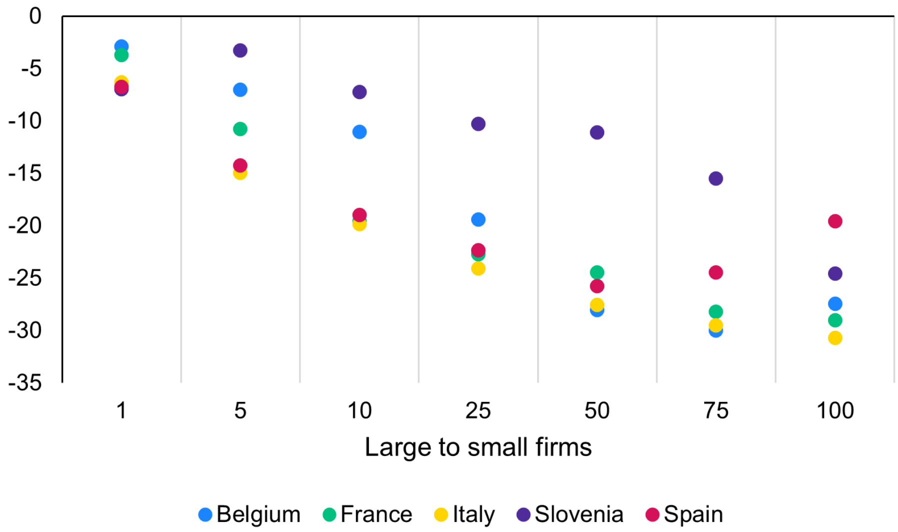
5.1 Heterogeneous effects across firms

Figure 7 shows the firm-level distribution of value-added changes when the production function is Leontief. The distribution has a fat left tail. Our 5 countries display similarly shaped bi-modal distributions, although Italy has a larger group of firms that are highly affected by the cut.[38]

Which firms lose more and why is that so? It turns out that the largest firms are relatively less affected by a cut in FCI supply (Figure 8). In fact, the value-added loss for the largest firms would range from 3% for Belgium to 7% for Slovenia. Conversely, conditional on importing FCIs from China-aligned countries, the impact is relatively higher for smaller firms, ranging from about -20% for Spain to -30% for Italy. Although the firm-level value-added changes are also shaped by technology

[38] As shown in Figure A14a, when the elasticity of substitution is higher ($\sigma = 0.2$), the mass flattens out and is more concentrated around zero. Figure A14 shows more robustness checks where we use a restricted set of FCIs; where only imports of Chinese critical inputs are cut; and where we consider the whole economy instead of the manufacturing sector.

Figure 8: Value-added Changes (in %) among Exposed Firms by Size



Notes: The figure reports the distribution of value-added changes (in %) across different types of firms. The scenario considered is a 50% cut in FCIs from China-aligned countries when $\sigma = 0$. The x-axis shows percentiles, e.g. 1 stands for the 1% largest firms in value added, 5 for the 1 to 5% largest, etc. Only firms importing critical inputs from China-aligned countries are considered.

parameters —see eq. (4), the results reported in Figure 7 and Figure 8 are consistent with the fact that the import share of FCIs from China-aligned countries is relatively higher for smaller importers (Fact 2) so that these firms will be relatively more affected by our geoeconomic fragmentation scenario.

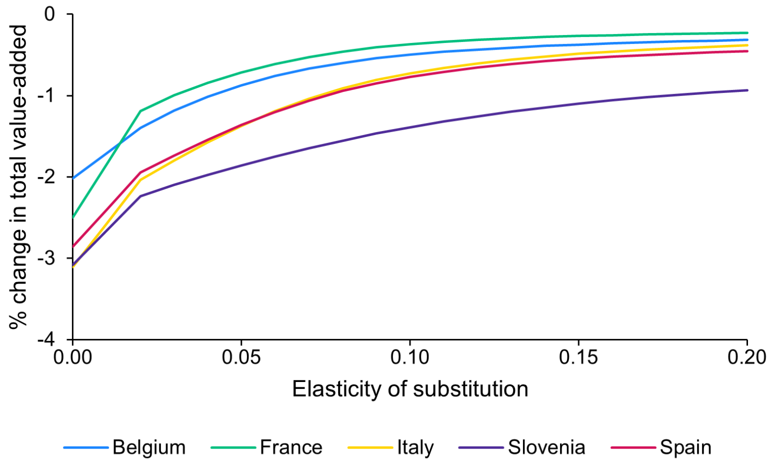
Overall, *heterogeneous exposure* to FCIs sourced from China-aligned countries leads to heterogeneous patterns of value-added losses across firms and countries.

5.2 Aggregate effects

We aggregate our firm-level results using eq. (5) and plot the aggregate value-added change as a function of the elasticity of substitution between FCIs and other intermediates, in Figure 9. When $\sigma = 0$, halving the supply of FCIs from China-aligned countries would result in a drop in manufacturing value-added of up to 2.0% for Belgium, 2.5% for France, 2.9% for Spain and 3.1% for Italy and Slovenia. The smaller aggregate impact —compared to Figure 7 —is reminiscent of the finding that firms may have Leontief technologies but that the aggregate production function exhibits a different shape (Houthakker, 1955; Jones, 2005). When higher values for σ are instead assumed, the aggregate value-added loss converges towards 0: as FCIs can be more easily substituted with other inputs, firms experience smaller value-added losses, and in turn this has a lower effect on aggregate value-added.

We test the robustness of these results in different ways. In the case where FCIs cannot be substituted, a larger 75% cut in the supply of FCIs from China-aligned

Figure 9: Aggregate Value-Added Change (in %) across Countries



Notes: Only manufacturing firms are included.

countries ($\delta = 0.75$) is associated with a drop in manufacturing value-added ranging from 3% for Belgium to more than 4.5% for Italy and Slovenia (Figure A15a). A smaller drop of 25% ($\delta = 0.25$) would lead to a 1 to 1.5% drop in value-added (Figure A15b), depending on the country. Furthermore, we use an alternative, restricted, list of critical inputs, in Figure A14b and Figure A15c, to show that our results remain similar (2.4% instead of a 2.7% average drop when $\sigma = 0$). Moreover, halving the supply of FCIs from China only implies a value-added decrease close to that obtained when reducing the entire supply of FCIs from China-aligned economies (2.3% drop on average).[39] This can be explained by the central role of China as a supplier of these inputs (see section 3). Finally, the shock is more diluted when studying the whole economy instead of the manufacturing sector and implies an average 1.5% drop in value-added.[40]

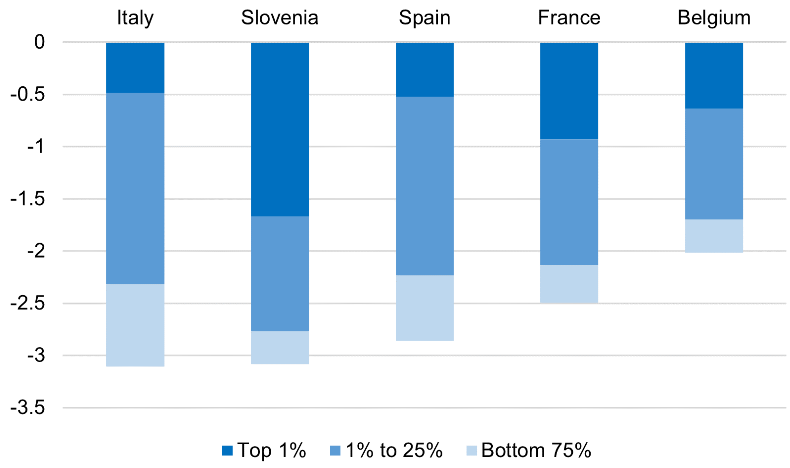
Which firms are driving this change in aggregate value-added? Given that we rely on a value-added weighted average in eq. (5) and given the results shown in Figure 8 and Figure 9, we expect large firms to drive the aggregate change —which echoes the famous result by Hulten (1978) for aggregate productivity and recently revived by Gabaix (2011).[41] The decomposition in Figure 10 confirms this intuition when $\sigma = 0$. The drop (the height of the bars matches the corresponding numbers provided in fig. 9) is mainly due to exposed firms in the highest quartile of the value-added distribution: 25% of exposed firms are responsible for 75% or more of

[39]See Figure A14c and Figure A15d

[40]See Figure A14d and Figure A15e.

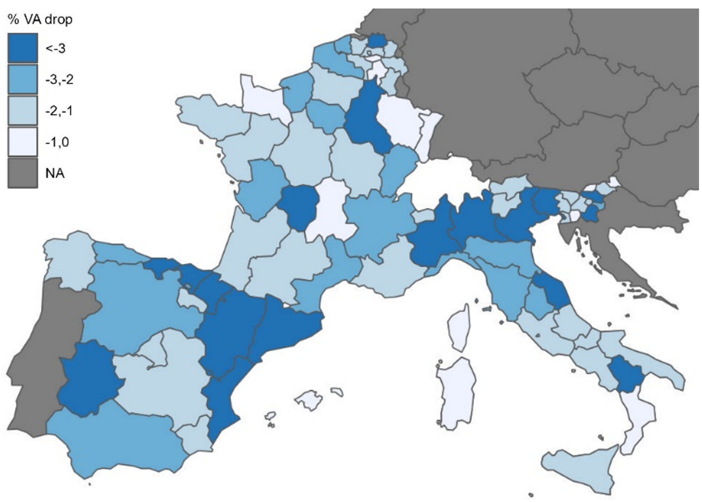
[41]Hulten (1978) shows that, in efficient economies and to a first-order approximation, the impact on aggregate productivity of a firm's change in TFP is given by that firm's sales share as a fraction of GDP —its Domar weight. See Baqaee and Farhi (2020) for a recent important contribution in inefficient economies with input-output linkages.

Figure 10: Decomposition of Value-added Change (in %) by Exposed Firm Size



Notes: Firm size is measured in terms of value-added. The percentile calculation only includes exposed firms operating in manufacturing.

Figure 11: Aggregate Value-added Change (in %) across Regions



Notes: The figure reports the value-added change (in %) across regions coming from a 50% drop in CP supply from China-aligned countries ($\sigma = 0$). Only manufacturing sectors are considered.

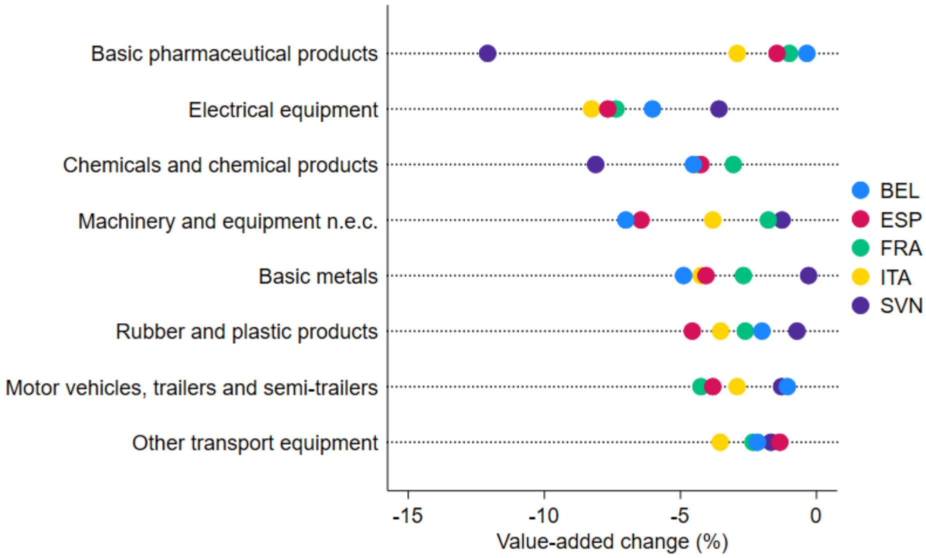
the decrease in all countries.[42] The results for the top 1% display more heterogeneity, driving around 15% of the drop for Italy and Spain, one-third for France and Belgium, and more than half of the drop in Slovenia. One reason is the presence of large multinationals which is arguably more salient in these three countries.[43,44]

[42]As a robustness test, Figure A16 reproduces the results using the number of employees as a proxy for firm size.

[43]See, among others, Di Giovanni et al. (2017) for the effect of multinationals and international linkages in driving cross-border comovement.

[44]For confidentiality reasons, we cannot display which firms drive our results.

Figure 12: Aggregate Value-added Change (in %) across Sectors



Notes: The figure reports the value-added change (in %) across the most exposed sectors from a 50% drop in FCI supply from China-aligned countries ($\sigma = 0$). Italy's dot is hidden by Belgium and Spain's dots for the Chemicals industry. Only manufacturing sectors with a significant size (> 1% of total value-added) are shown.

5.3 Regional and sectoral effects

The impact of our geoeconomic fragmentation scenario also varies substantially across sectors and regions.

5.3.1 Regional effects

Figure 11 shows the impact of a 50% cut on manufacturing value added by region (defined at the NUTS2 level or NUTS3 for Slovenia).[45,46] There is a lot of heterogeneity across regions within countries. This is driven by two factors: specialisation and concentration. Regions specialised in sectors heavily reliant on FCIs imported from extra-EU countries (Figure A7) are more heavily impacted, for example, the Italian region of Lombardy or the Spanish region of Catalonia, which specialise in pharmaceutical products. The concentration of top producers in some regions is the other factor driving this heterogeneity: the presence of large exposed firms implies that these firms have a more important effect on their region's value-added,[47] consistent with the aggregate effects rationalized above.

[45] We present results in the Leontief case where $\sigma = 0$, for the sake of simplicity. Results for alternative values of σ are available upon request.

[46] Figure A17 in the appendix instead shows the impact on the whole economy.

[47] Again, we can display neither the location nor the identity of the firms driving the impact in some of our regions.

5.3.2 Sectoral effects

There is also substantial heterogeneity across sectors. Figure 12 shows that the impact of the shock in the Leontief case would exceed 6.5%, on average, for the electrical equipment and would be higher than 4%, on average, for chemical products, and machinery and equipment industries. These effects are considerably higher than the results obtained for the entire manufacturing sector (2.7% on average),[48] reflecting the higher share of FCIs from China-aligned countries used by these industries.[49] Moreover, our results point to substantial heterogeneity *across* countries *within* certain sectors, reflecting different sub-sector compositions and firm-specific sourcing patterns that differ across countries. For instance, Belgium and Spain experience larger value-added drops within the machinery and equipment industry than the other countries.

5.4 Importance of micro data

How important are micro data in assessing the impact of supply disruptions of FCIs? To answer this question, we investigate how relying on sectoral data rather than firm-level data would affect our quantitative results.[50] Figure 13a shows the equivalent of Figure 9 when using sector-level data. Figure 13b thus shows that using macro data instead of more granular data may bias the impact of geoeconomic fragmentation.[51] Specifically, the use of macro data yields to overstating the effect for all countries but France, when the production function features complementarity between FCIs and other intermediate inputs: the size of the bias ranges from 2.3 percentage points for Italy to -0.3 percentage points for France in that case. The bias may thus also be negative —meaning that using macro data may understate the effect of supply disruptions of FCIs —for different levels of σ and converges towards 0 as the elasticity of substitution increases.

Why does using macro data bias the results and why does it differ across countries? The use of macro data yields different results because *exposure* to imports of FCIs from China-aligned countries is computed at the *sector-wide* level. Sector-level exposure thus masks substantial heterogeneity across firms. In fact, since we

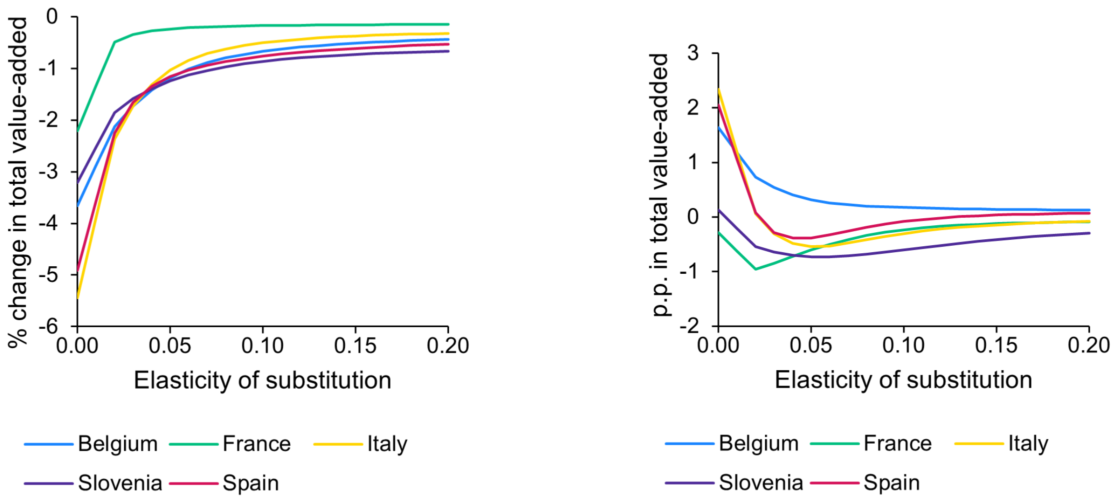
[48] Figure A18 shows the five sectors with the biggest average contribution to the drop, namely chemicals, electrical equipment, machinery and equipment, and motor vehicles.

[49] Figure A19 show non-manufacturing sectors for comparison. The results are on average smaller than for manufacturing owing to the lower exposure of firms to FCIs sourced from China-aligned countries.

[50] To recover a database at the sectoral level, we use our firm-level data to aggregate all relevant variables (imports, value-added etc.) at the 3-digit level.

[51] We have rerun our procedure using the sectoral level data and computed the difference in manufacturing value-added with that obtained using our baseline estimates. In other words, it is the difference between the values displayed in Figure 13a and those obtained in Figure 9.

Figure 13: Firm-Level vs Sector-Level Aggregation



(a) Value-Added Change with Sector-Level Data

(b) Aggregation Bias

Notes: The figures report the value-added change (in %) due to a 50% cut in FCIs and the resulting percentage point bias. The sector-level data use the NACE3 classification. Figure 13a is a variation of Figure 9 using sector-level data instead of firm-level data. Figure 13b represents the difference between Figure 9 and Figure 13a.

recover the aggregate change in value-added by aggregating firm-level changes in value-added —which themselves depend on *firms' exposure* to supply disruptions (see Equation (5)), there are two factors that can drive the direction of the bias. First, as discussed above with Hulten (1978)'s theorem, the distribution of value-added weights shapes the aggregate impact, everything else equal. If firms that exhibit large value-added changes because of their underlying exposure also have very large sample weights, the aggregate impact coming from *micro* data may be larger. Second, conditional on the distribution of value-added weights, exposure at the sectoral-level may be different although *firm-level* exposure and thus value-added changes may be *unaffected*. In this case, the aggregate impact coming from *macro* data may be different. To further illustrate these two explanations, we provide an analytical example in Appendix C.

Overall, the use of granular data is key to recovering *exposure* to supply disruptions of FCIs and the *relative size* of firms, and thus the impact of geoeconomic fragmentation, especially when the production function exhibits complementarity between FCIs and other intermediates. The size of the bias is driven by the distributions of value-added weights and FCI imports, which both vary across countries.

6 Conclusion

In this paper, we identify foreign critical inputs and exploit micro data of 5 European countries to provide an assessment of potential supply disruptions from China-aligned countries. In doing so, we propose a framework to obtain quantitative estimates of the impact of supply disruptions of FCIs on value-added at different levels of aggregation. We find that firms, sectors, regions and countries are highly exposed to such a supply shock with substantial heterogeneity across units stemming from heterogeneous import exposure.

More generally, the paper serves as a first attempt to understand the impact of firm-level exposure to aggregate geoeconomic shocks affecting the supply of key inputs. Our work joins the growing body of work focused on understanding why changes in the organisation of global value chains may affect firms and our economies differently. Our paper hopefully presents itself as one explanation to such a question.

Finally, we argue that micro data are crucial not only for mapping strategic dependencies (Mejean and Rousseaux, 2024), but also for quantifying their importance. In this context, to better design industrial policy and policies aimed at diversifying away from China-aligned countries, we stress the importance for institutions to foster the collection and availability of micro data for research purposes.

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Appendix

A Derivations

The CES aggregator combining intermediate goods and services given by

$$M_i = \left[\gamma_i^{\frac{1}{\sigma}} E_i^{\frac{\sigma-1}{\sigma}} + (1-\gamma_i)^{\frac{1}{\sigma}} X_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

gives us the following cost-minimisation problem:

$$\begin{aligned} &\min_{E_i, X_i} p_E E_i + P_X X_i \\ &\text{s.t.} \quad \left[\gamma_i^{\frac{1}{\sigma}} E_i^{\frac{\sigma-1}{\sigma}} + (1-\gamma_i)^{\frac{1}{\sigma}} X_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \geq M_i \end{aligned}$$

The first-order conditions yield:

$$p_E = \lambda \gamma_i^{\frac{1}{\sigma}} E_i^{\frac{-1}{\sigma}} M_i^{\frac{1}{\sigma}} \tag{7}$$

and

$$p_X = \lambda (1-\gamma_i)^{\frac{1}{\sigma}} X_i^{\frac{-1}{\sigma}} M_i^{\frac{1}{\sigma}} \tag{8}$$

where λ is the associated Lagrange multiplier. Taking the ratio of the two first-order conditions, one gets:

$$\frac{p_E}{p_X} = \left(\frac{\gamma_i}{1-\gamma_i} \right)^{\frac{1}{\sigma}} \left(\frac{E_i}{X_i} \right)^{\frac{-1}{\sigma}} \tag{9}$$

Solving for FCIs yields:

$$X_i = \left(\frac{p_E}{p_X} \right)^{\sigma} \frac{1-\gamma_i}{\gamma_i} E_i \tag{10}$$

We take a partial equilibrium point of view in that relative prices are normalised to one and so is the supply of non-FCIs E_i. The supply of FCIs is then pinned down by the expenditures shares γ_i.

Plugging this term and the fact that E_i is normalised to one prior to the shock yields:

$$M_i = \left[\gamma_i^{\frac{1}{\sigma}} + (1-\gamma_i)^{\frac{1}{\sigma}} \left(\frac{1-\gamma_i}{\gamma_i} \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

Given that expenditures on FCIs are given by $(1-\varepsilon_i)$ after the shock, the change in M is:[52]

$$\frac{\Delta M_i}{M_i} = \frac{\left[\gamma_i^{\frac{1}{\sigma}} (1-\varepsilon_i)^{\frac{\sigma-1}{\sigma}} + (1-\gamma_i)^{\frac{1}{\sigma}} \left(\frac{1-\gamma_i}{\gamma_i}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}}{\left[\gamma_i^{\frac{1}{\sigma}} + (1-\gamma_i)^{\frac{1}{\sigma}} \left(\frac{1-\gamma_i}{\gamma_i}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}} - 1 \tag{11}$$

We assume that K and L are fixed in the short-run. Proxying Δm with $\frac{\Delta M}{M}$, the log change in production can be recovered from eq. (2):

$$\Delta y_i = (1 - \alpha_s - \beta_s)\Delta m_i \tag{12}$$

From the Cobb-Douglas production function specified in eq. (2), expenditure shares on goods and services are pinned down by the Cobb-Douglas exponents, i.e., $p_M M_i / p_Y Y_i = (1 - \alpha_s - \beta_s)$. Value-added can thus be expressed as $\text{VA}_i = p_Y Y_i - p_M M_i = p_Y Y_i - (1 - \alpha_s - \beta_s) p_Y Y_i$. Normalising the price of the output good to unity, we obtain:

$$\Delta \text{va}_i = \Delta y_i \tag{13}$$

Combining eq. (11), eq. (12), and eq. (13) yields the firm-level impact of a reduction in FCIs on value-added given by eq. (4) in the text.

[52]When $\sigma = 0$, $\frac{\Delta M_i}{M_i} = -\varepsilon_i$. Conversely, when $\sigma = 1$, $\frac{\Delta M_i}{M_i} = \frac{\frac{1-\gamma}{\gamma}^{1-\gamma_i}(1-\varepsilon_i)^{\gamma_i}}{\frac{1-\gamma}{\gamma}^{1-\gamma_i}} - 1$.

B List of countries and ISO codes

List of US-aligned countries: Aruba (ABW), Anguilla (AIA), Albania (ALB), Netherlands Antilles (ANT), American Samoa (ASM), Fr. South Antarctic Terr. (ATF), Australia (AUS), Austria (AUT), Belgium (BEL), Bonaire (BES), Bulgaria (BGR), Bosnia Herzegovina (BIH), Saint Barthélemy (BLM), Belize (BLZ), Bermuda (BMU),Canada (CAN),Cocos Isds (CCK), Switzerland (CHE), Cook Isds (COK), Curaçao (CUW), Christmas Isds (CXR), Cayman Isds (CYM), Cyprus (CYP), Czechia (CZE), Germany (DEU), Denmark (DNK), Spain (ESP), Estonia (EST), Finland (FIN), Falkland Isds (Malvinas) (FLK), France (FRA), United Kingdom (GBR), Gibraltar (GIB), Greece (GRC), Greenland (GRL), Guatemala (GTM), Guam (GUM), Croatia (HRV), Haiti (HTI), Hungary (HUN), Br. Indian Ocean Terr. (IOT), Ireland (IRL), Iceland (ISL), Israel (ISR), Italy (ITA), Japan (JPN), Rep. of Korea (KOR), Liechtenstein (LIE), Lithuania (LTU), Luxembourg (LUX), Latvia (LVA), Monaco (MCO), Marshall Isds (MHL), TFYR of Macedonia (MKD), Malta (MLT), Montenegro (MNE), N. Mariana Isds (MNP), Montserrat (MSR), New Caledonia (NCL), Norfolk Isds (NFK), Niue (NIU), Netherlands (NLD), Norway (NOR), Nauru (NRU), New Zealand (NZL), Pitcairn (PCN), Palau (PLW), Poland (POL), Portugal (PRT), French Polynesia (PYF), Romania (ROU), Saint Helena (SHN), San Marino (SMR), Saint Pierre and Miquelon (SPM), Slovakia (SVK), Slovenia (SVN), Sweden (SWE), Saint Maarten (SXM), Turks and Caicos Isds (TCA), Tokelau (TKL), Taiwan (TWN), Ukraine (UKR), USA (USA), Br. Virgin Isds (VGB), Wallis and Futuna Isds (WLF)

List of China-aligned countries: Burundi (BDI), Benin (BEN), Burkina Faso (BFA), Bangladesh (BGD), Belarus (BLR), Bolivia (BOL), Central African Rep. (CAF), China (CHN), Congo (COG), Comoros (COM), Djibouti (DJI), Dominica (DMA), Eritrea (ERI), Ethiopia (ETH), Gabon (GAB), Guinea (GIN), Gambia (GMB), Guinea-Bissau (GNB), Equatorial Guinea (GNQ), China, Hong Kong SAR (HKG), Iran (IRN), Kyrgyzstan (KGZ), Lao People's Dem. Rep. (LAO), Lebanon (LBN), Libya (LBY), Sri Lanka (LKA), China, Macao SAR (MAC), Mali (MLI), Mozambique (MOZ), Mauritania (MRT), Nepal (NPL), Pakistan (PAK), Papua New Guinea (PNG), Dem. People's Rep. of Korea (PRK), State of Palestine (PSE), Russian Federation (RUS), Sudan (SDN), Solomon Isds (SLB), Sierra Leone (SLE), Somalia (SOM), South Sudan (SSD), Sao Tome and Principe (STP), Suriname (SUR), Togo (TGO), Tajikistan (TJK), Tonga (TON), Uganda (UGA), Venezuela (VEN), Yemen (YEM), Zambia (ZMB), Zimbabwe (ZWE)

List of neutral countries: Afghanistan (AFG), Angola (AGO), Andorra (AND), United Arab Emirates (ARE), Argentina (ARG), Armenia (ARM), Antigua and Barbuda (ATG), Azerbaijan (AZE), Bahrain (BHR), Bahamas (BHS), Brazil (BRA), Barbados (BRB), Brunei Darussalam (BRN), Bhutan (BTN), Botswana (BWA), Chile (CHL), Côte d'Ivoire (CIV), Cameroon (CMR), Dem. Rep. of the Congo (COD), Colombia (COL), Cabo Verde (CPV), Costa Rica (CRI), Cuba (CUB), Dominican Rep. (DOM), Algeria (DZA), Ecuador (ECU), Egypt (EGY), Fiji (FJI), FS Micronesia (FSM), Georgia (GEO), Ghana (GHA), Grenada (GRD), Guyana (GUY), Honduras (HND), Indonesia (IDN), India (IND), Iraq (IRQ), Jamaica (JAM), Jordan (JOR), Kazakhstan (KAZ), Kenya (KEN), Cambodia (KHM), Kiribati (KIR), Saint Kitts and Nevis (KNA), Kuwait (KWT), Liberia (LBR), Saint Lucia (LCA), Lesotho (LSO), Morocco (MAR), Rep. of Moldova (MDA), Madagascar (MDG), Maldives (MDV), Mexico (MEX), Myanmar (MMR), Mongolia (MNG), Mauritius (MUS), Malawi (MWI), Malaysia (MYS), Namibia (NAM), Niger (NER), Nigeria (NGA), Nicaragua (NIC), Oman (OMN), Panama (PAN), Peru (PER), Philippines (PHL), Paraguay (PRY), Qatar (QAT), Rwanda (RWA), Saudi Arabia (SAU), Senegal (SEN), Singapore (SGP), El Salvador (SLV), Serbia (SRB), Swaziland (SWZ), Seychelles (SYC), Syria (SYR), Chad (TCD), Thailand (THA), Turkmenistan (TKM), Timor-Leste (TLS), Trinidad and Tobago (TTO), Tunisia (TUN), Turkey (TUR), Tuvalu (TUV), United Rep. of Tanzania (TZA), Uruguay (URY), Uzbekistan (UZB), Saint Vincent and the Grenadines (VCT), Viet Nam (VNM), Vanuatu (VUT), Samoa (WSM), South Africa (ZAF)

C Aggregation Bias

Table A1: Illustration of Aggregation Bias ($\sigma = 0$)

Firm	FCI Risky Imports (1)	FCI Imports (2)	China-aligned share (3)	Value-added (4)	Δva (5)
Panel A. Baseline bias					
1	0	0		100	
2	5	400	0.0125	400	−0.625%
3	30	200	0.15	200	−7.5%
4	100	500	0.20	500	−10%
Firm-level data					−5.6%
Sectoral data	135	1100	0.12		−6.1%
Bias (p.p)					−0.5
Panel B. Alternative value-added weights					
4	100	500	0.20	700	−10%
Firm-level data					−6.3%
Sectoral data	135	1100	0.12		−6.1%
Bias (p.p)					0.2
Panel C. Alternative import values					
4	50	250	0.20	500	−10%
Firm-level data					−5.6%
Sectoral data	85	850	0.1		−5%
Bias (p.p)					0.6

Notes: The table illustrates the direction of the bias when using sectoral-level data. Panel A reports the baseline bias given the values reported in columns 1 to 5 for firms 1,2,3,4 and 5. Panels B and C only report the new values for firm 4 —the values used for the first three firms are left unchanged.

C.1 Set-up

We illustrate how using sectoral data may bias the results compared to using firm-level data in Table A1. We focus on four fictitious firms with fictitious values for imports and value-added —assuming that value-added is proportional to imports, without loss of generality. We further assume that firm 1 does not import.

For simplicity, we assume that the aggregate shock is equal to 50% ($\delta = 0.5$), that the production is Leontief ($\sigma = 0$) and we have normalized the Cobb-Douglas shares to unity ($1 - \alpha_s - \beta_s = 1$). Columns 1 and 2 report firm-level imports of FCIs from China-aligned countries and from all countries, respectively. Column 3 is the ratio of column 1 to column 2. Column 4 is the value-added of each firm. The change in value-added reported in column 5 is obtained by multiplying column 3 by the aggregate shock δ —see footnote 52: $\Delta\text{va} = -\text{China-aligned share} * 0.5$.

C.2 Baseline bias

As reported in the text, the change in aggregate value-added reported in column 5 when using micro data is obtained as follows:

$$\Delta\text{va} = \sum_i \Delta\text{va}_i \times \omega_i^{va},$$

In the firm-level data case, the change in value-added is thus obtained by taking a value-added weighted average of changes in value-added where the sample includes both exposed and *non-exposed* firms, i.e. firms which do not import FCIs from China-aligned countries. For instance, in panel A, the change in value-added when using firm-level data is obtained by computing $-0.625\% \times 400/1200 + -7.5\% \times 200/1200 + -10\% \times 500/1200 = -0.056$.

The change in value-added obtained when using sectoral-level data is different because exposure (column 3) is computed over the entire sector directly. In this case, the change in aggregate value-added is simply obtained by multiplying the share of FCI imports at risk (obtained by summing both imports of FCIs from China-aligned countries and total FCI imports across firms) by the aggregate shock ($0.12 \times -0.5 = -0.06$). In this case, the use of sectoral-level data yields to an overestimation of the impact of geoeconomic fragmentation. Indeed, exposure to imports of FCIs from China-aligned countries is relatively higher when using more aggregate data. This is because important changes in firm-level value-added are diluted by *weighting*.

C.3 Alternative value-added weights

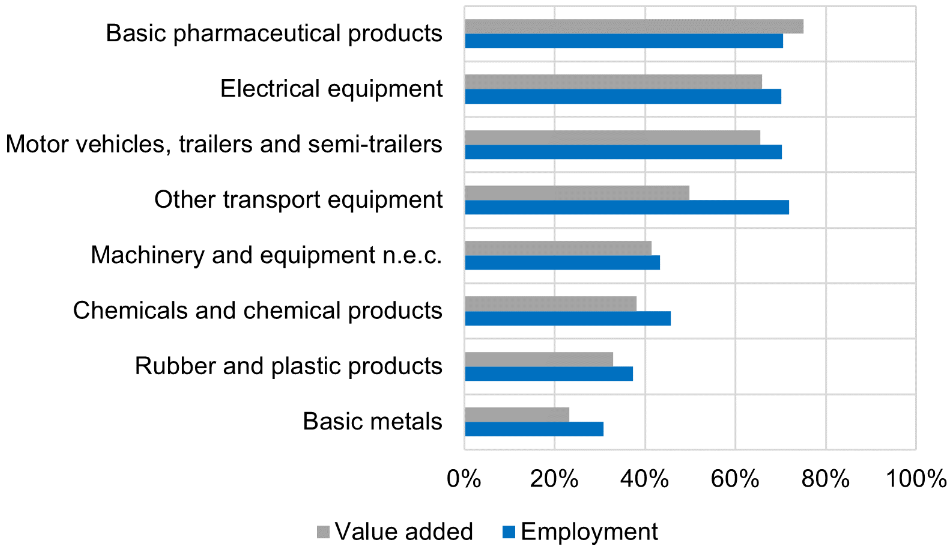
In panel B of Table A1, we instead change the value-added produced by firm 4 and thus the distribution of value-added weights. In this case, the weight associated to firm 4 is larger (going from 0.42 to 0.58). While the impact coming from sectoral data does not change (-6.1%), that obtained with micro data changes from -5.6% to -6.3%. This is due to the fact that firm 4 which experiences a larger change in value-added (-10%) is assigned a larger weight. In this case, using macro data may actually *understate* the impact of geoeconomic fragmentation.

C.4 Alternative import values

Panel C instead changes the import values of firm 4. Specifically, we halve both imports reported in columns 1 and 2, which entails that columns 3-5 remain unchanged when using micro data. However, the impact of geoeconomic fragmentation is lower when using macro data: the change is now -5% instead of -6.1%. This is because exposure coming from macro data is now underestimated, whereas exposure at the micro level is unaffected.

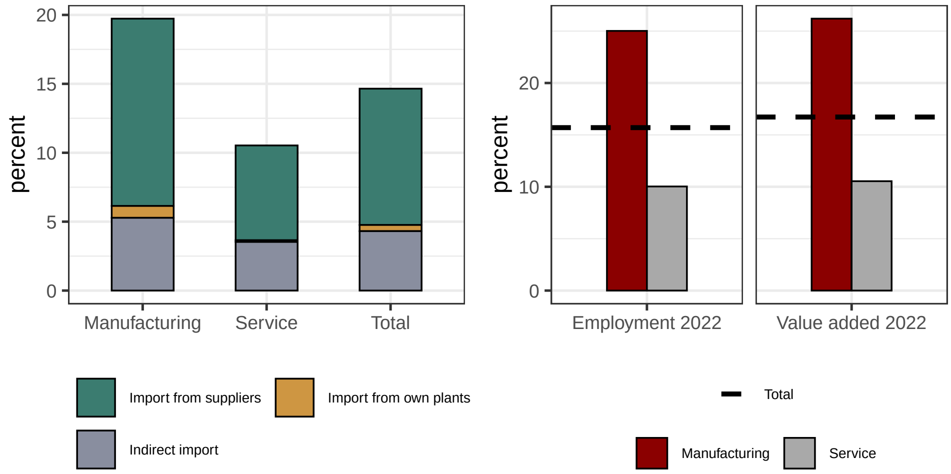
D Additional Figures

Figure A1: Exposure to China through FCIs by Sector (Share of Sectoral Employment and Value-added)



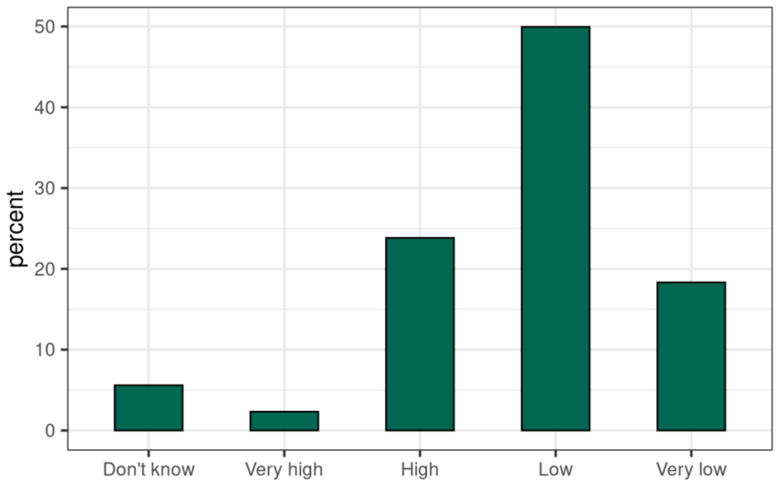
Notes: Firms are considered exposed if they import at least one FCI from China in 2019. The values of value added and employment are aggregated for the five countries.

Figure A2: Critical Inputs in Italy



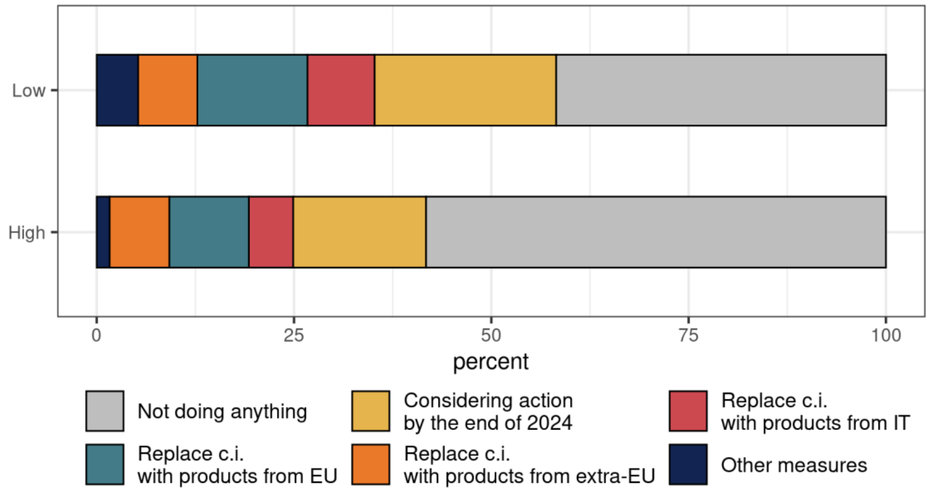
Source: Own elaboration on INVIND data. **Notes:** Left panel: Firms sourcing critical inputs from China (share of total firms). In this survey, critical inputs are defined as those whose shortage would lead to a reduction in the quality of the good or service produced, or without which a significant part of the production process would not be completed or would cause considerable delays. Right panel: Exposure to China (share of total employment and value-added).

Figure A3: Substitutability of Critical Inputs from China for Italy



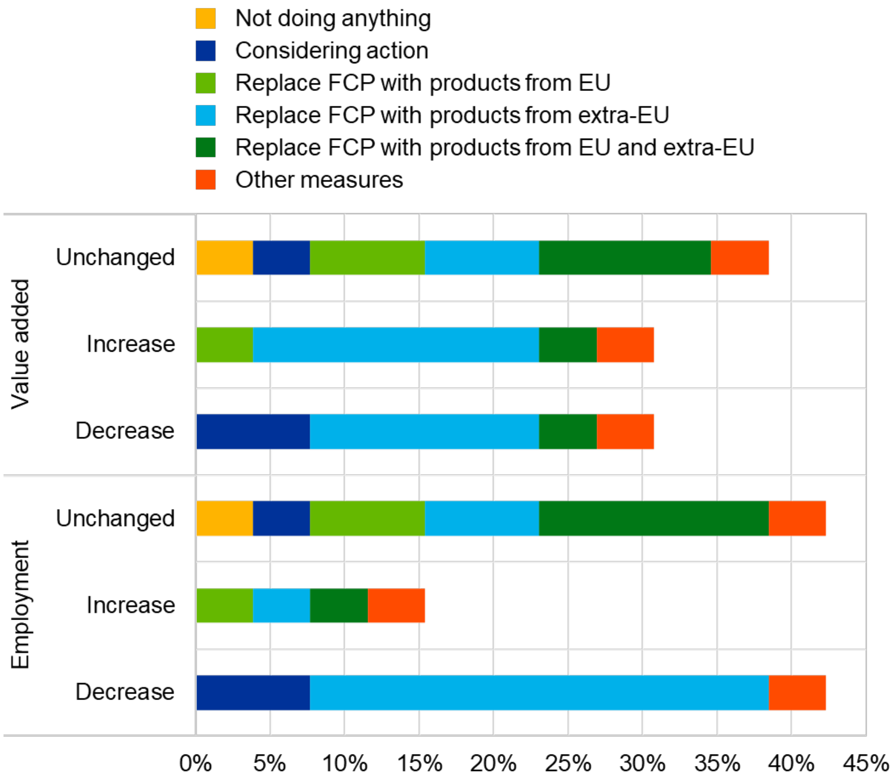
Source: Own elaboration on INVIND data. **Notes:** The bars refer to the extent to which critical inputs sourced from China (share of manufacturing firms sourcing critical inputs from China) can be substituted. In this survey, critical inputs are defined as those whose shortage would lead to a reduction in the quality of the good or service produced, or without which a significant part of the production process would not be completed or would cause considerable delays.

Figure A4: Supply Chain Strategies by Degree of Substitution of Critical Inputs for Italy



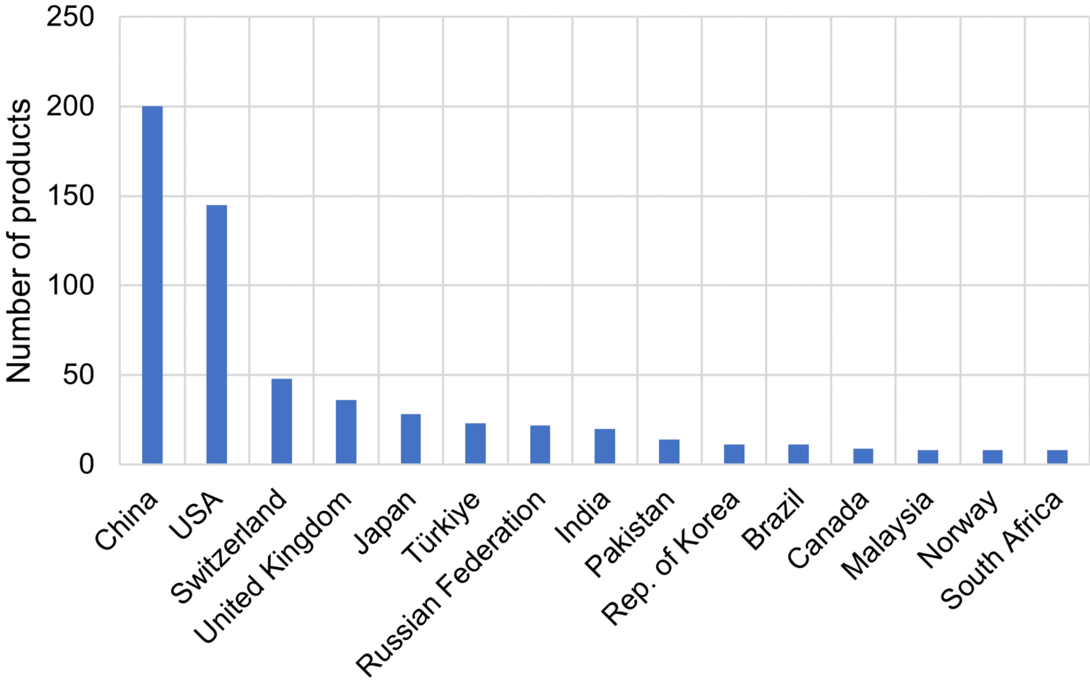
Source: Own elaboration on INVIND data. **Notes:** This figure displays the strategies to reduce exposure to sourcing from China (share of firms sourcing critical inputs from China; high/low substitutability). In this survey, critical inputs are defined as those whose shortage would lead to a reduction in the quality of the good or service produced, or without which a significant part of the production process would not be completed or would cause considerable delays.

Figure A5: Expected Impact on Value-added and Employment by Strategy



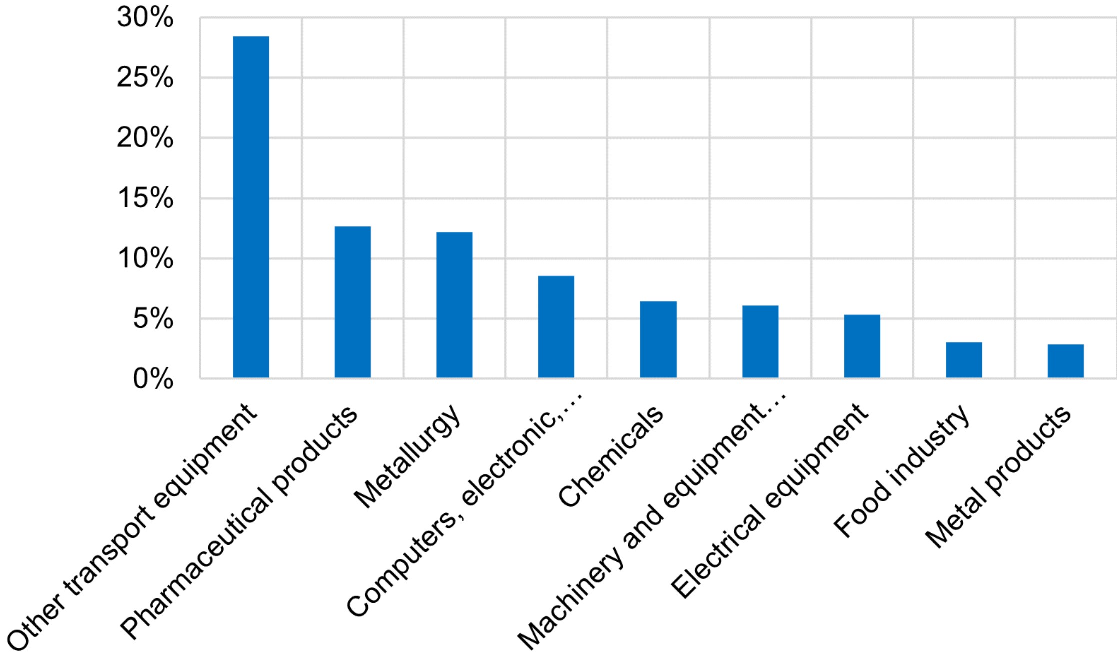
Source: ECB CTS, Attinasi et al. (2023b) and own elaboration. **Notes:** Responses to the question "What will be the impact of changes in production location and/or cross-border input sourcing on your company's activity, employment and selling prices in the EU in the next five years?". The responses refer only to those firms that reported sourcing critical inputs which depended (entirely or heavily) on supply from China. The categories "unchanged/increase/decrease" sum to 100%.

Figure A6: Number of FCIs by Country



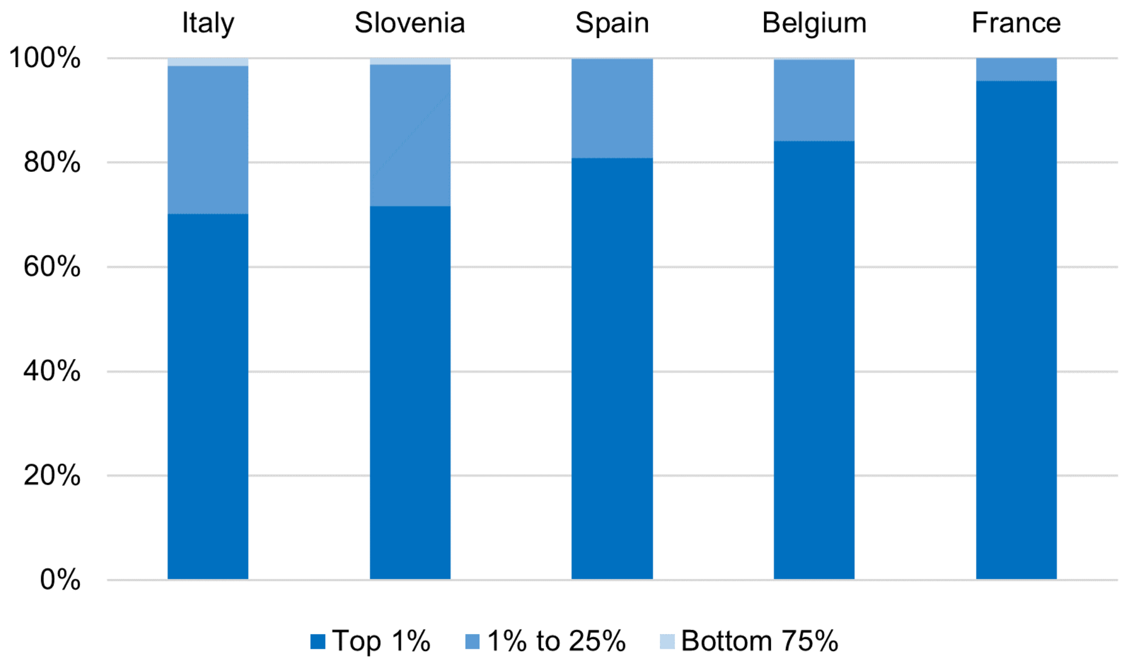
Notes: The bars represent the number of FCIs. The x-axis represents the main exporter of each FCI to the EU.

Figure A7: Extra-EU import share of FCIs by Sector



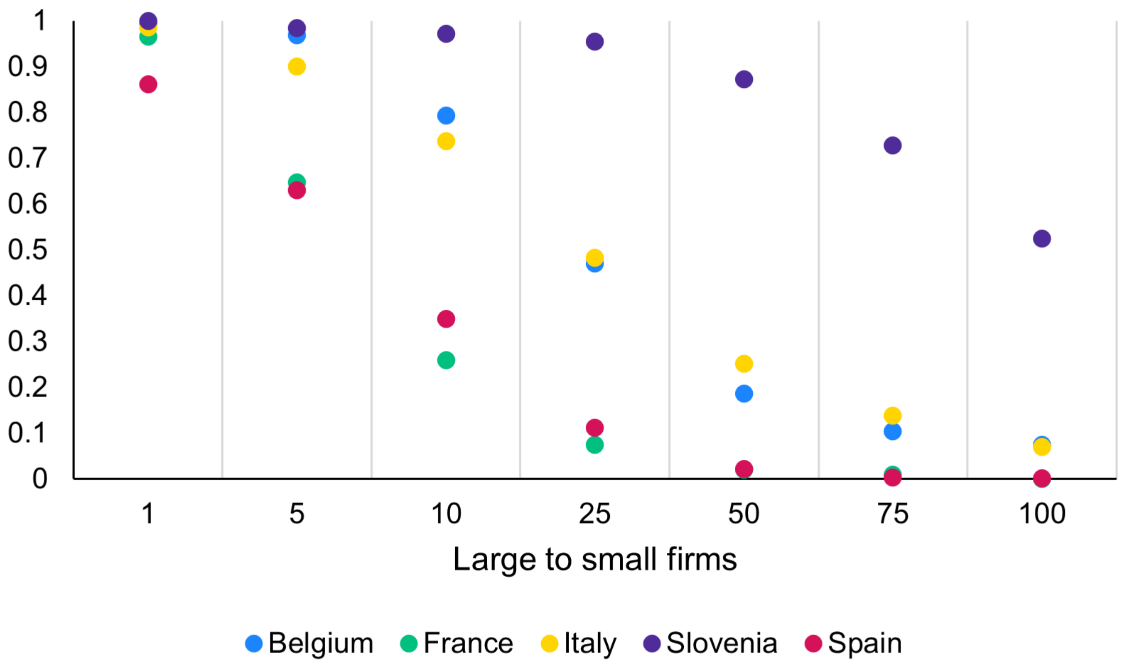
Notes: The bars represent the share of each sector's imports of FCIs in the total imports of FCIs (only the 10 sectors with the largest shares are shown). Only imports of manufacturing sectors are considered. Import values of BFISS (from the customs data) are aggregated.

Figure A8: Share of Value-added by Exposed Firm Size



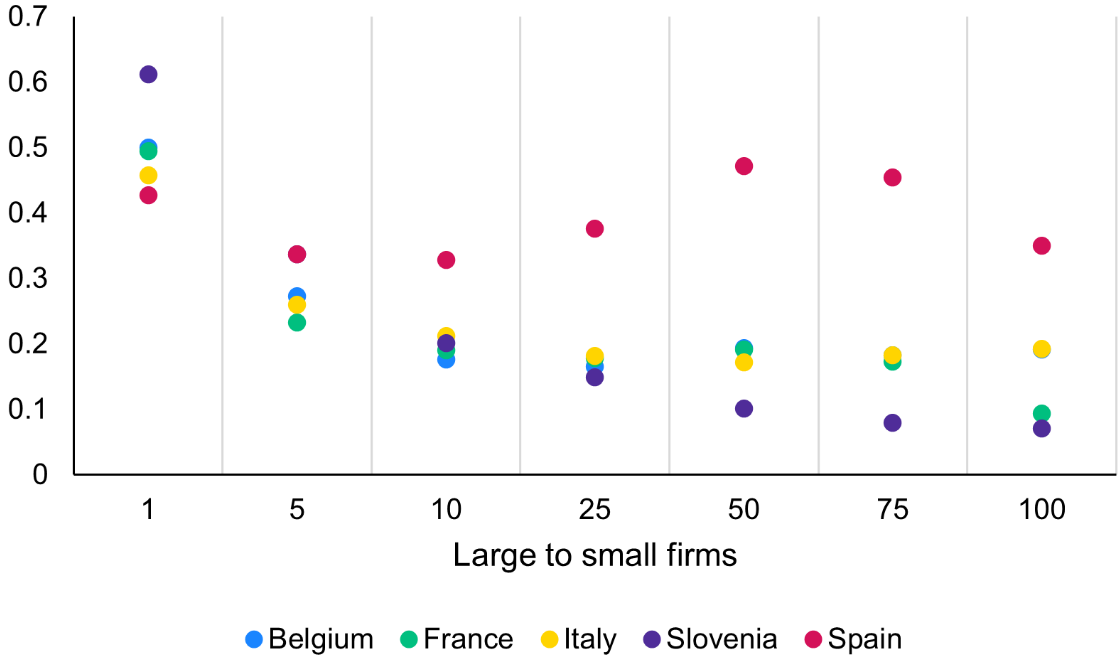
Notes: Percentiles of value added. Only firms importing critical inputs from China-aligned countries are considered. The French statistical institute (INSEE) groups legal entities that belong to the same firm together ("Profilage d'un groupe de sociétés"), which explains why the largest French firms have a higher share of VA than the other countries.

Figure A9: Share of Importing Firms by Firm Size



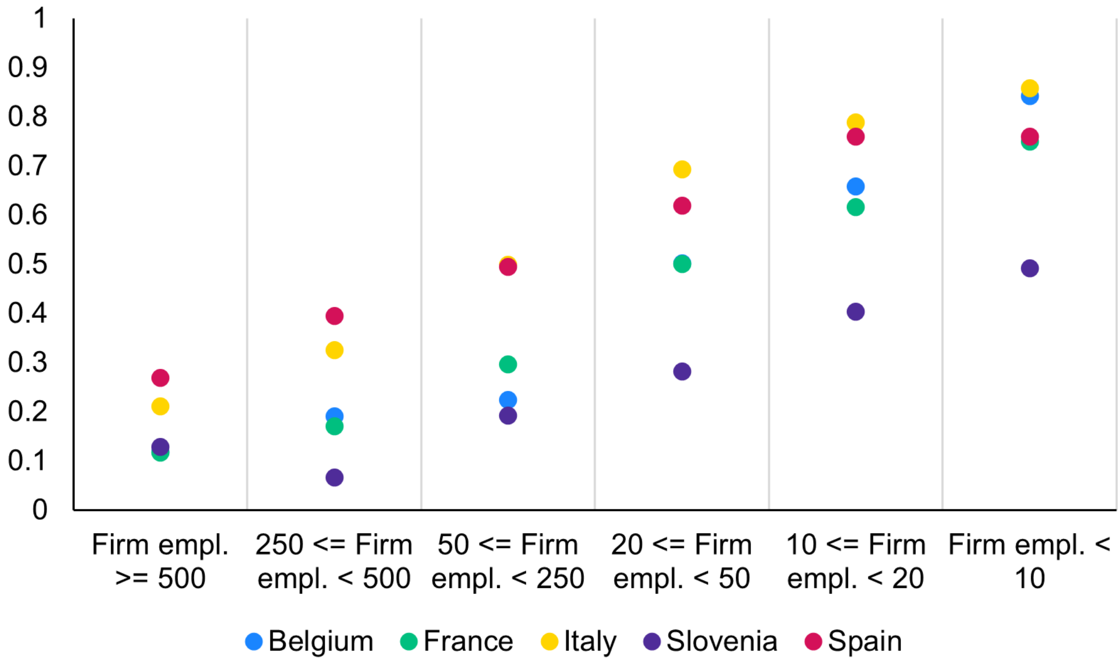
Notes: The x-axis shows percentiles, e.g. 1 stands for the 1% largest firms in value added, 5 for the 1 to 5% largest, etc. The share is computed over the total number of firms.

Figure A10: Share of Exposed Firms among Importers by Firm Size



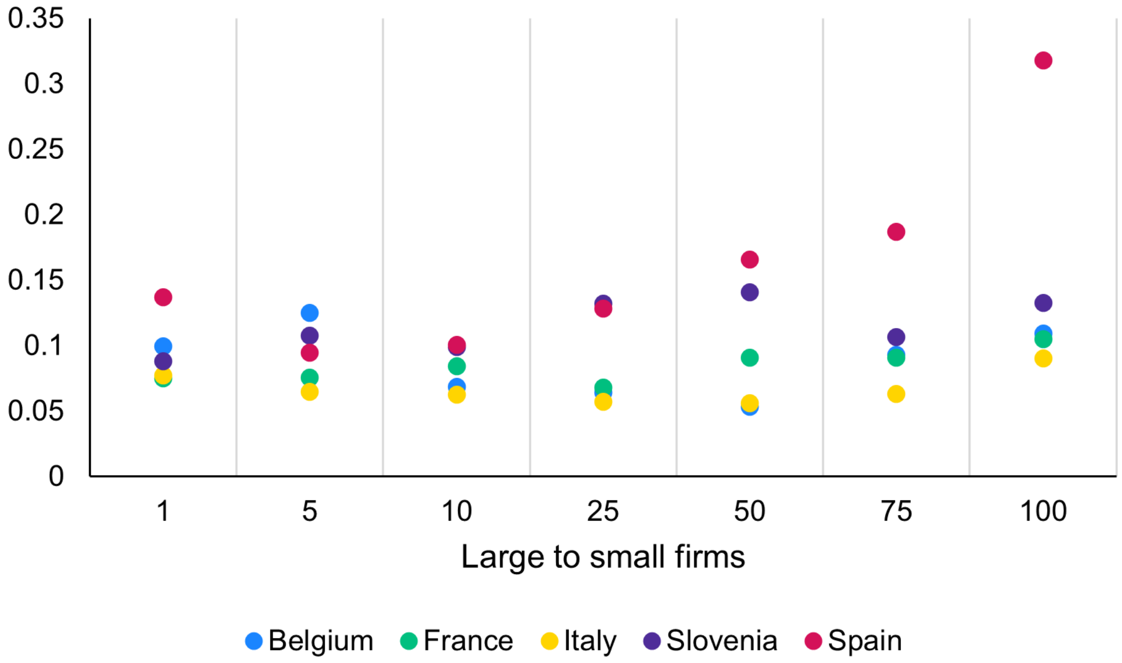
Notes: The x-axis shows percentiles, e.g. 1 stands for the 1% largest firms in value added, 5 for the 1 to 5% largest, etc. Exposed firms are firms importing foreign critical inputs from China-aligned countries.

Figure A11: Import Share of FCIs from China-aligned Countries by Firm Size



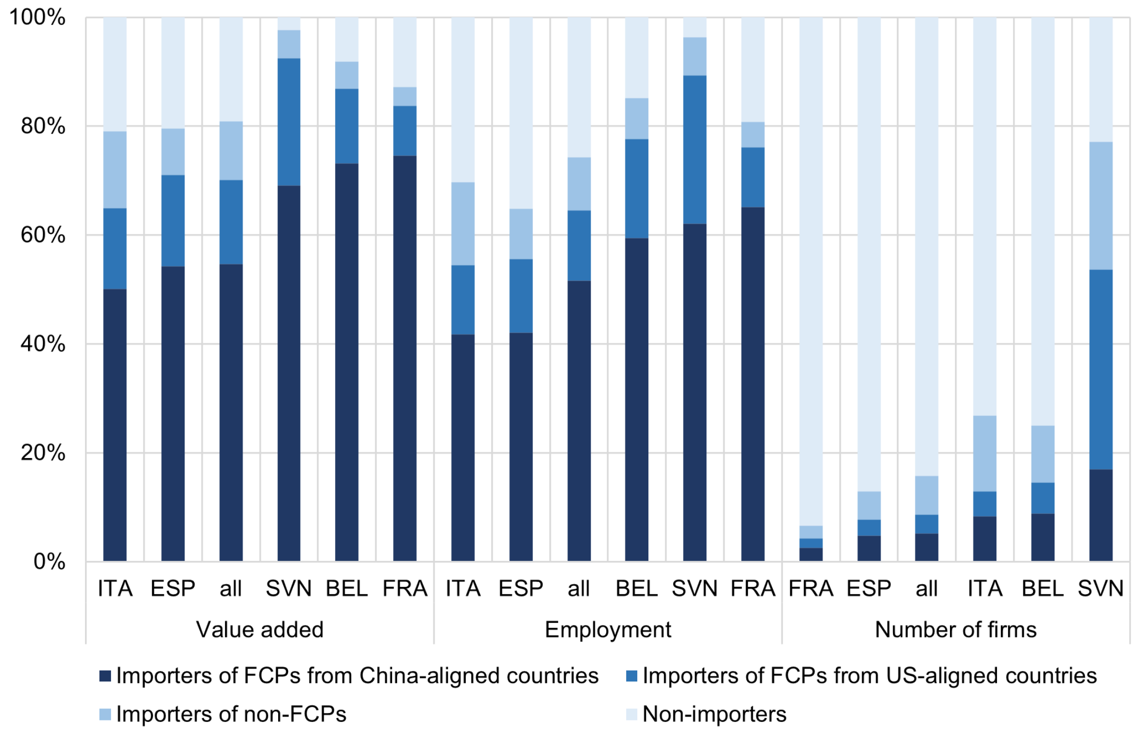
Notes: Firm size measured in number of employees, full-time equivalent. Only manufacturing firms are included. Only firms importing critical inputs from China-aligned countries are considered.

Figure A12: Share of Foreign Critical Inputs over Total Inputs



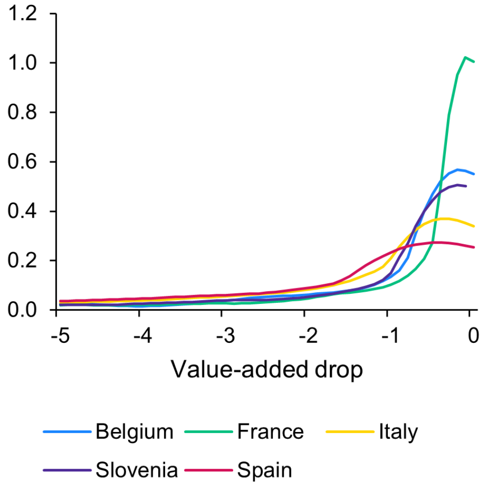
Notes: The x-axis shows percentiles, e.g. 1 stands for the 1% largest firms in value added, 5 for the 1 to 5% largest, etc. Only firms importing critical inputs are considered (from China-aligned and non-China-aligned countries). When imports-to-inputs ratio is above 1, the latter is winsorised to 1.

Figure A13: Share of Value-added, Employment and Number of firms by Status

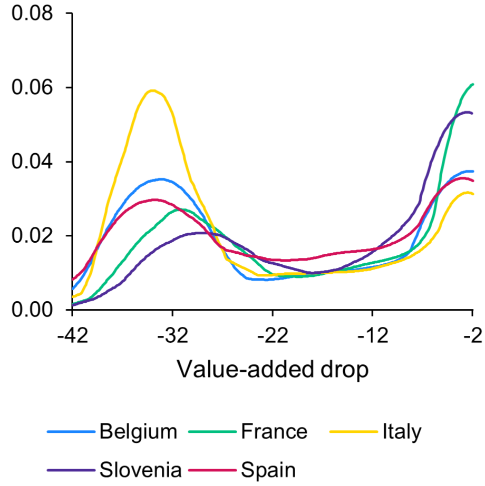


Notes: Only manufacturing firms are considered.

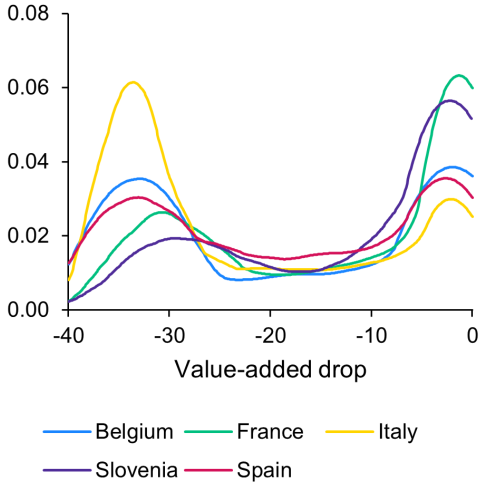
Figure A14: Distribution of Value-added Change (in %) – Variations of Figure 7



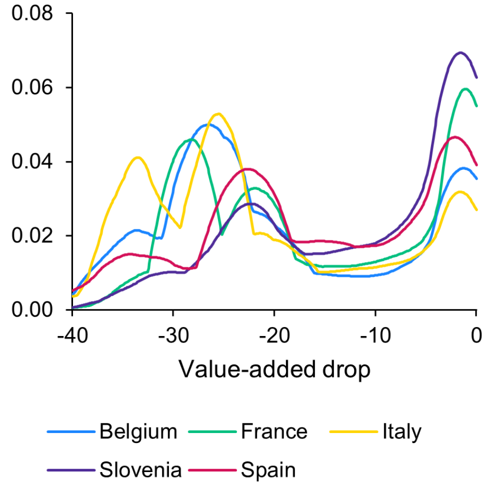
(a) $\sigma = 0.2$ instead of $\sigma = 0$



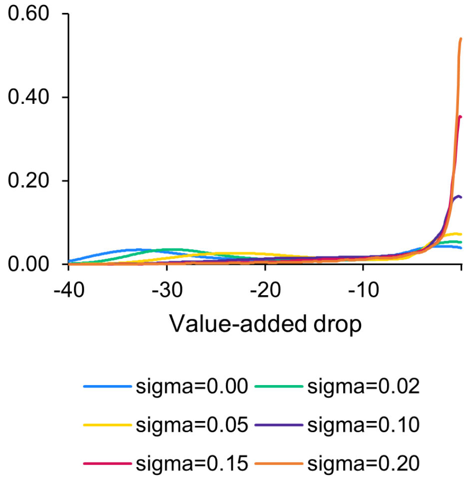
(b) Restricted FCIs list



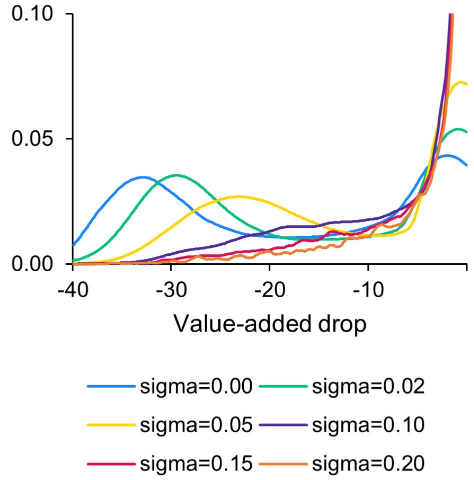
(c) Cut from China only



(d) Whole economy



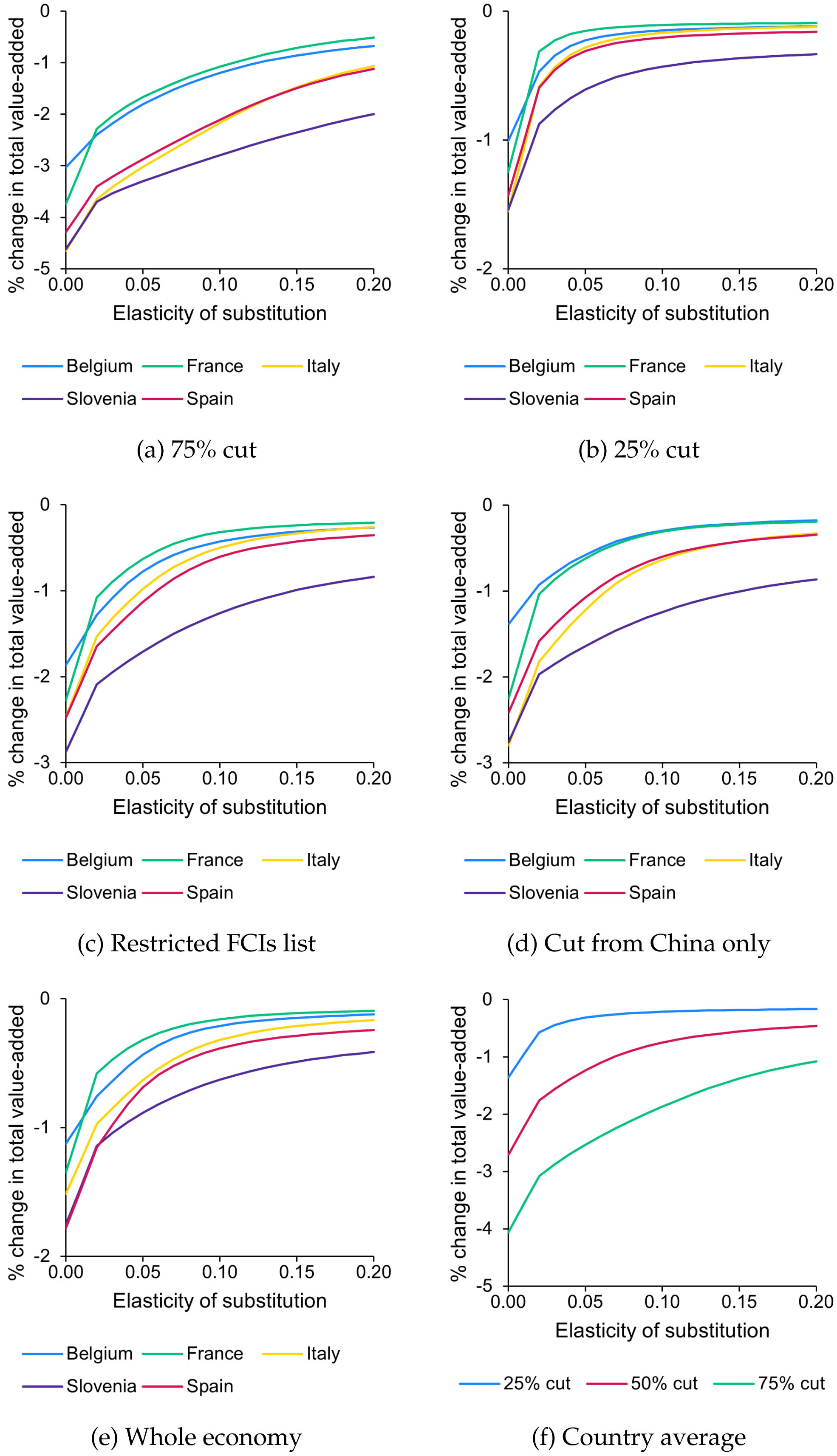
(e) Country average (large scale)



(f) Country average (zoom)

Notes: The figure reports the distribution of value-added changes (in %) due to a 50% cut in FCIs. The restricted list concentrates on inputs which are advanced technology products, products key for the green transition, and high-concentrated raw materials at the global level. Country average is a simple average; results are very similar with a weighted average.

Figure A15: Aggregate Value-added Change (in %) – Variations of Figure 9



(a) 75% cut

(b) 25% cut

(c) Restricted FCIs list

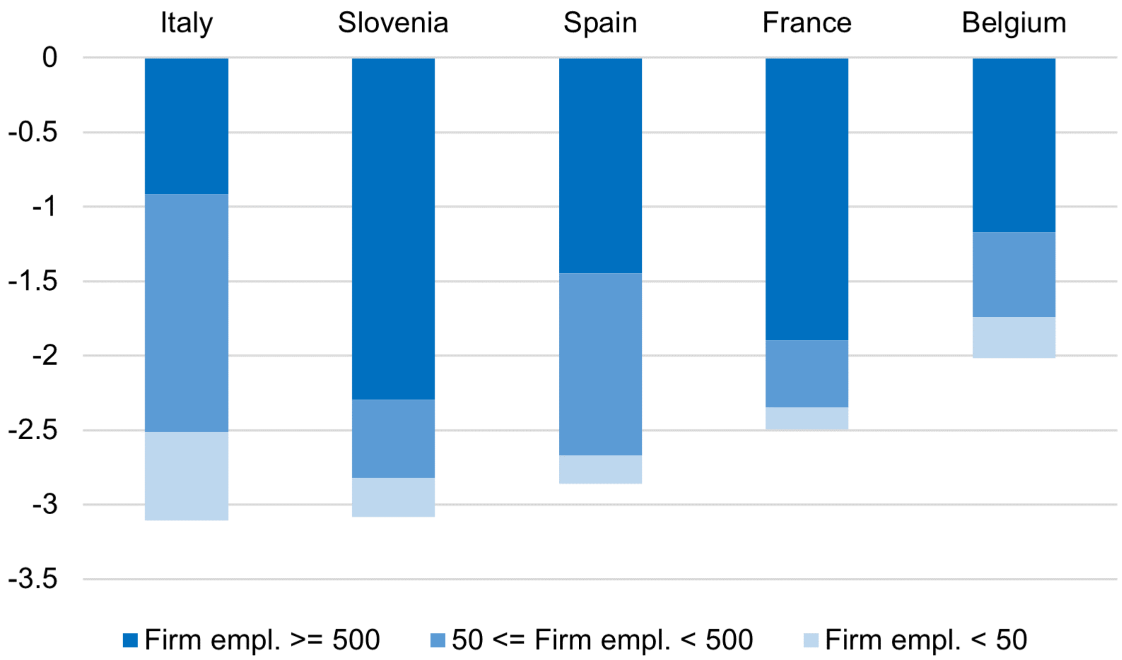
(d) Cut from China only

(e) Whole economy

(f) Country average

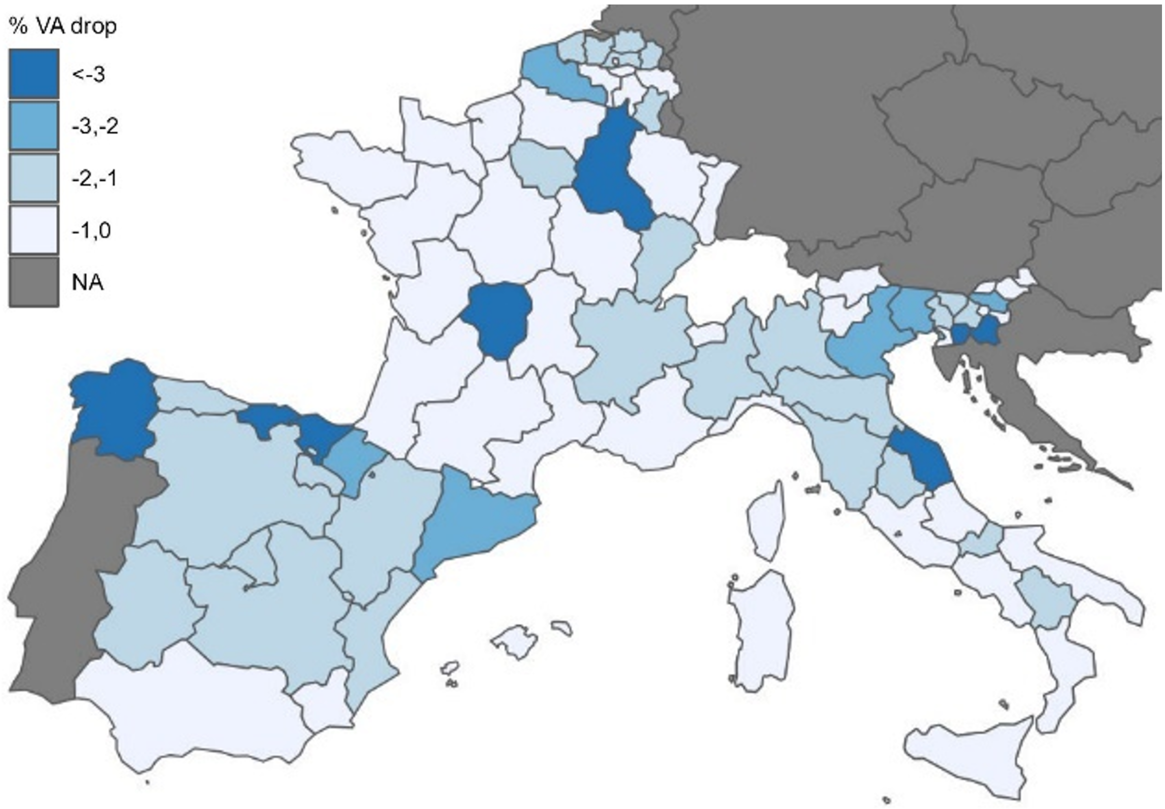
Notes: The restricted list concentrates on inputs which are advanced technology products, products key for the green transition, and high-concentrated raw materials at the global level. Country average is a simple average; results are very similar with a weighted average.

Figure A16: Decomposition of Value-added Change (in %) by Exposed Firm Size



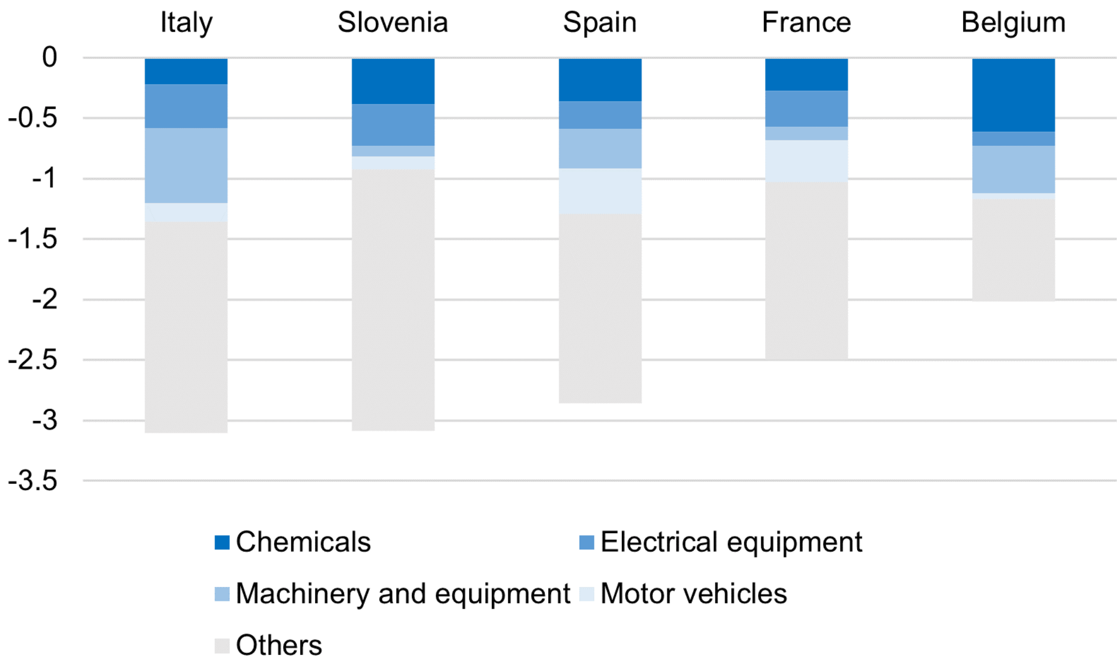
Notes: Firm size is measured with the number of employees, full-time equivalent. Only manufacturing firms importing critical inputs from China-aligned countries are considered.

Figure A17: Aggregate Value-added Change (in %) across Regions for the Whole Economy



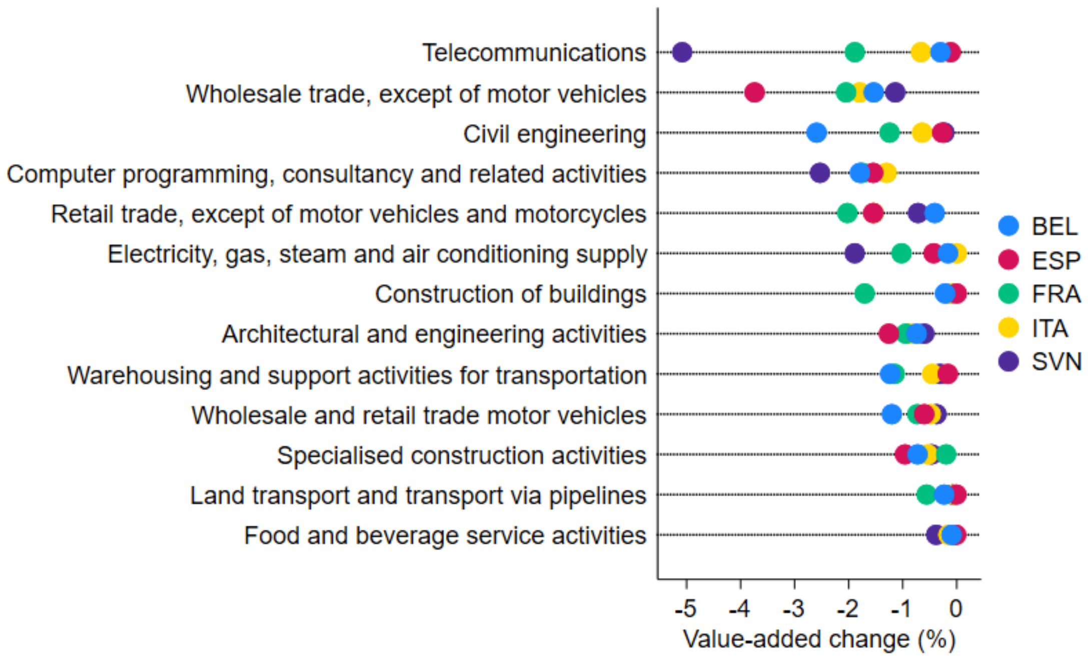
Notes: The figure reports the value-added change (in %) across regions coming from a 50% drop in FCI supply from China-aligned countries ($\sigma = 0$).

Figure A18: Decomposition of Value-added Change (in %) by Sector



Notes: Only the manufacturing sector is considered. The five sectors with the biggest contribution to the drop were selected (average across the 5 countries).

Figure A19: Aggregate Value-added Change across Sectors excluding Manufacturing



Notes: The figure reports the value-added change (in %) across the most exposed sectors arising from a 50% drop in FCI supply from China-aligned countries ($\sigma = 0$). Only non-manufacturing sectors with a significant share (> 1% of total value added) are shown.

E Additional Tables

Table A2: Summary Statistics for FCIs

		Mean	Min	p10	p50	p90	p99	Max	Obs.
Belgium	FCIs for each firm	7.3	1	1	3	19	50	110	2831
	Non-FCIs for each firm	27.9	1	1	6	80	228	612	4790
	source countries, FCI × firm	1.5	1	1	1	3	8	42	20724
	source countries, Non-FCIs × firm	1.6	1	1	1	3	8	66	133422
France	FCIs for each firm	7.6	1	1	3	18	67	241	8478
	Non-FCIs for each firm	31.9	1	2	12	77	310	1075	12861
	source countries, FCI × firm	1.8	1	1	1	3	11	63	64494
	source countries, Non-FCIs × firm	1.7	1	1	1	3	10	56	410549
Italy	FCIs for each firm	4.3	1	1	2	10	32	154	15556
	Non-FCIs for each firm	11.8	1	1	3	32	113	610	31037
	source countries, FCI × firm	1.5	1	1	1	2	7	60	66132
	source countries, Non-FCIs × firm	1.5	1	1	1	2	7	47	367210
Slovenia	FCIs for each firm	6.1	1	1	3	15	38	131	3644
	Non-FCIs for each firm	30.6	1	1	21	68	181	661	5153
	source countries, FCI × firm	1.4	1	1	1	2	7	35	22391
	source countries, Non-FCIs × firm	1.4	1	1	1	2	6	36	157756
Spain	FCIs for each firm	3.8	1	1	2	8	25	89	4056
	Non-FCIs for each firm	13.9	1	1	8	32	87	572	6656
	source countries, FCI × firm	1.6	1	1	1	3	8	30	15280
	source countries, Non-FCIs × firm	1.6	1	1	1	3	8	39	92206
All	FCIs for each firm	5.8	1	1	3	14	42	145	6913
	Non-FCIs for each firm	23.2	1	1.2	10	58	184	706	12099
	source countries, FCI × firm	1.6	1	1	1	3	8	46	37804
	source countries, Non-FCIs × firm	1.5	1	1	1	3	8	49	232229

Notes: The table displays summary statistics on imports of foreign critical inputs in 2019. The sample includes manufacturing firms only. See Table A3 for the whole economy. The category "all" refers to a simple average of the countries. For Spain, contrary to Table 1, Table A2 includes all importing firms —including small ones.

Table A3: Summary Statistics for FCIs (Whole Economy)

		Mean	Min	p10	p50	p90	p99	Max	Obs.
Belgium	FCIs for each firm	5.13	1	1	2	13	46	291	16556
	Non-FCIs for each firm	15.8	1	1	2	38	210	2307	38045
	source countries, FCI × firm	1.58	1	1	1	3	9	70	84907
	source countries, Non-FCIs × firm	1.59	1	1	1	3	9	155	601000
France	FCIs for each firm	6.14	1	1	3	14	51	243	35169
	Non-FCIs for each firm	24.22	1	1	8	58	250	2130	67004
	source countries, FCI × firm	1.61	1	1	1	3	9	63	215932
	source countries, Non-FCIs × firm	1.55	1	1	1	3	8	81	1622609
Italy	FCIs for each firm	4.15	1	1	2	10	34	221	33845
	Non-FCIs for each firm	12.05	1	1	3	30	147	2101	74476
	source countries, FCI × firm	1.43	1	1	1	2	7	60	140559
	source countries, Non-FCIs × firm	1.47	1	1	1	2	7	47	897737
Slovenia	FCIs for each firm	5.27	1	1	3	12	29	289	24664
	Non-FCIs for each firm	21.71	1	1	8	56	145	2547	43303
	source countries, FCI × firm	1.3	1	1	1	2	5	37	129892
	source countries, Non-FCIs × firm	1.25	1	1	1	2	5	50	940061
Spain	FCIs for each firm	2.8	1	1	1	6	21	137	27172
	Non-FCIs for each firm	6.07	1	1	2	14	60	1091	80258
	source countries, FCI × firm	1.46	1	1	1	2	7	42	76055
	source countries, Non-FCIs × firm	1.46	1	1	1	2	7	39	487535
All	FCIs for each firm	4.70	1	1	2	11	36	236	27481
	Non-FCIs for each firm	15.97	1	1	5	39	162	2035	60617
	source countries, FCI × firm	1.48	1	1	1	2	7	54	129469
	source countries, Non-FCIs × firm	1.46	1	1	1	2	7	74	909788

Notes: The table displays summary statistics for foreign critical inputs imports in 2019. The category "all" refers to a simple average of the countries. Contrary to Table A4 for Spain, Table A3 includes all importing firms, including small ones.

Table A4: Summary Statistics for FCI Importers (Whole Economy)

		Mean	p10	p50	p90	SD	Obs.
Belgium	FCIs, share of firms' total purchases	6.2	0.0	0.6	18.3	14.7	11997
	FCIs from US-align countries, share of firm's total purchases	5.9	0.0	0.5	17.1	14.5	9272
	FCIs from China-align countries, share of firm's total purchases	3.8	0.0	0.3	9.3	11.0	5218
France	FCIs, share of firms' total purchases	8.4	0.0	1.0	27.0	17.5	29400
	FCIs from US-align countries, share of firm's total purchases	7.3	0.0	0.8	22.5	16.5	24820
	FCIs from China-align countries, share of firm's total purchases	5.4	0.0	0.5	15.8	13.7	12406
Italy	FCIs, share of firms' total purchases	6.7	0.0	1.0	19.8	14.4	28759
	FCIs from US-align countries, share of firm's total purchases	5.8	0.0	0.6	16.5	13.8	22113
	FCIs from China-align countries, share of firm's total purchases	4.9	0.0	0.9	13.5	11.0	12811
Slovenia	FCIs, share of firms' total purchases	6.6	0.0	1.2	17.9	14.5	16277
	FCIs from US-align countries, share of firm's total purchases	6.0	0.0	1.1	16.2	13.6	15894
	FCIs from China-align countries, share of firm's total purchases	4.9	0.0	0.5	12.6	12.5	2279
Spain	FCIs, share of firms' total purchases	12.5	0.1	2.4	40.8	22.8	8605
	FCIs from US-align countries, share of firm's total purchases	11.3	0.1	1.8	36.0	21.8	7564
	FCIs from China-align countries, share of firm's total purchases	7.3	0.1	1.3	19.7	16.4	3447
All	FCIs, share of firms' total purchases	8.1	0.0	1.2	24.7	16.8	19008
	FCIs from US-align countries, share of firm's total purchases	7.3	0.0	1.0	21.7	16.0	15933
	FCIs from China-align countries, share of firm's total purchases	5.28	0.02	0.69	14.15	12.91	7232

Notes: The table displays summary statistics for firms importing foreign critical inputs in 2019. The variables are expressed in percentage points. The category "all" refers to a simple average of the countries. Intermediate goods refer to expenditures on goods and services. All countries but Spain use the population of importing firms; in the case of Spain, only importers are included in Directorio. Differences between Spain and the other countries are explained by the fact that Directorio excludes the majority of small-size importing firms.

Table A5: FCI Premia (Whole Economy)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	All firms				Extra-EU importers			
Import FCI	log Employment	log Turnover	log Wages	log Labor Prod.	log Employment	log Turnover	log Wages	log Labor Prod.
Belgium	1.456***	1.872***	0.382***	0.325***	0.801***	0.906***	0.159***	0.142***
	(0.0172)	(0.0196)	(0.00657)	(0.00885)	(0.0222)	(0.0253)	(0.00879)	(0.0119)
Obs.	138618	138618	138618	138618	19353	19353	19353	19353
France	1.785***	2.347***	0.310***	0.335***	1.096***	1.175***	0.116***	0.110***
	(0.0112)	(0.0120)	(0.00418)	(0.00518)	(0.0168)	(0.0182)	(0.00729)	(0.00893)
Obs.	1,123,126	1,123,126	1,123,126	1,123,126	39,485	39,485	39,485	39,485
Italy	1.407***	1.947***	0.338***	0.376***	0.813***	0.971***	0.153***	0.165***
	(0.00955)	(0.0106)	(0.00265)	(0.00454)	(0.0117)	(0.0130)	(0.00336)	(0.00593)
Obs.	527,951	527,951	527,951	527,951	57,830	57,830	57,830	57,830
Slovenia	0.755***	1.143***	0.108***	0.214***	0.695***	0.804***	0.103***	0.122***
	(0.0150)	(0.0178)	(0.00439)	(0.00877)	(0.0384)	(0.0471)	(0.0106)	(0.0221)
Obs.	36,368	36,368	36,368	36,368	8,719	8,719	8,719	8,719
Spain	1.154***	1.508***	0.151***	0.317***	0.802***	0.924***	0.0729***	0.138***
	(0.0200)	(0.0229)	(0.00547)	(0.00911)	(0.0249)	(0.0283)	(0.00671)	(0.0116)
Obs.	23,923	23,923	23,923	23,923	13,121	13,121	13,121	13,121
3-digit industry FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: The table reports estimates from eq. (1) in the text for the whole economy. Standard errors clustered at the firm level. * significant at 10%, ** significant at 5%, *** significant at 1%.