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INPUTS IN DISTRESS:
GEOECONOMIC FRAGMENTATION AND FIRMS' SOURCING

by Ludovic Panon*, Laura Lebastard**, Michele Mancini*, Alessandro Borin*, Peonare Caka***, Gianmarco Cariola****, Dennis Essers*****, Elena Gentili****, Andrea Linarello*, Tullia Padellini*, Francisco Requena****** and Jacopo Timini*******

Abstract

We study how disruptions to the supply of foreign critical inputs (FCIs) – inputs primarily sourced from extra-EU countries with highly concentrated supply, advanced technology products, or inputs which are key to the 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 EU economies differently. Our baseline calibration suggests that a 50 per cent reduction in imports of FCIs from China and other countries with a similar geopolitical orientation would result in sizeable value added losses with significant heterogeneity across firms, sectors, regions, and countries, driven by the heterogeneous exposure of firms. Our findings show that the short-term costs of supply disruptions of FCIs can be substantial, especially if firms cannot easily switch away from these inputs.

JEL Classification: F10, F14, F50, F60.

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

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1 Introduction[1]

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 the vulnerability of 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.[2] 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 key inputs are central 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 supply risks for manufacturing value-added.[3] We use our micro data to calibrate a tractable yet parsimonious model of supply disruptions that considers firm-level

[1]Ludovic Panon, Laura Lebastard and Michele Mancini are co-leads. A previous version of this paper circulated under the title "Inputs in geopolitical distress: a risk assessment based on micro data". We thank Antoine Berthou, Francesco Paolo Conteduca, Ivelina Ilkova, Noemi Matavulj, Richard Morris, Enrico Sette and seminar participants at the ESCB Trade Expert Network, ECB-Bank of Canada conference on Global trade integration and shifting geopolitics, and OECD-WPIA for their insightful comments. We thank the Chief Economist Team of DG GROW (European Commission) for providing us with a list of strategic products. Access to firm-level confidential data from France has been made possible within a secure environment offered by CASD – Centre d'accès sécurisé aux données (Ref. 10.34724/CASD). For Spain, access to firm-level customs data on a secure server was provided by the Chamber of Commerce of Spain and access to the firm-level balance-sheet SABI data was provided by Asier Minondo and Aitor Garmendia. Work on the Belgian data was executed on a secure server and has benefited from conversations with and data extraction codes written by Gert Bijnens, Cédric Duprez, Emmanuel Dhyne and Catherine Fuss. The views expressed in this paper are solely those of the authors and do not necessarily reflect those of the National Bank of Belgium, Bank of Italy, Bank of Slovenia, Bank of Spain and the European Central Bank.

[2]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 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.

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

exposure to such shocks —induced by selected countries reducing their exports of critical inputs. We then use the model to simulate the economic impact of a sudden reduction in imports of foreign critical inputs (FCIs) —defined as inputs with highly concentrated extra-EU imports, which are mostly imported from outside the EU, and difficult to substitute, or which are advanced technologies and are key to the green transition —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, for each country, to retrieve the economic impact at different levels of aggregation —firm, sectoral, regional and aggregate level —with an arguably relatively high degree of external validity.

More in detail, we start by showing that EU firms report being strongly dependent on critical inputs from China.[4] To this aim, we rely on a survey from the European Central Bank, complemented by a national survey from the Bank of Italy,[5] 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 then identify FCIs and recover a list of 667 inputs at the HS6 product level.[6,7] We are able to leverage on our detailed customs data to map vulnerabilities at the firm level. Matching our list of FCIs to balance-sheet data on the near universe of Belgium, French, Italian, Slovenian, and Spanish firms, we establish a set of five stylised facts on importers of FCIs: 1) the share of exposed firms —those importing FCIs from China-aligned countries —is higher for large firms; 2) importers of FCIs account for a sizable share of the economy; 3) diversification of sourcing is limited for FCIs and large importers are *less* vulnerable; 4) FCIs account for a modest share of firms' total purchases, and 5) importers of FCIs are larger and more productive than other firms, even within narrowly defined industries. All in all, our facts for our BFISS countries motivate the use of a framework accounting for heterogeneous firm-level exposure

[4]The definition of critical inputs in the survey differs from that used in the rest of the paper. See the next section for more details.

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

[6]Our methodology builds on that of the European Commission, which typically identifies vulnerable inputs according to three criteria (European Commission, 2021) —inputs with highly concentrated extra-EU imports, primarily sourced 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 a wider range of high-tech products and products that are key for the green transition. More details are provided in Section 3.

[7]China is a major supplier of FCIs (accounting for 30% of overall EU FCI imports from extra-EU countries).

to geoeconomic fragmentation.

We thus build a framework in which firms combine labour, capital and intermediates in a Cobb-Douglas production function to produce an output good. Importantly, intermediates are produced using FCIs and non-FCIs in a constant-elasticity of substitution (CES) fashion.[8] Our baseline scenario consists of halving the supply of FCIs from China-aligned countries.[9] The benefit of using granular data is that this aggregate shock can be combined with firms' heterogeneous exposure to FCIs —firms' FCI share imported from China-aligned countries —to generate idiosyncratic shocks. These shift-share shocks are then fed into our model to assess how geoeconomic fragmentation may affect firms, sectors, regions and countries. As our model features a CES nest, the impact of firm-level supply disruptions arising from decoupling is governed by the elasticity of substitution between FCIs and non-FCIs. We offer a range of estimates that are contingent on this parameter,[10] 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 particularly 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 intermediate inputs is assumed to be low (Peter and Ruane, 2023).

We find that the impact of geoeconomic fragmentation is heterogeneous across firms and countries. On average, larger firms experience *lower* value-added losses, consistent with Fact 3, according to which they are also relatively *less* exposed to FCI disruptions. Aggregating these firm-level effects using value-added weights, we find that, under the baseline shock scenario, 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.[11] We further show that large firms, given their larger weights in the economy, are those driving the aggregate change (Gabaix, 2011). 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 source

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

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

[10] 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).

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

of risk, or the whole economy.

Finally, we show that relying on industry-level data —rather than firm-level data —may bias the impact of geoeconomic fragmentation if the assumed value of the elasticity of substitution is low enough. The bias stemming from using more aggregated 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. This 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 using 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. However, it is also parsimonious in that it only captures direct exposure, and partial equilibrium in that it 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.

Finally, by providing a firm-level analysis for different European countries, we 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 information at the firm level (survey-based or micro data for a single country) to assess firms' exposure to potential sources of geoeconomic fragmentation and the measures planned to mitigate them (Jaravel and Méjean, 2021; 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.[12,13] Other recent work such as Berthou et al. (2024) maps global value chain (GVC) vulnerabilities using input-output tables and trade data from Comtrade, and quantifies output losses arising from supply disruptions to direct imports of vulnerable products. 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 demonstrate the potential bias in results that arises when using more aggregated data. Moreover, the fact that we conduct our analysis on five different EU countries provides a relatively high degree of external validity.

The rest of the paper is organised as follows. In Section 2, we report survey-based evidence on the exposure of firms to foreign risk. Section 3 explains how we identify foreign critical inputs and introduces our stylised facts. Section 4 presents our framework, while Section 5 introduces our results on the impact of geoeconomic fragmentation. Section 6 concludes.

2 Exposure to foreign risk: evidence from survey data

In this Section, we rely on data collected by the European Central Bank in the summer of 2023 in the context of a survey of large European firms.[14] 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 abroad and to provide a first assessment of the associated economic risks. 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.[15,16]

[12]This literature typically relies on models à la Caliendo and Parro (2015), Allen et al. (2020), Antràs and Chor (2022), or Baqaee and Farhi (2024), 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. (2024), Attinasi et al. (2023a), Borin et al. (2023), Campos et al. (2023), Felbermayr et al. (2023), and Hakobyan et al. (2023).

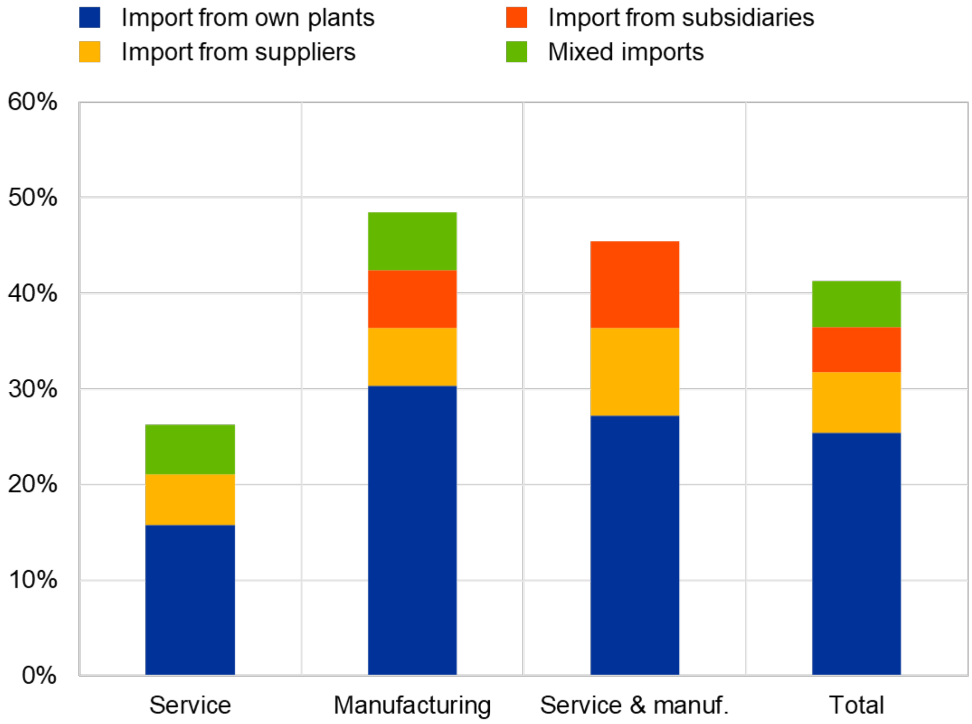
[13]Other studies use different frameworks, such as large macroeconomic models (the METRO model in OECD (2020) and the World Bank ENVISAGE model in Chepeliev et al. (2022)), Hypothetical Extraction Method (HEM) models (Wu et al., 2021; Giammetti et al., 2022), or computable general equilibrium (CGE)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

[14]The survey was sent to companies with which the ECB maintains regular contact as part of its gathering of information on current business trends under the umbrella of the Corporate Telephone Survey (CTS). 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.

[15]In the survey, "critical" inputs are defined as goods without which a significant part of the business activity could not be completed, would suffer significant delays, or the quality of the good or service produced by the firm would significantly decrease. This definition contrasts with that used in all the following sections.

[16]For comparison, Figure A1 highlights, for our FCIs, the most exposed manufacturing sectors in terms of value added and employment, using customs and balance sheet data of Belgium, France,

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".

Moreover, the results we provide are consistent with and build on a recent joint Eurosystem effort. In the course of 2023, Banca d'Italia, Banco de España and Deutsche Bundesbank exploited their respective firm surveys to ask a set of coordinated questions aiming to better understand the level of exposure of European economies to the sourcing of critical inputs from China. This additional evidence is reported in Balteanu et al. (2024).[17]

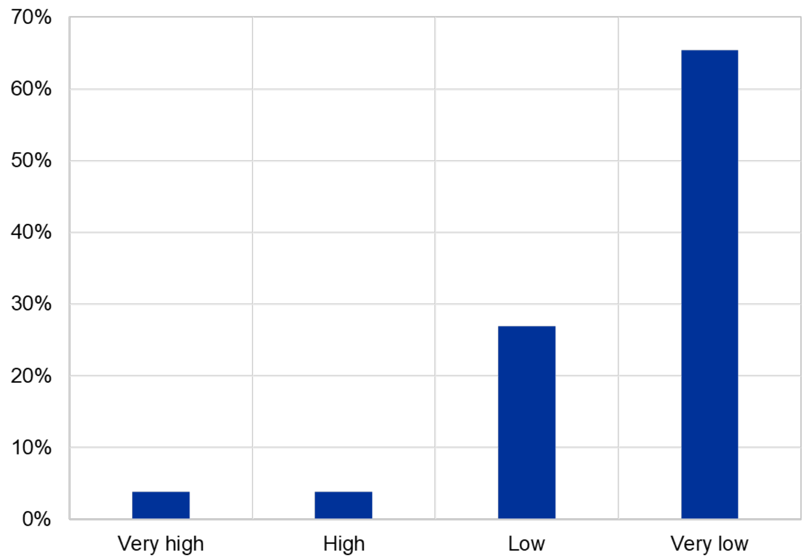
Exposure to critical inputs is high. About 40% of these large European firms rely on inputs from China that they deem critical for their activity, as shown in Figure 1. Intra-group imports are the biggest channel of exposure (60%). This is not surprising, since the firms surveyed are multinationals. 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.[18] 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%,

Italy, Slovenia and Spain.

[17]Additional results provided in Appendix D are only based on the Bank of Italy survey. Other results can be found in Balteanu et al. (2024).

[18]The Survey of Industrial and Service Firms (INVIND hereafter) covers 4,000 Italian firms. Figure A2 contains mirror results of Figure 1 for Italy. We find that about 20% of Italian manufacturing firms report importing critical inputs from China.

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.

respectively).[19]

Substitutability of critical inputs is low. 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 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 .[20]

Potential impact of growing tensions with China. As reported in Balteanu et al. (2024), an escalation of tensions increasing barriers to trade between China and the West would negatively impact a large share of European companies. Around 40% of Italian and Spanish manufacturing companies indicate that higher tensions could have a negative effect on their activity. This share is much higher for German firms (75%), which reflects their higher exposure to China. One of the main channels of disruption to business activity would be the loss of access to Chinese inputs.

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

[19] The share of manufacturing firms importing critical inputs from China averages 20% and 35% for Spain and Germany, respectively (Balteanu et al., 2024).

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

3 Identifying foreign critical inputs

Given the exposure of firms to China, we detail the data and methodology used to identify foreign critical inputs before establishing a set of key stylised facts on firms importing FCIs.

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 date, the quantity and value of the transaction, as well as the specific product traded, and the 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 Country 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 provided by the Central Balance Sheet Office (CBSO) of the National Bank of Belgium. We use VAT declarations, collected by the Belgian tax authority (Federal Public Service Finance), 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 the *Rijksdienst voor Sociale Zekerheid / Office national de securité sociale* (RSZ/ONSS). Information on the region of firm headquarters comes from the Crossroads Bank for Enterprises (CBE).

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.[21]

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 Dijk'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 link customs data and SABI directly 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

[21] 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.

for a sample of firms, which account for almost 90 percent of Spain's total imports in 2019.

3.2 Methodology

Inputs are classified as foreign critical inputs if they align with the following two, conceptually different, criteria. 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 (IRC Trade Expert Network, 2024) —which major economies are actively seeking to secure and enhance resilience, since they could be used by geopolitical rivals to exert pressure (i.e. weaponisation 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;[22] *ii*) inputs and raw materials key for the green transition (IRC Trade Expert Network, 2024) —such as lithium, nickel, and photovoltaic cells;[23] *iii*) inputs for which the "EU experiences an important level of foreign dependencies" according to the European Commission (Arjona et al., 2023).[24]

For our baseline scenario, we combine items *i*, *ii* and *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 approaches based solely on United Nations voting patterns to assess geopolitical alignment —as those recently

[22]The US Census considers as Advanced Technology Products 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.

[23]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.

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

used in the literature (Campos et al., 2023; Javorcik et al., 2024; Gopinath et al., 2024). More specifically, we build 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. The measures include the frequency of sanctions, military import disparities, China's official lending, and voting on specific 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 bloc. Other countries are assigned to a "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 also based on political and economic alignment, as both measures are conceptually close.[25] As can be seen in Appendix B, the China-aligned bloc consists, among others, of China, Russia, and Pakistan.[26]

Foreign critical inputs for the EU. We investigate the main sourcing countries of FCIs for the EU as a whole, using data from BACI (Gaulier and Zignago, 2010). As is evident in Figure 3, 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.[27]

3.4 Stylised facts

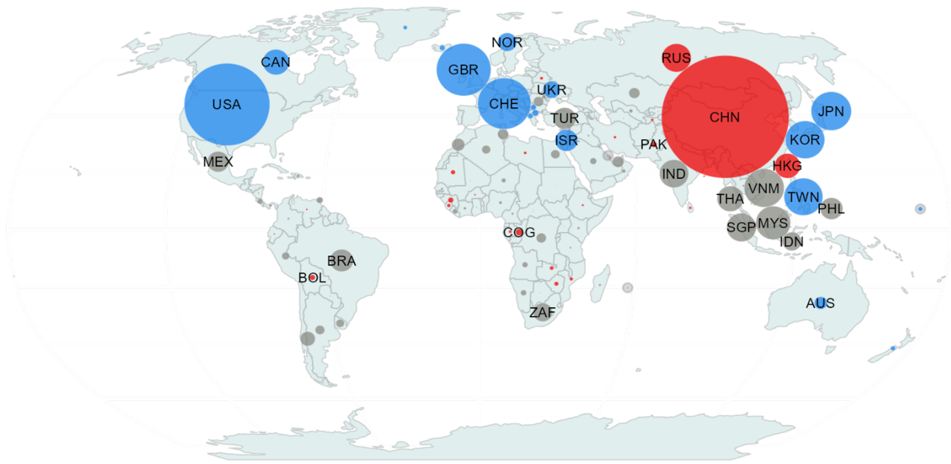
To motivate our firm-level framework, we now rely on our micro data from the BFISS countries to establish five stylised facts on the characteristics of firms importing FCIs. In our five combined datasets, there are 34,074 importers of FCIs in the manufacturing sector (20,325 from China-aligned countries) —accounting for 9% of the total number of firms in manufacturing.

[25]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 Neutral. For the overlapping sample, the two classifications are highly correlated, as only three countries (out of 63) are assigned to different blocs. Click here to access the list of Capital Economics (2023).

[26]China-aligned countries account for about 30% of global GDP in purchasing power parity.

[27]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 FCIs (Figure A4).

Figure 3: Extra-EU Import Share of FCIs by Country and Partner Alignment



Notes: The circle sizes represent the share of each extra-EU country's exports of FCIs in EU imports of FCIs from all extra-EU countries. International trade data are recovered through the CEPII BACI dataset, which provides data on bilateral trade flows for 200 countries at the HS6 product level —see Gaulier and Zignago (2010). See Appendix B for the complete list of US-aligned (blue circles), China-aligned (red), and neutral countries (grey).

3.4.1 Exposure to FCI disruptions

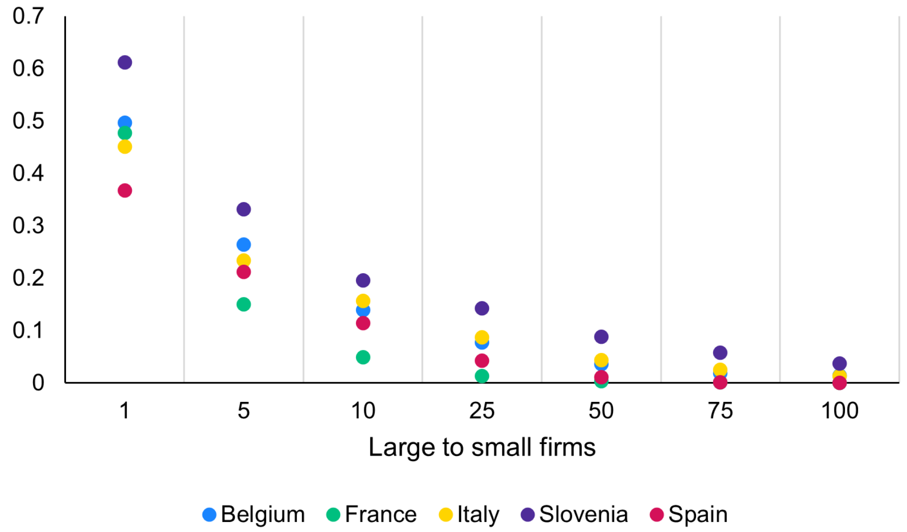
Which firms are exposed to FCI disruptions? Across all manufacturing firms, the largest ones are more likely to be exposed to an import cut of FCIs from China-aligned countries. Indeed, 37% of Spanish firms and 61% of Slovenian firms in the top 1% of the corresponding value-added distribution import FCIs from China-aligned countries (Figure 4). 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 A5).

The over-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).[28] 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 the top 1% of the value-added distribution).[29]

Fact 1: *The share of exposed firms is much higher for large firms and large exposed firms account for the lion's share of total exposed value-added. This is driven by two factors: (1) almost all large firms are importers; (2) large importers are more exposed than small ones as*

[28]See Figure A6.
[29]See Figure A7.

Figure 4: 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).

a share of the relevant population.

We have seen that the share of exposed firms is higher for large firms. But how large are importers of FCIs? Figure A8 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.[30]

Fact 2: *Firms importing FCIs account for a sizable share of the economy.*

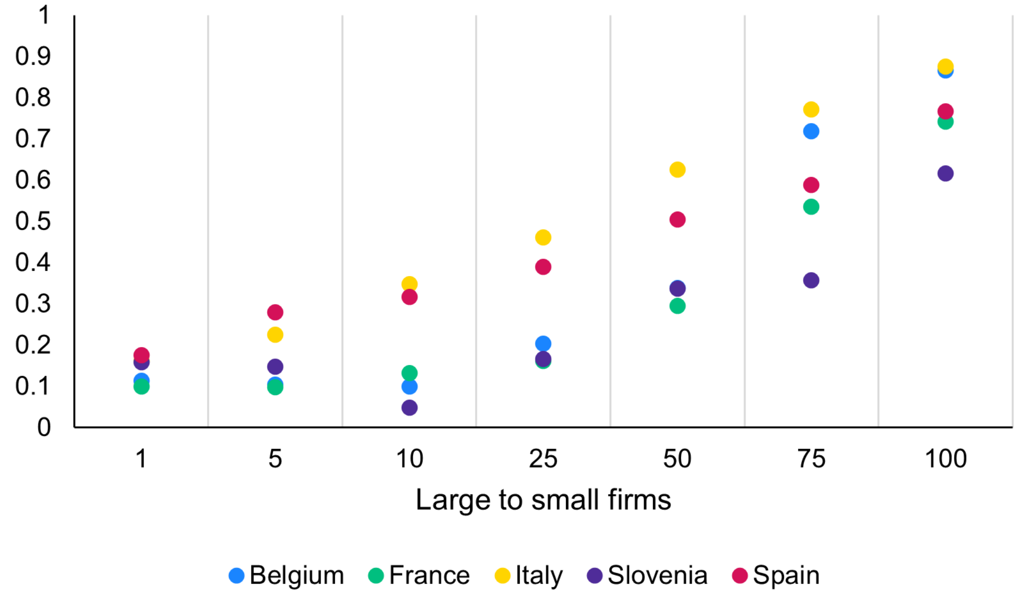
3.4.2 Sourcing strategy

We then dig deeper into firms' sourcing strategies. Firms import 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.[31] 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.

[30] As shown in the previous subsection, 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.

[31] See Table A3 for the whole economy.

Figure 5: 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.

We then compute the import share of FCIs sourced from China-aligned countries. Figure 5 shows that smaller firms tend to be more heavily exposed to China-aligned countries for their FCI imports, while larger firms face a lower risk in that regard.[32]

Fact 3: *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%.[33]

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

[32] Figure 5 defines firm size using value added. Alternatively, Figure A9 reproduces the results when measuring firm size by the number of employees.

[33] Despite some variation in these shares, the share of foreign critical inputs over total inputs is rather stable along the firm size distribution (Figure A10).

Table 1: Summary Statistics for FCI Importers

		Mean	p10	p50	p90	SD	Obs.
Belgium	FCIs, share of firms' total purchases	4.9	0.0	0.7	13.3	11.4	2,748
	FCIs from low-risk countries, share of firm's total purchases	4.3	0.0	0.6	10.9	10.7	2,422
	FCIs from high-risk countries, share of firm's total purchases	3.2	0.0	0.3	8.0	8.7	975
France	FCIs, share of firms' total purchases	5.9	0.0	1.0	17.0	12.9	8,366
	FCIs from low-risk countries, share of firm's total purchases	5.3	0.0	0.8	14.8	12.3	7,657
	FCIs from high-risk countries, share of firm's total purchases	2.8	0.0	0.2	6.6	8.2	3,224
Italy	FCIs, share of firms' total purchases	4.6	0.0	0.8	12.8	10.4	15,238
	FCIs from low-risk countries, share of firm's total purchases	3.9	0.0	0.5	10.4	9.6	12,346
	FCIs from high-risk countries, share of firm's total purchases	3.4	0.0	0.6	9.3	7.7	6,604
Slovenia	FCIs, share of firms' total purchases	6.3	0.1	1.3	18.3	13.2	3,570
	FCIs from low-risk countries, share of firm's total purchases	5.7	0.1	1.2	15.4	12.3	3,490
	FCIs from high-risk countries, share of firm's total purchases	4.1	0.0	0.4	10.6	10.7	642
Spain	FCIs, share of firms' total purchases	8.6	0.1	1.6	24.4	17.4	4,030
	FCIs from low-risk countries, share of firm's total purchases	7.6	0.1	1.3	21.0	16.3	3,594
	FCIs from high-risk countries, share of firm's total purchases	5.0	0.0	1.0	12.5	11.7	1,476
All	FCIs, share of firms' total purchases	6.0	0.0	1.1	17.2	13.1	6,790
	FCIs from low-risk countries, share of firm's total purchases	5.3	0.0	0.9	14.5	12.2	5,902
	FCIs from high-risk countries, share of firm's total purchases	3.7	0.0	0.5	9.4	9.4	2,584

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. Total purchases refer to expenditures on intermediate goods and services. All countries but Spain use the population of importing firms; in the case of Spain, the sample corresponds to the importers 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.

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. Table 1 shows that the FCI share from China-aligned and US-aligned countries averages 4% and 5%, respectively.[34]

Fact 4: *FCIs, on average, account for a modest share of firms' total purchases. The ratio of imports of FCIs to total expenditures on intermediate inputs is relatively constant along the firm size distribution.*

3.4.4 FCIs and size premia

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

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

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 differences in demand or supply that could explain size differences across firms as well as

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

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.	12,343	12,343	12,343	12,343	4,071	4,071	4,071	4,071
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. All countries but Spain use the population of importing firms; in the case of Spain, the sample corresponds to the importers 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.

the fact that firms in specific industries may need FCIs for their production process by including three-digit (NACE3) sector fixed effects δ_s.

Table 2 presents our results for the manufacturing sector.[35] 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 indeed 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 indicate that importers of FCIs are relatively large and that the degree of exposure to disruptions from China-aligned countries varies across firms. This motivates the use of a framework accounting for heterogeneous expo-

[35]See Table A5 for the whole economy.

sure 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 its advantages and limitations.

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 intermediate goods and services.

In turn, intermediate goods and services are combined through a firm-specific CES aggregator:[36]

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

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

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

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 and 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 firms exposed to the shock 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 intermediates.[37] The sectoral shares $1 - \alpha_s - \beta_s$ are the ratio of expenditures on intermediates to turnover. To minimise the importance of outliers that could be driven by differences in definitions of turnover across countries' databases, 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 —with industries 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-

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

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

$$\varepsilon_i = \text{China-aligned share}_i \times \delta \tag{6}$$

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 —a 50% reduction —but we provide robustness checks using alternative values.

A number of remarks are in order. 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 more when the degree of exposure to disruptions of 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-aligned countries and FCIs from US-aligned/neutral countries.[38]

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).[39,40]

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),[41] 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 value-added losses can be readily recovered from eq. (4). Third, our framework can be used to shed light on the role played by firm-level exposure to aggregate geoeconomic shocks

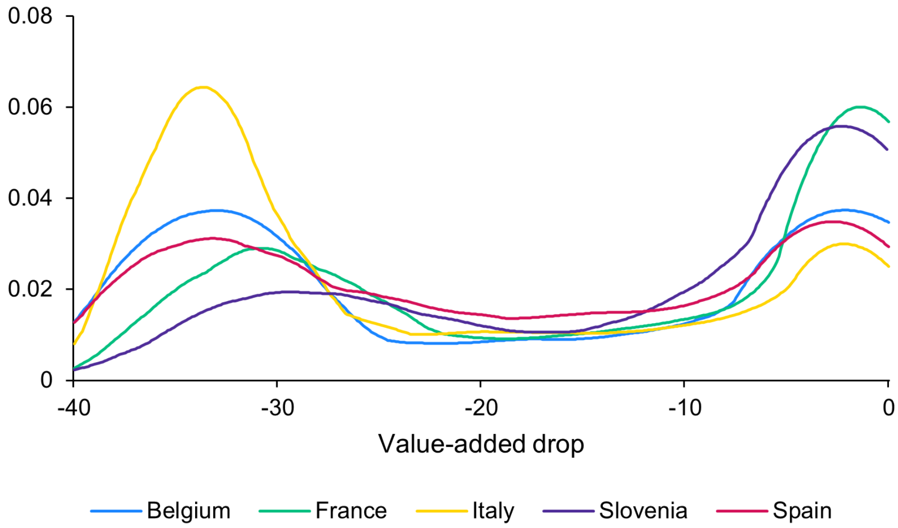
[38] For instance, $\delta = 0.5$ could result from either a 100% drop in the supply of critical inputs, partially mitigated by substituting 50% of this supply from elsewhere, or from a 50% drop in the supply of critical inputs without any substitution.

[39] 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.

[40] See footnote 59 in Appendix A for the change in value-added in the Leontief case.

[41] Not accounting for indirect exposure may lead us to underestimate the impact of geoeconomic fragmentation. At the same time, firms may also adjust their sourcing strategies (either domestically and/or internationally), helping them mitigate the losses arising from exposure to foreign risk —this margin of adjustment may take time to manifest and may depend on how substitutable different producers and/or types of inputs are. The empirical question of which effect dominates remains and would be a fruitful avenue for future research.

Figure 6: 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.

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 consider our framework to be complementary to recent papers relying on Baqaee and Farhi (2024)'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.

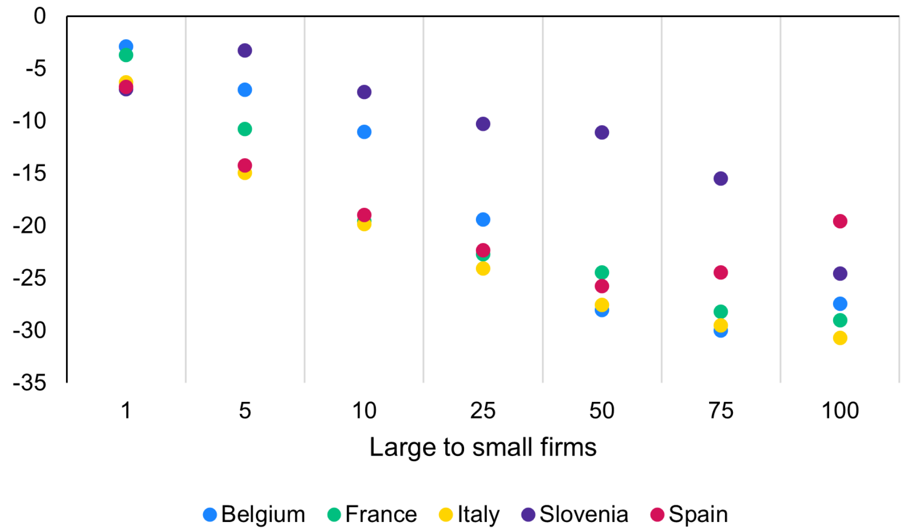
5.1 Heterogeneous effects across firms

Figure 6 shows the firm-level distribution of value-added changes when the production function is Leontief. The distribution has a fat left tail. Our five BFISS countries display similarly shaped bi-modal distributions, although Italy has a larger group of firms that are highly affected by the cut.[42]

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 7). In fact, the value-added

[42]As shown in Figure A11a, when the elasticity of substitution is higher ($\sigma = 0.2$), the mass flattens out and is more concentrated around zero. Figure A11 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 7: 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.

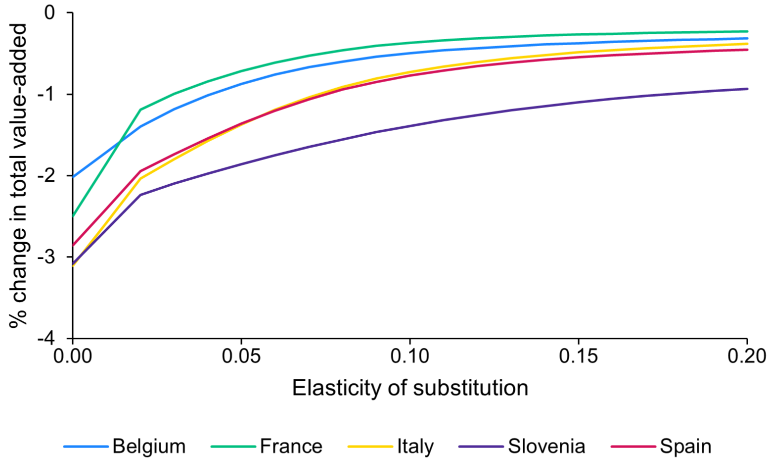
loss for the largest firms would range from 3% for Belgium to 7% for Slovenia. Conversely, conditional on importing FCIs from China-aligned countries, the impact is relatively larger for smaller firms, ranging from about -20% for Spain to -30% for Italy. Although the firm-level value-added changes are also shaped by technology parameters —see eq. (4), the results reported in Figure 6 and Figure 7 are consistent with the fact that the import share of FCIs from China-aligned countries is higher for smaller importers (Fact 3) so that these firms will be relatively more affected in our geoeconomic fragmentation scenario.

Overall, *heterogeneous exposure* to FCIs sourced from China-aligned countries leads to heterogeneous patterns of value-added losses across importing 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 8. 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 6 —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

Figure 8: Aggregate Value-Added Change (in %) across Countries



Notes: Only manufacturing firms are included.

for σ are 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 this in turn lowers the effect on aggregate value-added.

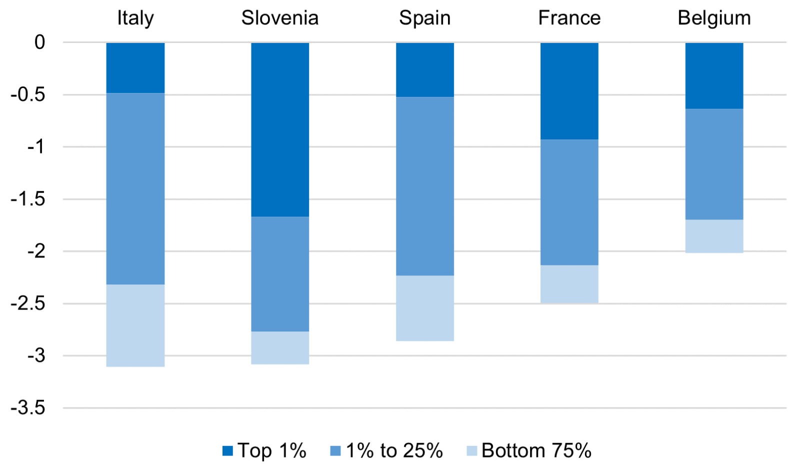
We test the robustness of these results in different ways. In the case where FCIs cannot be substituted, a larger 75% cut in the supply of FCIs from China-aligned countries ($\delta = 0.75$) is associated with a drop in manufacturing value-added ranging from 3% for Belgium to more than 4.5% for Italy and Slovenia (Figure A12a). A smaller drop of 25% ($\delta = 0.25$) would lead to a 1 to 1.5% drop in value-added (Figure A12b), depending on the country. Furthermore, we use an alternative, restricted, list of critical inputs, in Figure A11b and Figure A12c, 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 that is relatively close to that obtained when reducing the supply of FCIs from all China-aligned economies (2.3% drop on average).[43] 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.[44]

Which firms are driving this change in aggregate value-added? Given that we rely on a weighted average in eq. (5) and given the results shown in Figure 7 and Figure 8, we expect large firms to drive the aggregate change —which echoes the famous result by Hulten (1978) for aggregate productivity and recently revived by

[43]See Figure A11c and Figure A12d

[44]See Figure A11d and Figure A12e.

Figure 9: Decomposition of Value-added Change (in %) by Exposed Firm Size



Notes: Firm size is measured in terms of value-added. Percentile calculations only include exposed firms operating in manufacturing.

Gabaix (2011).[45,46] The decomposition in Figure 9 confirms this intuition for when $\sigma = 0$. The drop (the height of the bars matches the corresponding numbers provided in Figure 8) 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 the decrease in all countries.[47] 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 the latter three countries.[48,49]

5.3 Regional and sectoral effects

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

[45] 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 focusing on inefficient economies with input-output linkages.

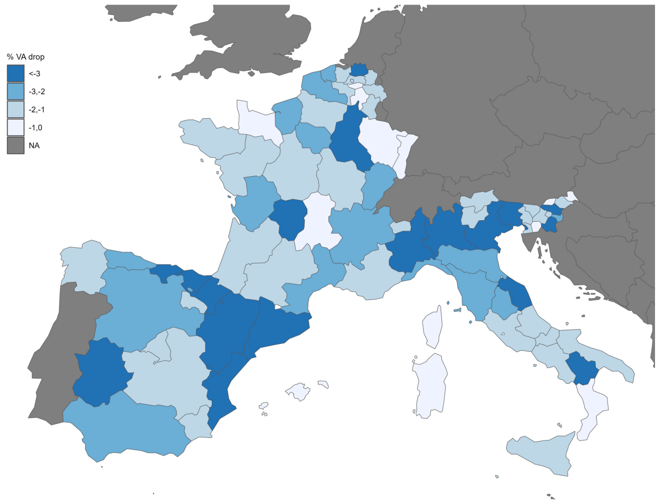
[46] Homogeneous drops in value-added across firms of similar size could also be driving the results. However, this explanation would arguably be harder to reconcile with our fat-tailed distribution of firm size (Figure A8). We come back to this point below when discussing how specialisation may be relevant at the regional level.

[47] As a robustness test, Figure A13 reproduces the results using the number of employees as a proxy for firm size.

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

[49] For confidentiality reasons, we cannot disclose which firms are driving our results.

Figure 10: 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.

5.3.1 Regional effects

Figure 10 shows the impact of a 50% cut on manufacturing value added by region (defined at the NUTS2 level or NUTS3 for Slovenia).[50,51] 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 may be more heavily impacted. This is best illustrated by the Italian region of Marche, which is relatively more specialised than other regions in the production of electrical equipment —a particularly exposed and affected industry, as shown below. 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,[52] consistent with the aggregate effects rationalised above.

5.3.2 Sectoral effects

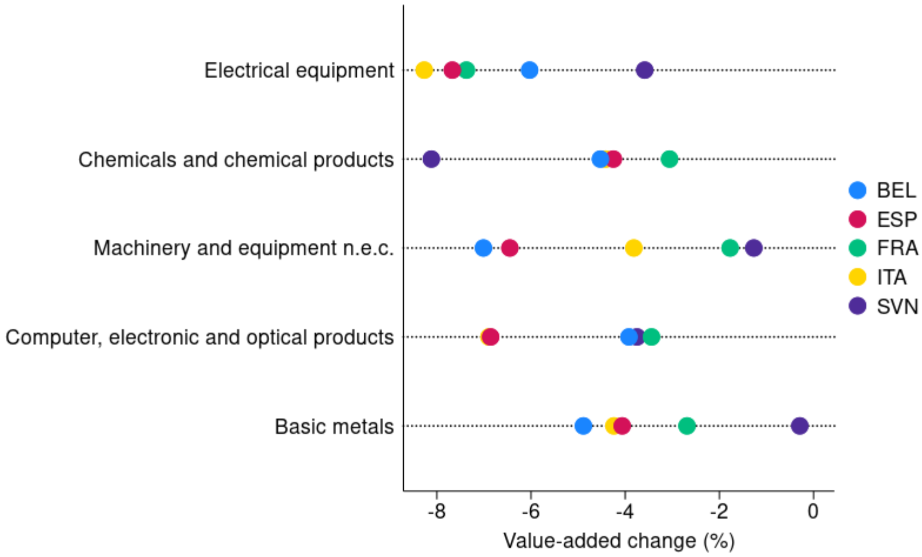
There is also substantial heterogeneity across manufacturing industries. Figure 11, which focuses on the five sectors experiencing the largest decrease, shows that the impact of the shock in the Leontief case would exceed 6.5%, on average, for the electrical equipment and would be higher than 4%, on average, for chemical products,

[50]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.

[51]Figure A14 instead shows the impacts on the whole economy across regions.

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

Figure 11: 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 and by Spain's dot for the computer industry. Manufacturing sectors with the highest median value-added drop across countries are represented.

and machinery and equipment industries. These effects are considerably higher than the results obtained for the entire manufacturing sector (2.7% on average),[53] reflecting the higher share of FCIs from China-aligned countries used by these industries.[54] 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 is the use of micro data in assessing the impact of supply disruptions of FCIs? To answer this question, we investigate how relying on more aggregated data rather than firm-level data would affect our quantitative results.[55] Figure 12a shows the equivalent of Figure 8 when using sector-level data. Figure 12b thus shows that using macro data instead of more granular data may bias the sim-

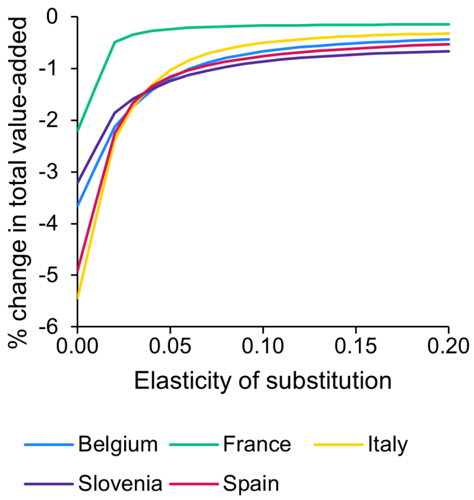
[53] Figure A15 shows the decomposition along the five sectors with the biggest average contribution to the drop, namely chemicals, electrical equipment, machinery and equipment, and motor vehicles.

[54] Figure A16 show non-manufacturing sectors for comparison. The results are on average smaller than for manufacturing owing to the lower exposure of firms active in those sectors to FCIs sourced from China-aligned countries.

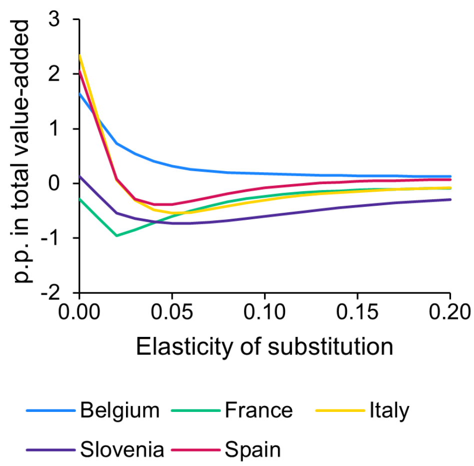
[55] To recover a database at the sectoral level, we use our firm-level data to aggregate all relevant variables (imports, value-added, etc.) at the 3-digit level (NACE3).

ulated impact of geoeconomic fragmentation.[56] Specifically, the use of macro data leads to overstating the effect on value-added for all BFISS 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.[57]

Figure 12: 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 are at the NACE3 level. Figure 12a is a variation of Figure 8 using sector-level data instead of firm-level data. Figure 12b represents the difference between Figure 8 and Figure 12a.

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, which masks substantial heterogeneity in exposure across firms. In fact, since we recover the overall change in value-added by aggregating firm-level changes in value-added —which themselves depend on *firms' exposure* to supply disruptions (see eq. (5)), there are two factors that can drive the direction of the bias. First, as discussed above in reference to Hulten (1978)'s theorem, the distribution of value-added weights shapes the aggregate impact, everything else equal. If firms that

[56] We have rerun our procedure using the sectoral level data and computed the difference in manufacturing value-added losses with those obtained using our baseline firm-level data. In other words, it is the difference between the values displayed in Figure 12a and those obtained in Figure 8.

[57] As explained in Section 5.2, factors of production are more easily substitutable with higher values of σ so that disruptions to the supply of FCIs become less costly in terms of value-added, everything less equal.

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 even if *firm-level* exposure and thus value-added changes are *unaffected* —from eq. (4).[58] In this case, the aggregate impact coming from *macro* data may be different. To further illustrate these two channels, 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 five European countries to provide an assessment of potential supply disruptions from China-aligned countries. In doing so, we propose a parsimonious framework of firm-level sourcing, to obtain quantitative estimates of the impact of supply disruptions of FCIs on value-added at different levels of aggregation. More generally, the paper serves as a first multi-country 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 economies differently. Our paper hopefully presents itself as one explanation for such a question.

We find that firms, sectors, regions and countries are significantly impacted by such a supply shock, with substantial heterogeneity across units stemming from heterogeneous import exposure. For instance, the manufacturing value-added loss would range from 2% to 3.1%, for a 50% reduction in imports of FCIs from China-aligned countries.

Finally, we argue that micro data are crucial not only for mapping strategic dependencies (Méjean and Rousseaux, 2024), but also for quantifying their importance in case shocks materialise. In this context, to better design industrial policy and policies aimed at diversifying away from China-aligned countries, we echo the

[58] For instance, one could adjust, for a subset of firms, both their imports of FCIs from China-aligned countries and their total imports of FCIs by the same scaling factor so that their exposure —the ratio of the former to the latter —would not change. However, at the aggregate level, sector-level exposure —defined as the ratio of the *sum* of imports of FCIs from China-aligned countries to the *sum* of total imports of FCIs —would change because this scaling factor would affect both the numerator and the denominator in different proportions.

call of Pichler et al. (2023) and 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 back into the CES aggregator 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:[59]

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

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.

[59]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), French Southern and Antarctic Territories (ATF), Australia (AUS), Austria (AUT), Belgium (BEL), Bonaire (BES), Bulgaria (BGR), Bosnia Herzegovina (BIH), Saint Barthélemy (BLM), Belize (BLZ), Bermuda (BMU), Canada (CAN), Cocos Islands (CCK), Switzerland (CHE), Cook Islands (COK), Curaçao (CUW), Christmas Islands (CXR), Cayman Islands (CYM), Cyprus (CYP), Czechia (CZE), Germany (DEU), Denmark (DNK), Spain (ESP), Estonia (EST), Finland (FIN), Falkland Islands (Malvinas) (FLK), France (FRA), United Kingdom (GBR), Gibraltar (GIB), Greece (GRC), Greenland (GRL), Guatemala (GTM), Guam (GUM), Croatia (HRV), Haiti (HTI), Hungary (HUN), British Indian Ocean Territory (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 Islands (MHL), North Macedonia (MKD), Malta (MLT), Montenegro (MNE), Northern Mariana Islands (MNP), Montserrat (MSR), New Caledonia (NCL), Norfolk Islands (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 Islands (TCA), Tokelau (TKL), Taiwan (TWN), Ukraine (UKR), United States of America (USA), British Virgin Islands (VGB), Wallis and Futuna Islands (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), Rep. of 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 Islands (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), 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), Tanzania (TZA), Uruguay (URY), Uzbekistan (UZB), Saint Vincent and the Grenadines (VCT), Vietnam (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 made-up 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 normalised 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 59 in Appendix A: $\Delta\text{va} = -\text{China-aligned share} * 0.5$).

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. In panel A of Table A1, the change in value-added when using firm-level data is obtained by computing $-0.625\% \times 400/1200 + -7.5\% \times 200/1200 + -10\% \times 500/1200 = -5.6\%$.

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 ($0.1227 \times -0.5 = -6.1\%$). In this case, the use of sectoral-level data leads to an overestimation of the impact of geoeconomic fragmentation. Indeed, exposure to imports of FCIs from China-aligned countries is 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

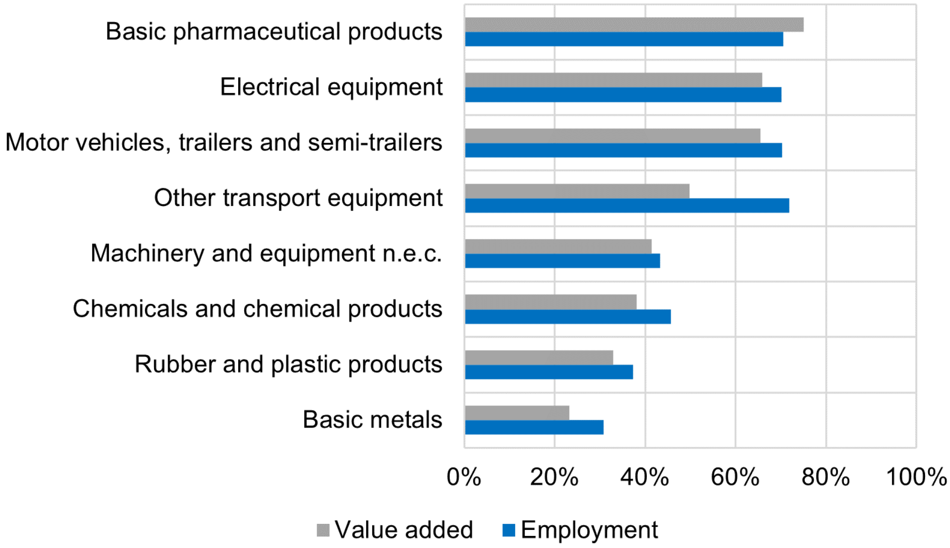
In panel B of Table A1, we change the value-added produced by firm 4 and thus the distribution of value-added weights. In this case, the weight associated to firm 4 is larger (going from 0.42 to 0.58). While the impact calculated from sectoral data does not change (-6.1%), that obtained with micro data 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 result in an *underestimation* of 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 estimated impact of geoeconomic fragmentation is lowered when using macro data: the change is now -5% instead of -6.1%. This is because the exposure coming from macro data is now underestimated, whereas exposure at the micro level is unaffected.

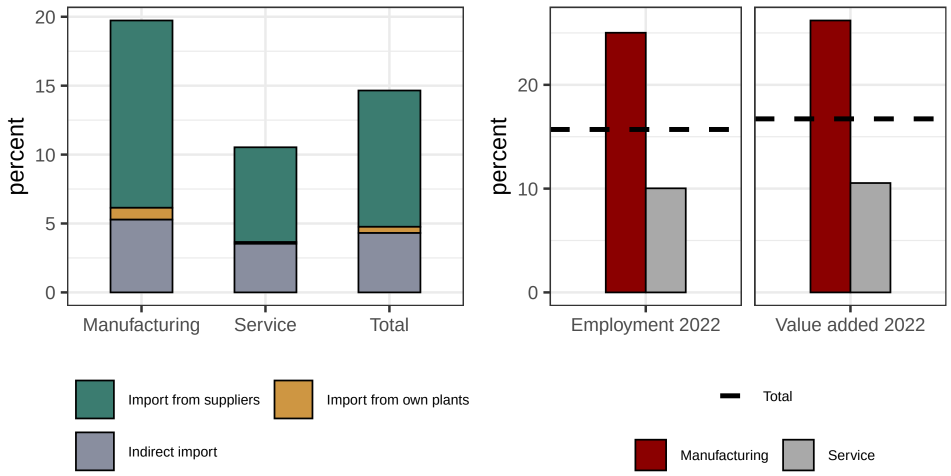
D Additional Figures

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



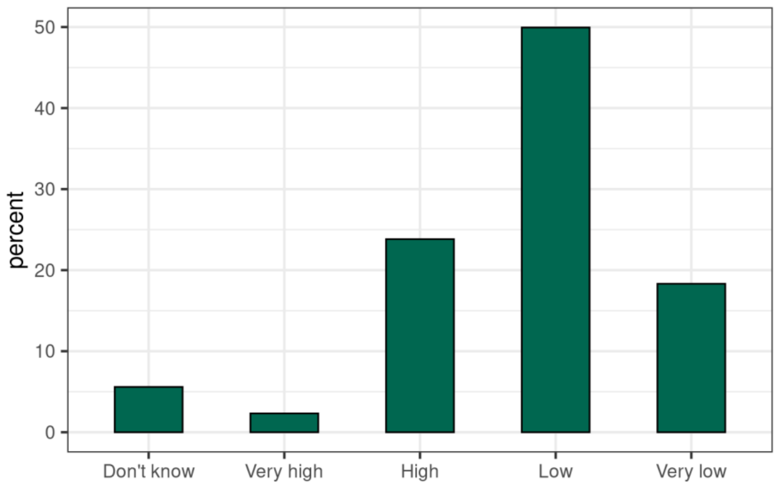
Notes: Firms are considered exposed if they import at least one FCI from China in 2019. The values of value-added and employment are aggregated for the five BFISS countries.

Figure A2: Critical Inputs from China among Italian Firms



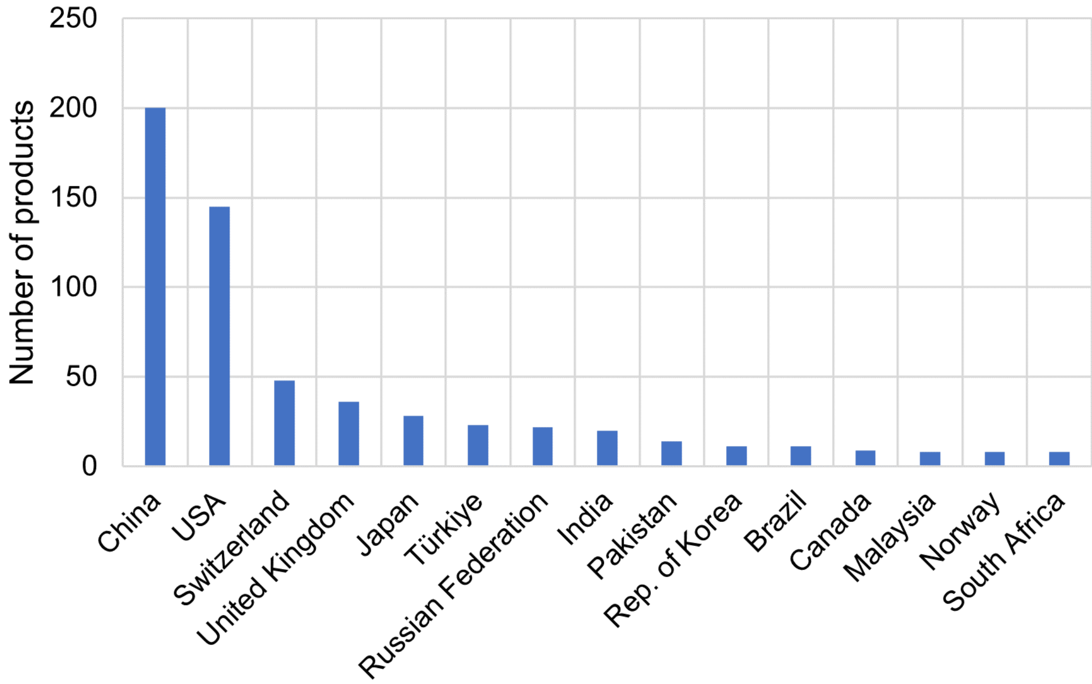
Source: Own elaboration on INVIND data. **Notes:** Left panel: Firms sourcing critical inputs from China (share of total firms). In this survey, critical inputs are defined as those whose shortage would lead to a reduction in the quality of the good or service produced, or without which a significant 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



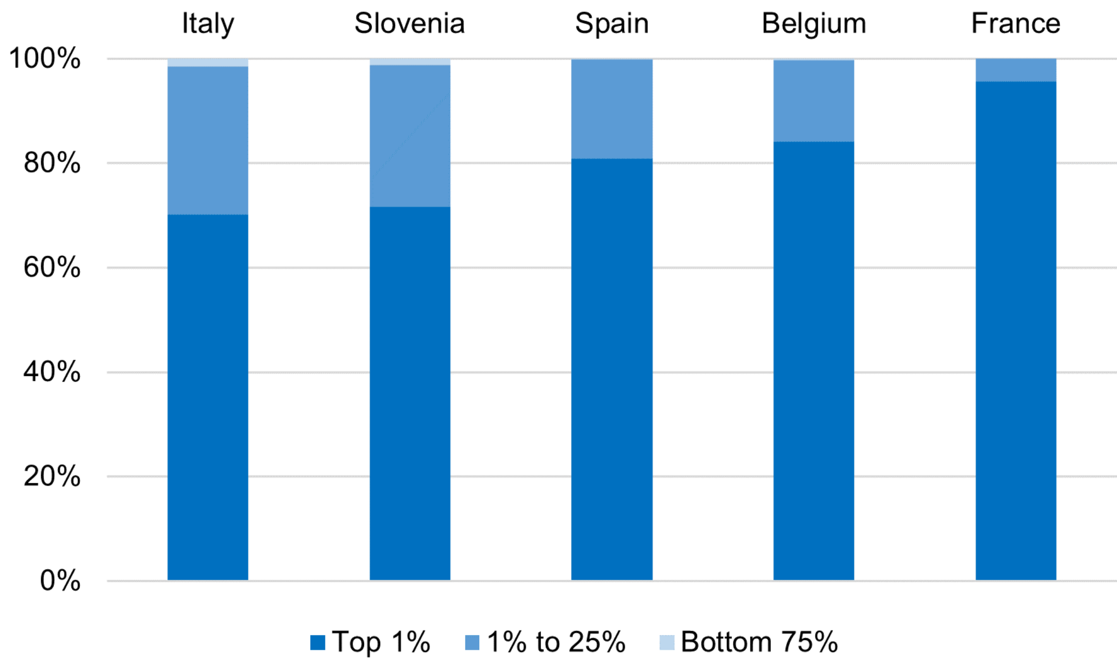
Source: Own elaboration on INVIND data. **Notes:** The bars refer to the extent to which critical inputs sourced from China (share of manufacturing firms sourcing critical inputs from China) can be substituted. In this survey, critical inputs are defined as those whose shortage would lead to a reduction 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: Number of FCIs by Country



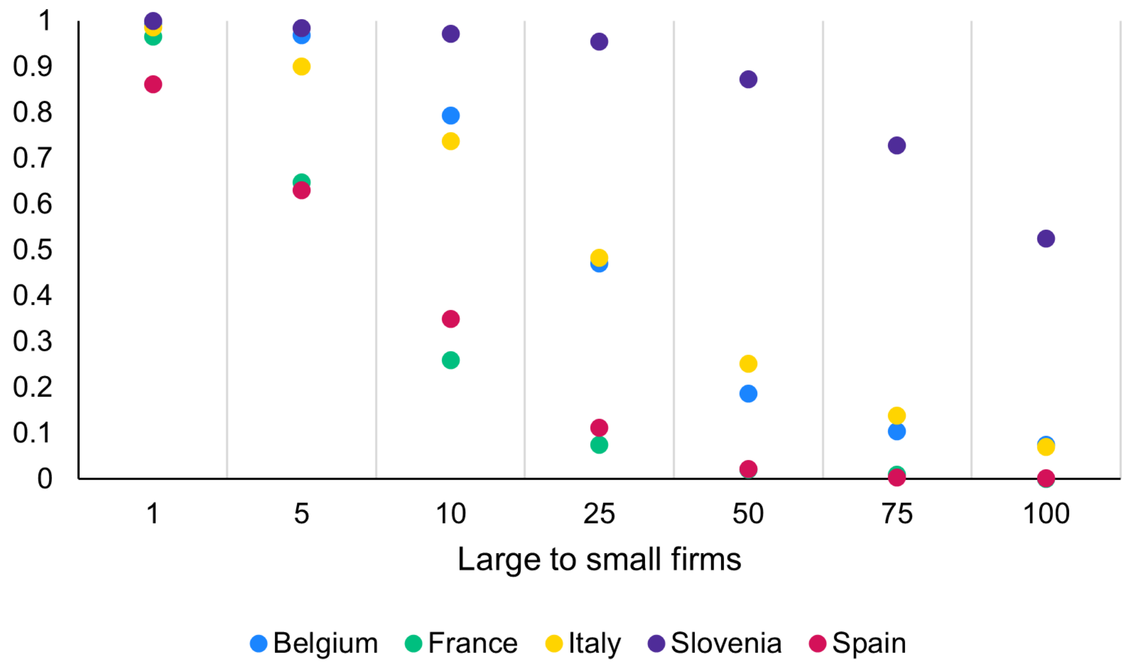
Notes: The bars represent the number of FCIs. The x-axis represents the main exporter of each FCI to the EU coming from the CEPII BACI dataset, which provides data on bilateral trade flows for 200 countries at the HS6 product level —see Gaulier and Zignago (2010).

Figure A5: Share of Value-added by Exposed Firm Size



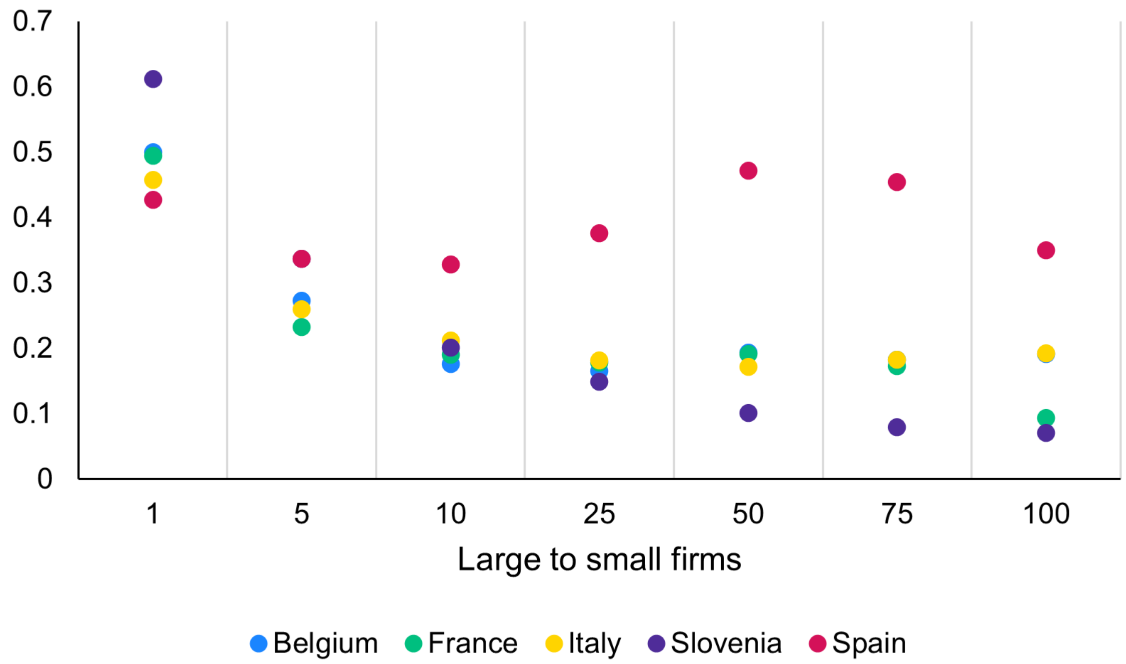
Notes: Percentiles of value added. Only firms importing critical inputs from China-aligned countries are considered. The French statistical institute (INSEE) groups legal entities that belong to the same firm together ("Profilage d'un groupe de sociétés"), which explains why the largest French firms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

Figure A6: Share of Importing Firms by Firm Size



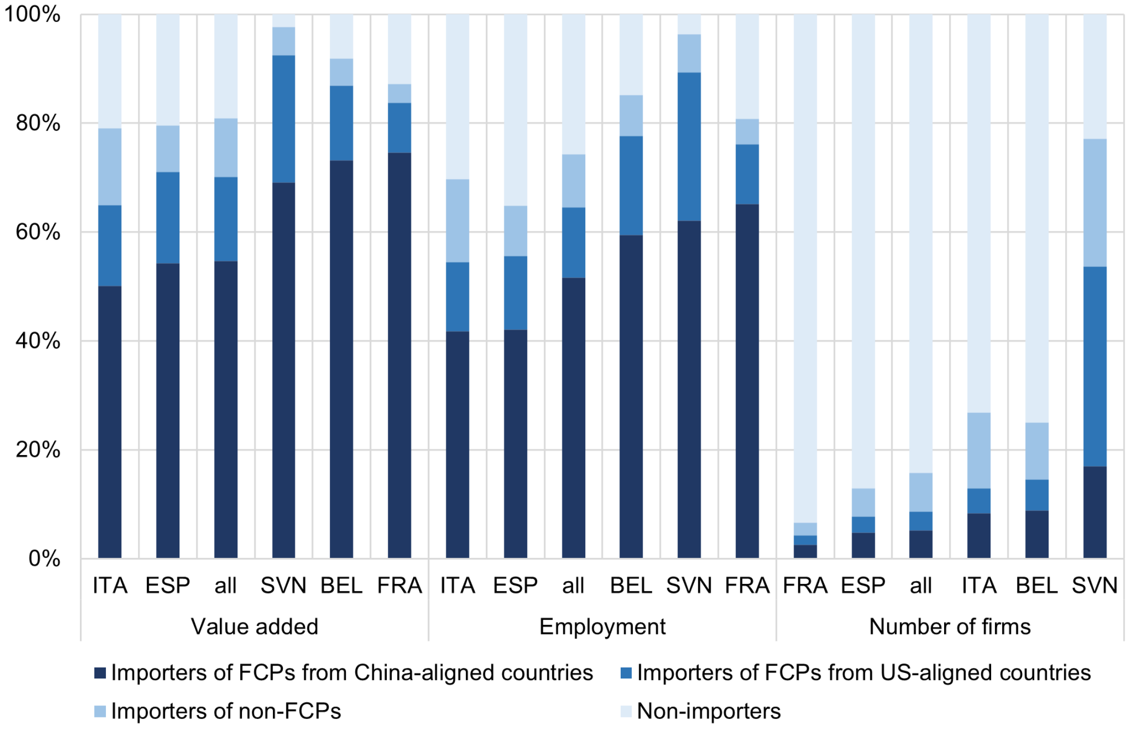
Notes: The x-axis shows percentiles, e.g. 1 stands for the 1% largest firms in value added, 5 for the 1 to 5% largest, etc. The share is computed over the total number of firms.

Figure A7: Share of Exposed Firms among Importers by Firm Size



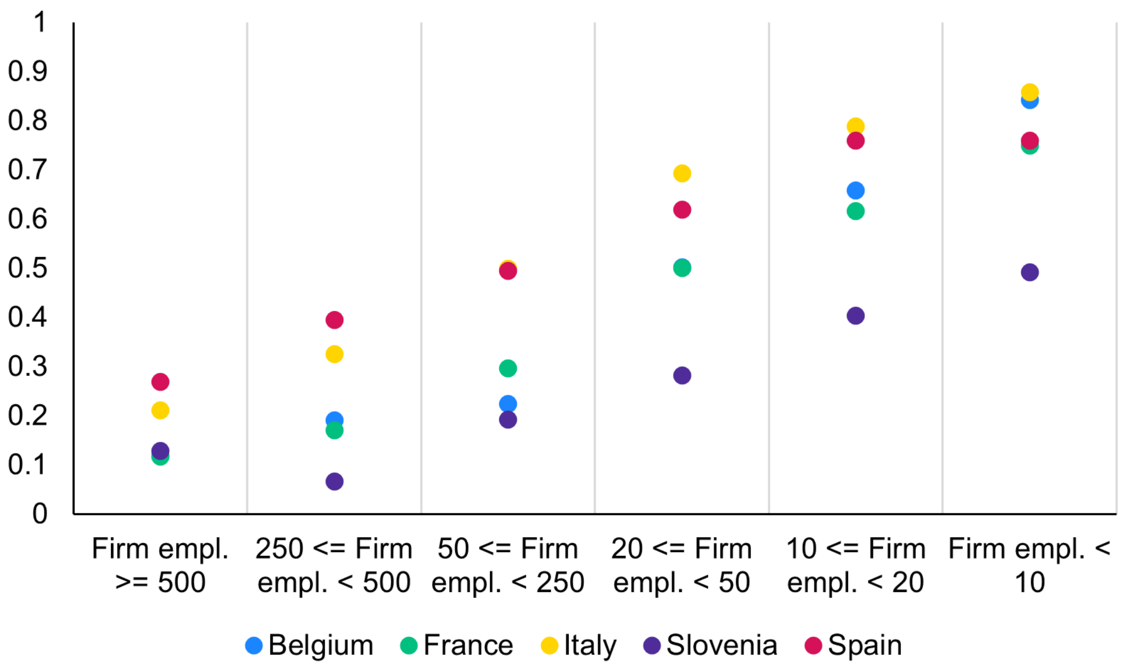
Notes: The x-axis shows percentiles, e.g. 1 stands for the 1% largest firms in value added, 5 for the 1 to 5% largest, etc. Exposed firms are firms importing foreign critical inputs from China-aligned countries.

Figure A8: Share of Value-added, Employment and Number of firms by Status



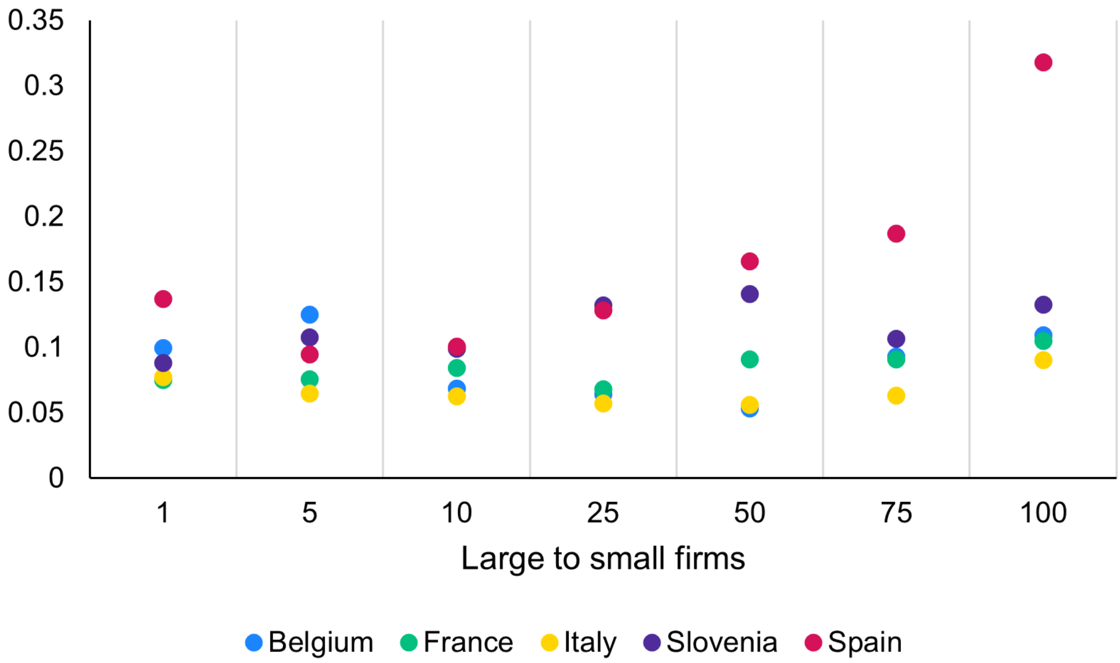
Notes: Only manufacturing firms are considered.

Figure A9: Import Share of FCIs from China-aligned Countries by Firm Employment Size



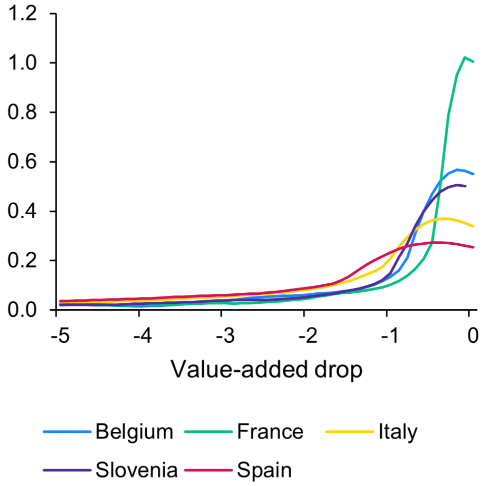
Notes: Firm size measured in number of employees, full-time equivalent. Only manufacturing firms are included. Only firms importing critical inputs from China-aligned countries are considered.

Figure A10: Share of Foreign Critical Inputs over Total Inputs

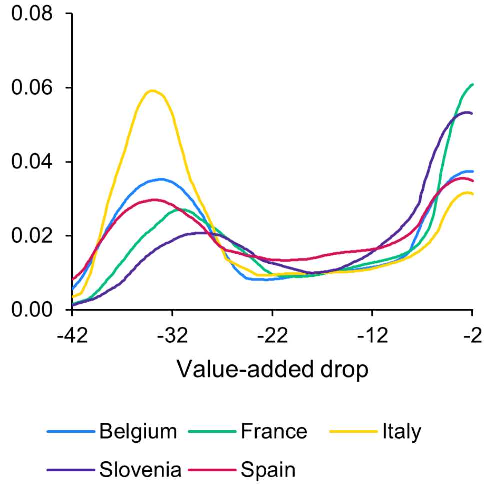


Notes: The x-axis shows percentiles, e.g. 1 stands for the 1% largest firms in value added, 5 for the 1 to 5% largest, etc. Only firms importing critical inputs are considered (from China-aligned and non-China-aligned countries). Imports-to-inputs ratios above 1 are winsorised.

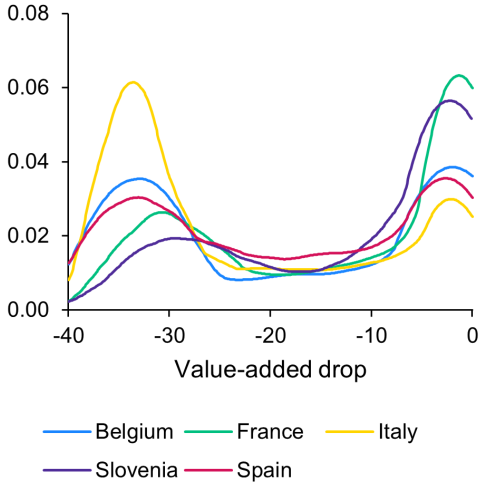
Figure A11: Distribution of Value-added Change (in %) – Variations of Figure 6



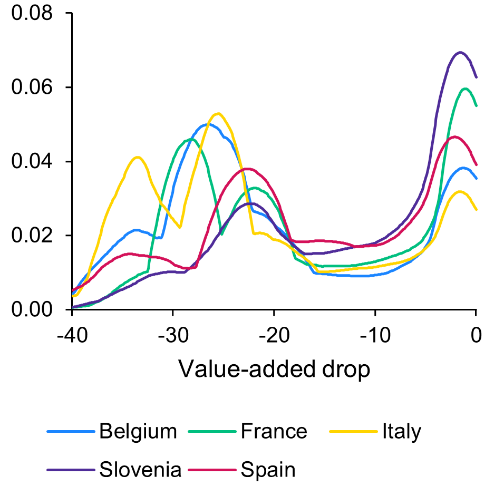
(a) $\sigma = 0.2$ instead of $\sigma = 0$



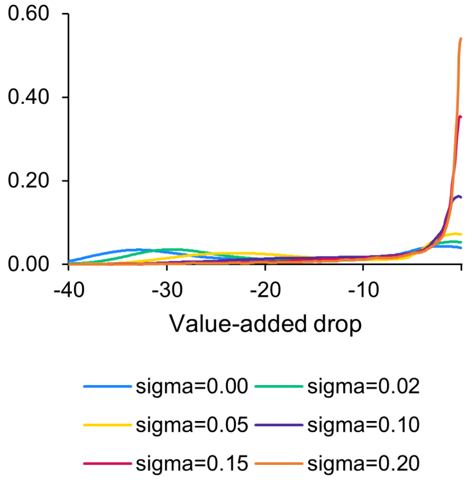
(b) Restricted FCIs list



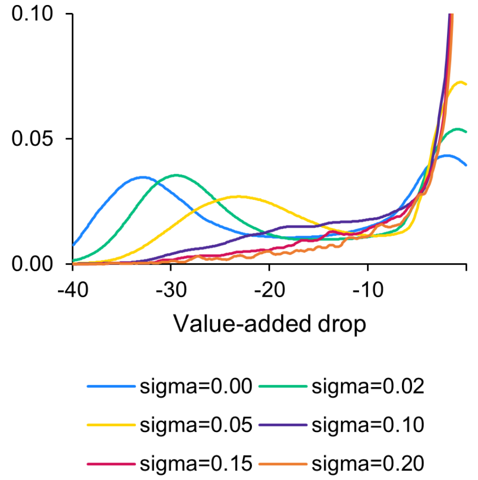
(c) Cut from China only



(d) Whole economy



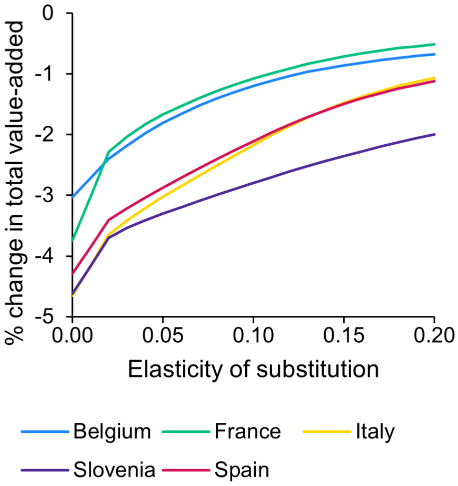
(e) Country average (large scale)



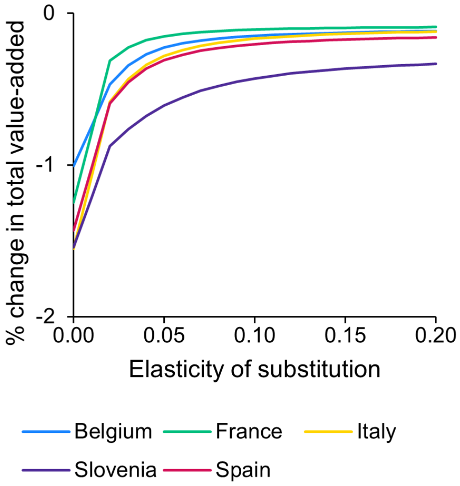
(f) Country average (zoom)

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 highly concentrated raw materials at the global level. Country average is a simple average; results are very similar with a weighted average.

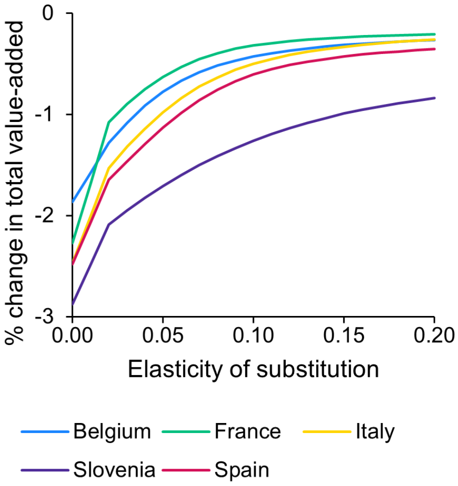
Figure A12: Aggregate Value-added Change (in %) – Variations of Figure 8



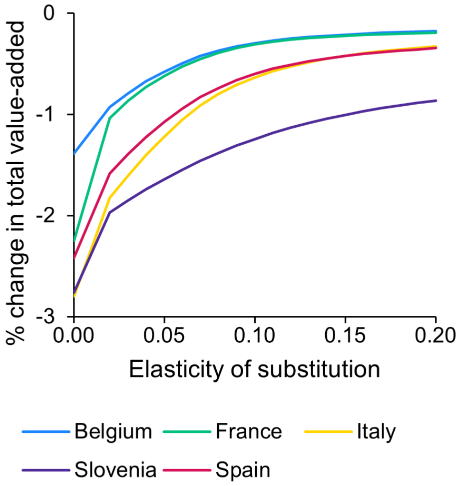
(a) 75% cut



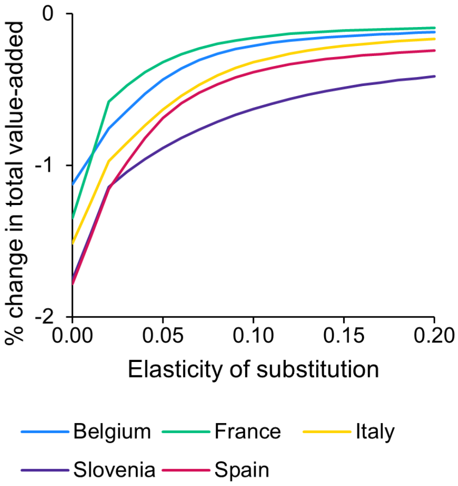
(b) 25% cut



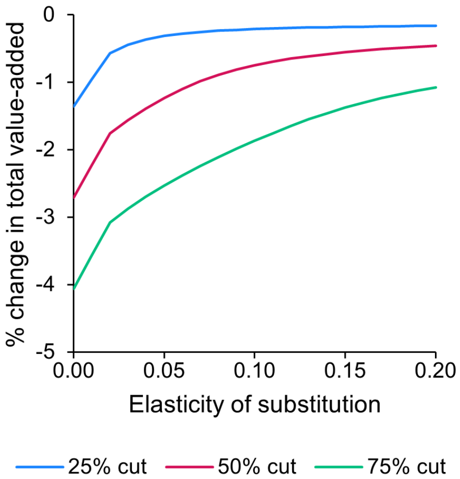
(c) Restricted FCIs list



(d) Cut from China only



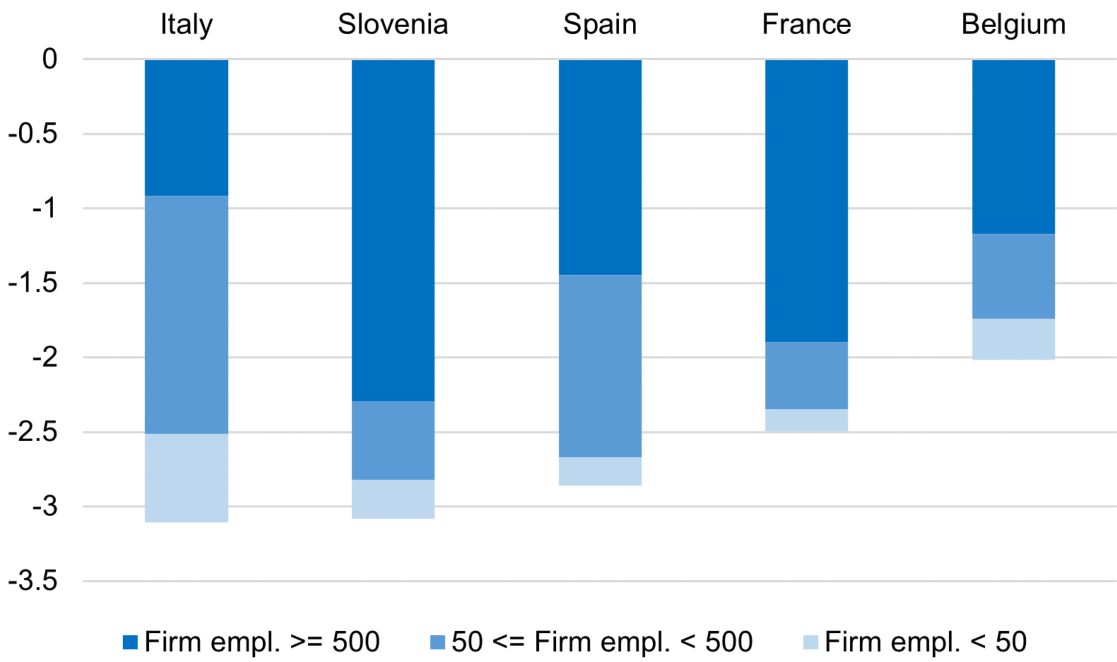
(e) Whole economy



(f) Country average

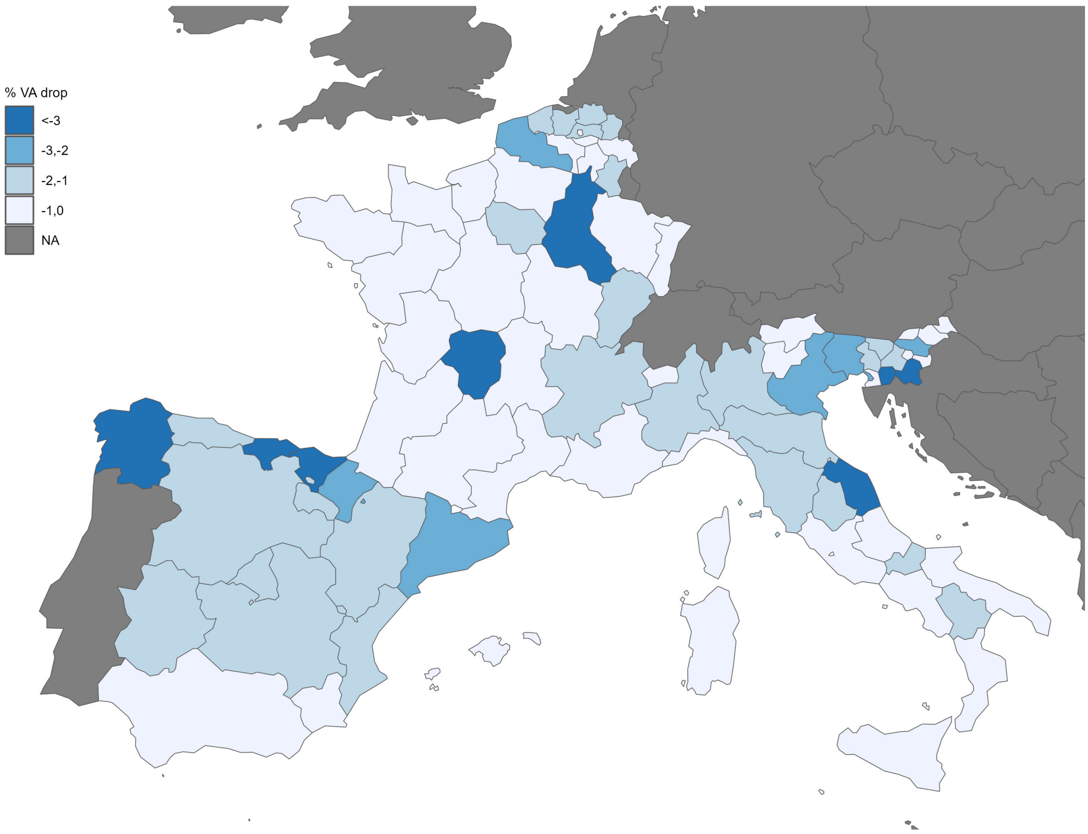
Notes: The restricted list concentrates on inputs which are advanced technology products, products key for the green transition, and highly concentrated raw materials at the global level. Country average is a simple average; results are very similar with a weighted average.

Figure A13: Decomposition of Value-added Change (in %) by Exposed Firm Size



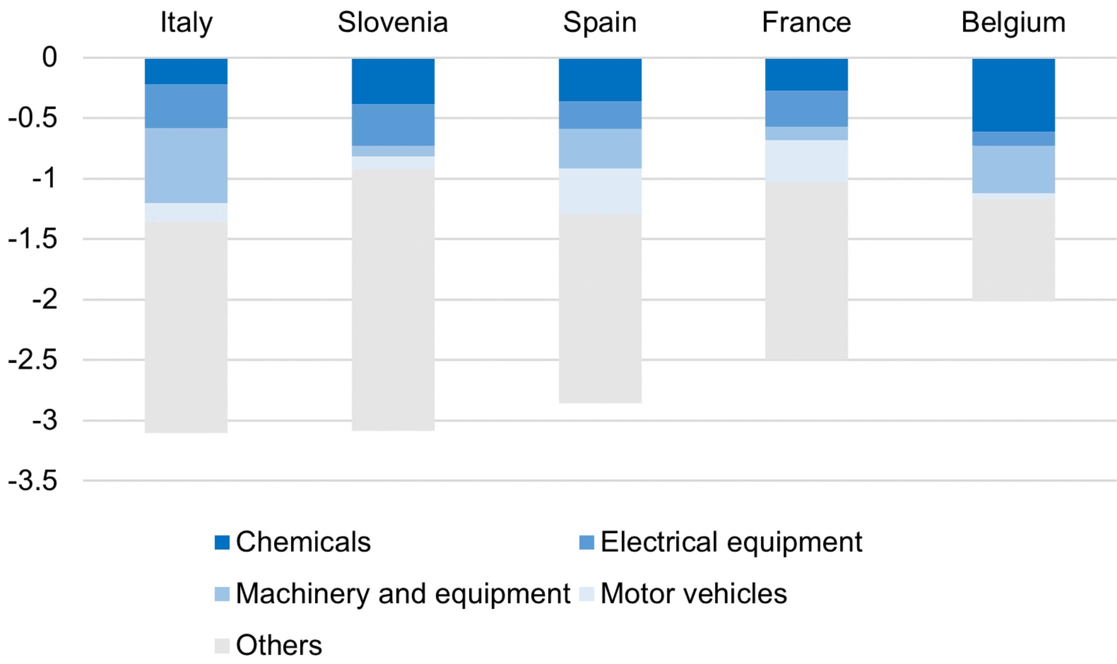
Notes: Firm size is measured with the number of employees, full-time equivalent. Only manufacturing firms importing critical inputs from China-aligned countries are considered.

Figure A14: Aggregate Value-added Change (in %) across Regions for the Whole Economy



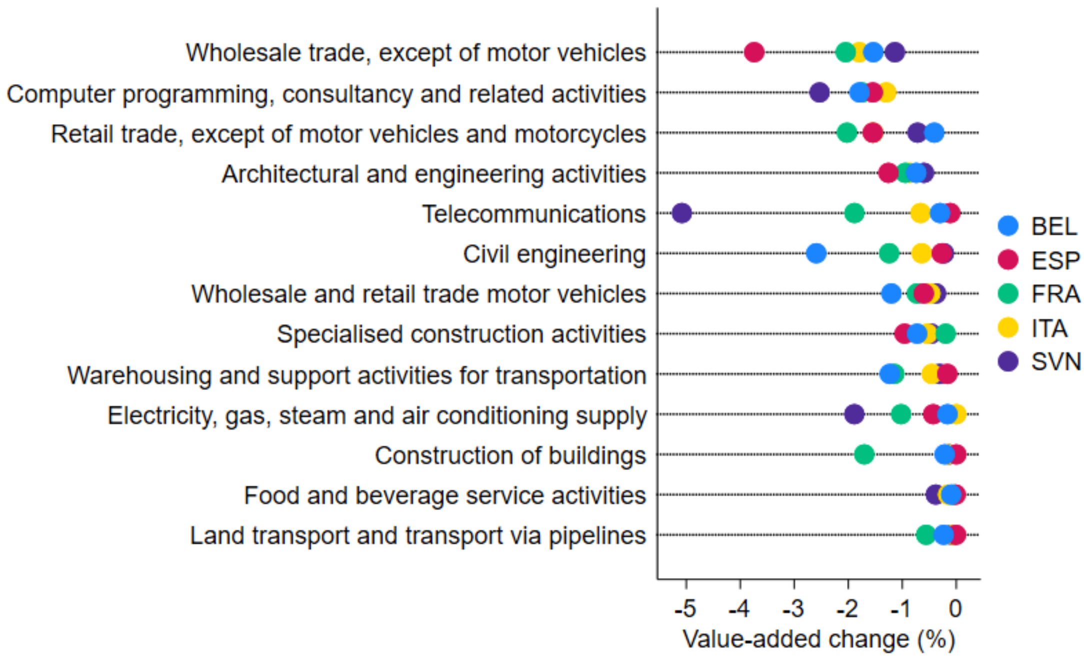
Notes: The figure reports the value-added change (in %) across regions coming from a 50% drop in FCI supply from China-aligned countries ($\sigma = 0$).

Figure A15: 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 A16: 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	1	1	3	19	50	110	2,831
	Non-FCIs for each firm	28	1	1	6	80	228	612	4,790
	source countries, FCI × firm	2	1	1	1	3	8	42	20,724
	source countries, Non-FCIs × firm	2	1	1	1	3	8	66	133,422
France	FCIs for each firm	8	1	1	3	18	67	241	8,478
	Non-FCIs for each firm	32	1	2	12	77	310	1075	12,861
	source countries, FCI × firm	2	1	1	1	3	11	63	64,494
	source countries, Non-FCIs × firm	2	1	1	1	3	10	56	410,549
Italy	FCIs for each firm	4	1	1	2	10	32	154	15,556
	Non-FCIs for each firm	12	1	1	3	32	113	610	31,037
	source countries, FCI × firm	1	1	1	1	2	7	60	66,132
	source countries, Non-FCIs × firm	1	1	1	1	2	7	47	367,210
Slovenia	FCIs for each firm	6	1	1	3	15	38	131	3,644
	Non-FCIs for each firm	31	1	1	21	68	181	661	5,153
	source countries, FCI × firm	1	1	1	1	2	7	35	22,391
	source countries, Non-FCIs × firm	1	1	1	1	2	6	36	157,756
Spain	FCIs for each firm	4	1	1	2	8	25	89	4,056
	Non-FCIs for each firm	14	1	1	8	32	87	572	6,656
	source countries, FCI × firm	2	1	1	1	3	8	30	15,280
	source countries, Non-FCIs × firm	2	1	1	1	3	8	39	92,206
All	FCIs for each firm	6	1	1	3	14	42	145	6,913
	Non-FCIs for each firm	23	1	1	10	58	184	706	12,099
	source countries, FCI × firm	2	1	1	1	3	8	46	37,804
	source countries, Non-FCIs × firm	2	1	1	1	3	8	49	232,229

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 BFISS 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	1	1	2	13	46	291	16,556
	Non-FCIs for each firm	16	1	1	2	38	210	2307	38,045
	source countries, FCI × firm	2	1	1	1	3	9	70	84,907
	source countries, Non-FCIs × firm	2	1	1	1	3	9	155	601,000
France	FCIs for each firm	6	1	1	3	14	51	243	35,169
	Non-FCIs for each firm	24	1	1	8	58	250	2130	67,004
	source countries, FCI × firm	2	1	1	1	3	9	63	215,932
	source countries, Non-FCIs × firm	2	1	1	1	3	8	81	1,622,609
Italy	FCIs for each firm	4	1	1	2	10	34	221	33,845
	Non-FCIs for each firm	12	1	1	3	30	147	2101	74,476
	source countries, FCI × firm	1	1	1	1	2	7	60	140,559
	source countries, Non-FCIs × firm	1	1	1	1	2	7	47	897,737
Slovenia	FCIs for each firm	5	1	1	3	12	29	289	24,664
	Non-FCIs for each firm	22	1	1	8	56	145	2547	43,303
	source countries, FCI × firm	1	1	1	1	2	5	37	129,892
	source countries, Non-FCIs × firm	1	1	1	1	2	5	50	940,061
Spain	FCIs for each firm	3	1	1	1	6	21	137	27,172
	Non-FCIs for each firm	6	1	1	2	14	60	1091	80,258
	source countries, FCI × firm	1	1	1	1	2	7	42	76,055
	source countries, Non-FCIs × firm	1	1	1	1	2	7	39	487,535
All	FCIs for each firm	5	1	1	2	11	36	236	27,481
	Non-FCIs for each firm	16	1	1	5	39	162	2035	60,617
	source countries, FCI × firm	1	1	1	1	2	7	54	129,469
	source countries, Non-FCIs × firm	1	1	1	1	2	7	74	909,788

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	11,997
	FCIs from low-risk countries, share of firm's total purchases	5.9	0.0	0.5	17.1	14.5	9,272
	FCIs from high-risk countries, share of firm's total purchases	3.8	0.0	0.3	9.3	11.0	5,218
France	FCIs, share of firms' total purchases	8.4	0.0	1.0	27.0	17.5	29,400
	FCIs from low-risk countries, share of firm's total purchases	7.3	0.0	0.8	22.5	16.5	24,820
	FCIs from high-risk countries, share of firm's total purchases	5.4	0.0	0.5	15.8	13.7	12,406
Italy	FCIs, share of firms' total purchases	6.7	0.0	1.0	19.8	14.4	28,759
	FCIs from low-risk countries, share of firm's total purchases	5.8	0.0	0.6	16.5	13.8	22,113
	FCIs from high-risk countries, share of firm's total purchases	4.9	0.0	0.9	13.5	11.0	12,811
Slovenia	FCIs, share of firms' total purchases	6.6	0.0	1.2	17.9	14.5	16,277
	FCIs from low-risk countries, share of firm's total purchases	6.0	0.0	1.1	16.2	13.6	15,894
	FCIs from high-risk countries, share of firm's total purchases	4.9	0.0	0.5	12.6	12.5	2,279
Spain	FCIs, share of firms' total purchases	12.5	0.1	2.4	40.8	22.8	8,605
	FCIs from low-risk countries, share of firm's total purchases	11.3	0.1	1.8	36.0	21.8	7,564
	FCIs from high-risk countries, share of firm's total purchases	7.3	0.1	1.3	19.7	16.4	3,447
All	FCIs, share of firms' total purchases	8.1	0.0	1.2	24.7	16.8	19,008
	FCIs from low-risk countries, share of firm's total purchases	7.3	0.0	1.0	21.7	16.0	15,933
	FCIs from high-risk countries, share of firm's total purchases	5.3	0.0	0.7	14.2	12.9	7,232

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, the sample corresponds to the importers 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 Labour Prod.	log Employment	log Turnover	log Wages	log Labour 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.	138,618	138,618	138,618	138,618	19,353	19,353	19,353	19,353
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. All countries but Spain use the population of importing firms; in the case of Spain, the sample corresponds to the importers 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. Standard errors clustered at the firm level. * significant at 10%, ** significant at 5%, *** significant at 1%.