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Beefing Up the Service Sector: Commodity Export Booms and Production Network Spillovers*

Francesco Amodio† Giorgio Chiovelli‡ Serafín Frache§

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Abstract

We show that commodity export booms can propagate up the value chain, reshape production networks, and drive growth and transformation in the service sector. We study Uruguay's beef export boom to China in the 2010s, combining customs, firm-to-firm transactions, employer-employee, and balance sheet data. Domestic suppliers to beef exporters that expanded trade with China recorded higher sales, especially in services, with associated gains in employment, wages, and sales per worker, along with increased imports of high-quality products. Aggregate sales in the economy rose by 1.79%, with each export dollar generating 46 more cents in domestic sales, including 10 cents in services. Over time, service firms reoriented their connections toward beef exporters, amplifying their gains from trade.

Keywords: commodity exports, production network, services, China shock.

JEL Codes: F14, L14, O14, O54.

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1 Introduction

China's emergence as a manufacturing superpower has reshaped global trade. A large body of research has documented the adverse effects of Chinese import competition on manufacturing employment in high-income countries (Autor, Dorn and Hanson, 2013; Pierce and Schott, 2016; Caliendo, Dvorkin and Parro, 2019). Far less is known about how China's industrial boom and rising incomes have driven a surge in demand for raw materials and food, creating new export opportunities for low- and middle-income countries, from cobalt in the Democratic Republic of the Congo to soy and beef across Latin America and beyond.[1]

Commodity exports are often portrayed as low value-added activities with limited spillovers and high exposure to terms-of-trade shocks. These concerns loom large in developing countries, where opportunities for manufacturing-led growth are shrinking (Rodrik, 2016). However, this view overlooks that commodity exporters now sit at the end of complex supply chains and rely on a wide range of inputs. As commodities have become increasingly service-intensive, drawing on logistics, ICT, finance, and other professional activities, their expansion can stimulate economic activity well beyond the primary sector (UNCTAD, 2021; Miroudot and Cadestin, 2017; Bonadio et al., 2025*a*). The key question is whether, and how, external commodity demand shocks translate into broader domestic gains, a question central to reassessing the developmental role of commodity trade.

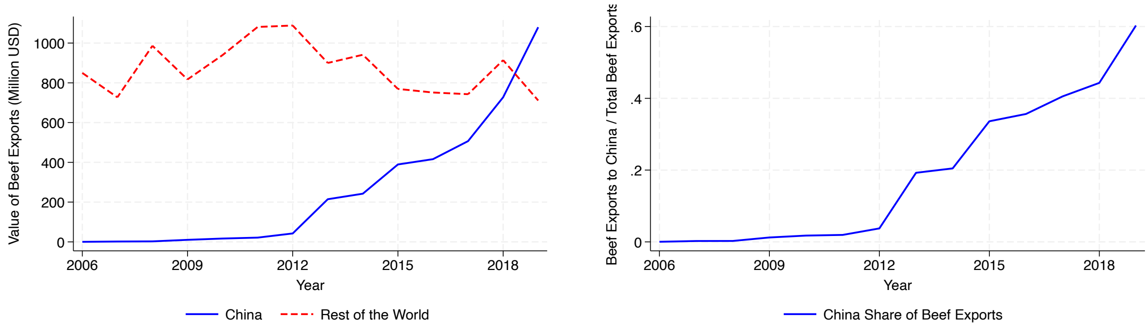
This paper addresses this question by exploiting the surge in Uruguay's beef exports to China during the 2010s as a sharp external shock. As shown in Figure 1, exports expanded dramatically, rising from negligible levels in the early 2000s to more than USD 1 billion by 2019, equivalent to 1.7 percent of Uruguay's GDP. This pattern was not unique to Uruguay but mirrored across Latin America and beyond, underscoring that the boom was fundamentally driven by demand conditions in China.[2] We integrate customs data with administrative tax records on domestic transactions, matched employer–employee data, and firm balance sheets. Using detailed firm-to-firm sales records, we identify companies across all sectors that are linked—both directly and indirectly—to beef exporters. We compare outcomes within and across firms with strong versus weak ties to beef exporters, leveraging variation in how much the latter expanded trade with China over time. We also quantify the aggregate effects of the export boom on the domestic economy and the role of changing firm linkages in propagating

[1] Panel (a) of Appendix Figure A.1 shows, for selected countries, changes in China's export and import shares between 2000 (the year before its WTO accession) and 2017 (the onset of the US–China trade war). Exports to China rose by about 20 pp in Uruguay, Brazil, Peru, and Chile, and by roughly 40 pp in the Democratic Republic of the Congo, compared with a 17 pp rise in imports. In the United States, Chinese imports grew by 13 pp and exports by less than 5 pp. Other high-income countries saw smaller, more balanced shifts—around 5 pp in both directions. Panel (b) of Appendix Figure A.1 generalizes these patterns by income group, showing that lower-income economies generally experienced larger export than import increases. Furthermore, Appendix Figure A.2 documents that these gains were concentrated in a few commodity sectors whereas high-income countries saw more diffuse changes in imports across manufacturing sectors.

[2] See Section 2.1.1 and Online Appendix Figure A.4 for a discussion of similar export dynamics operating simultaneously in major beef-exporting countries.

Figure 1: Uruguay Exports of Beef

(a) Value (b) China Share



Notes. The left panel shows the value of beef exports over time and separately towards China and the rest of the world. The right panel shows beef exports to China as a share of all beef exports over the same period.

these effects.

Beyond the specifics of China's rise and Uruguay's beef exports, our analysis speaks to the broader debate on globalization and its challenges. The resurgence of economic nationalism has revived concerns about the resilience of global supply chains, the unequal distribution of globalization's gains, and the strategic use of trade relationships for geopolitical and economic ends (Goldberg and Reed, 2023; Clayton, Maggiori and Schreger, 2025; Bonadio et al., 2025*b*; Khandelwal, 2025). We investigate whether even small economies experience ripple effects from commodity booms through domestic production networks, and in which sectors. Understanding these mechanisms is essential for assessing the developmental impact of globalization on lower-income countries worldwide.

Results Preview We provide four sets of results. First, we present reduced-form evidence showing sizable indirect benefits of the China beef export shock for domestic suppliers to beef exporters. To achieve identification, we adopt a shift-share design that combines variation across firms in their baseline linkages to beef exporters with time variation in exporters' sales to China. We find that firms more exposed to the surge in exports recorded significantly higher sales than less exposed firms. A one-standard-deviation increase in exposure to the China beef boom raised a supplier firm's total sales by roughly 8% on average. These gains were especially pronounced for smaller firms, and close to zero and statistically insignificant for the largest firms. To support the validity of our empirical strategy, we conduct several placebo tests and robustness checks. First, using balance-sheet data available for an earlier period for a subset of firms, we find no evidence of differential pre-trends in sales among firms more exposed to the subsequent China shock. Second, we obtain estimates similar to the baseline when constructing the exposure measure using the growth of Brazilian beef exports to China, consistent with the boom being driven by common demand shocks originating in China rather than by factors specific to Uruguay.

Next, we explore heterogeneity across sectors and find that the China beef export shock had particularly strong effects on service-sector suppliers. A one-standard-deviation increase in exposure raised sales by around 14% for service firms, more than double the effect estimated for agricultural suppliers. More exposed service firms also expanded employment and raised wages: employment and average wages both increased by around 3% relative to less-exposed firms. Leveraging matched employer–employee data, we show that these employment gains reflect both higher retention of incumbent workers and increased hiring of new employees. Combined with the sales results, this implies meaningful improvements in labor productivity measured by sales per worker, which increased by nearly 7%. We also show that more exposed service suppliers significantly increased their imports of high-quality products, defined as products whose unit prices belong to the top quartile of the HS6 product code-year price distribution. The fact that it occurs alongside sizable gains in sales per worker and wages is suggestive of firm-level upgrading among service suppliers connected to the expanding export sector.

Third, we document how the positive effects of the China beef export shock propagated farther through the domestic production network and triggered broader structural adjustments. The positive effects on services were not confined to immediate suppliers of the beef exporters. We document that service providers supplying first-tier suppliers also experienced indirect boosts in sales, indicating that the shock propagated further up the value chain and amplified economic activity in the broader service sector. At the sector level, industries with greater exposure to the beef trade shock saw rising total sales and input purchases overall, but also a decline in the number of active firms, consistent with a degree of consolidation. Moreover, firms with stronger pre-existing ties to beef exporters were significantly less likely to exit the market during this period. This evidence of reallocation towards more connected firms and increased concentration of activity around the booming export sector highlights how a commodity trade shock can reconfigure domestic network structure in response to new opportunities.

Finally, we account for these structural changes in measuring the aggregate effects of the China beef export shock on the Uruguayan economy. Using a standard production network framework (Acemoglu et al., 2012) as an accounting device, we estimate that rising beef exports to China increased aggregate firm sales by 1.79% annually, with roughly one-third of these gains arising through inter-firm linkages. Consistent with the reduced-form evidence, services were a major beneficiary: each dollar of beef exports generated 46 cents in additional domestic sales, including about 10 cents in services. Production network adjustments were critical for these gains. Holding the network fixed at its 2014 structure implies that, absent exports to China, aggregate service-sector sales would have been higher than observed, indicating an opportunity cost from changing relationships between firms.[3] Yet these costs were more than offset by the gains from adaptation: service firms reoriented their linkages toward the expanding export sector and reaped sizable gains as a result. By contrast, agriculture ben-

[3]Our approach is similar to Makarin and Korovkin (2021), who study the impact of the 2014 Russia-Ukraine conflict on the Ukrainian railway shipment and production network.

efited mainly through pre-existing linkages. Overall, network restructuring was essential for firms to benefit from the China beef export boom, thereby transforming a commodity windfall into a service-led development impulse.

Related Literature and Contributions The key contribution of this paper is to show that rising commodity exports to China affect emerging economies beyond the directly impacted sectors, with particularly strong effects in services. This suggests that growing commodity exports are not necessarily detrimental to structural transformation. These findings speak to the literature on premature deindustrialization (Rodrik, 2016), the role of globalization in development (Goldberg and Reed, 2023), and the expansion of production services as a development pathway (Fan, Peters and Zilibotti, 2023; Rodrik and Sandhu, 2024; Peters, Zhang and Zilibotti, 2026; Gollin et al., 2026).

Our evidence on service-sector suppliers points to a mechanism through which commodity export booms can foster the expansion and transformation of service providers. A large body of work studies how access to international markets induces manufacturing firms in developing countries to upgrade product quality, adopt better technologies, and improve the quality of the inputs and workers they employ (Verhoogen, 2023). Existing evidence, however, has focused primarily on manufacturing firms directly engaged in export markets (Verhoogen, 2008; Atkin, Khandelwal and Osman, 2017). We contribute to this literature by documenting how service-sector firms that are not themselves exporters, but are linked through domestic production networks to commodity exporters, experience sizable gains in sales per worker and wages. More exposed service suppliers also increase their imports of high-quality products, consistent with a greater use of sophisticated imported inputs as production expands. Together, these findings suggest that commodity export booms can stimulate growth and upgrading among domestic service providers connected to the export sector.

We also contribute to the literature studying how idiosyncratic shocks propagate and get amplified through the production network (Acemoglu et al., 2012; Boehm, Flaaen and Pandalai-Nayar, 2019; Couttenier, Monnet and Piemontese, 2022; Khanna, Morales and Pandalai-Nayar, 2022; Fujiy, Ghose and Khanna, 2024; Makarin and Korovkin, 2021; Korovkin, Makarin and Miyauchi, 2024) and, in particular, to works focusing on international trade shocks (Carvalho et al., 2021; Dhyne et al., 2022). Using plant-level data from Chile, Linarello (2018) shows that trade liberalization in downstream industries increases the productivity of intermediate input suppliers. Huneeus (2020) uses Chilean firm-to-firm transaction data and a dynamic general equilibrium model to evaluate how international trade shocks during the Great Recession propagated in Chile. Alfaro-Ureña, Manelici and Vasquez (2022) use similar data from Costa Rica to study the effects of becoming a supplier to multinational corporations (MNCs).[4] Alfaro-Ureña, Manelici and Vasquez (2021) also brings in employer-employee matched data to estimate the

[4] Using a subset of our data for Uruguay, Carballo, Marra de Artiñano and Volpe Martincus (2019) show that suppliers to multinationals are also more likely to export.

effects of MNCs on workers. Our contribution is to combine customs data with rich administrative firm-to-firm, balance sheet, and labor data to identify the indirect effects of a commodity export boom and quantify its aggregate consequences through a production-network lens. A key insight is that tracking how linkages evolve over time is essential: a counterfactual that holds the network fixed at its initial configuration implies negative effects outside agriculture, which are overturned once network adjustments are taken into account.

Our paper also relates to the literature on the *China shock*. Most of the existing literature emphasizes the adverse effects of rising import competition on manufacturing employment in the US (Autor, Dorn and Hanson, 2013; Autor et al., 2014; Pierce and Schott, 2016; Acemoglu et al., 2016) and, more recently, in Europe (Dorn and Levell, 2021) and emerging markets such as Brazil and Peru (Costa, Garred and Pessoa, 2016; Medina, 2024). Far less is known about the export side of China's rise. The limited evidence suggests potentially positive impacts: Costa, Garred and Pessoa (2016) find faster wage growth in Brazilian regions benefiting from Chinese demand, and Hansen and Wingender (2023) show that cropland expanded globally to supply China, though with muted wage effects in the US. We advance this literature by examining Uruguay's beef export boom and tracing how a commodity-driven trade surge propagates across sectors through domestic production networks, with services playing a central role.

Structure The remainder of the paper is organized as follows. Section 2 provides a brief overview of the Uruguayan economy, its trade profile, the beef sector, and its tax system. Section 3 presents the data sources and their descriptives. Section 4 outlines the reduced-form empirical strategy and presents the main results. Section 5 focuses on aggregate quantifications and counterfactual analyses. Finally, Section 6 concludes.

2 Background

Although much smaller in size than neighboring Argentina and Brazil, Uruguay has a higher GDP per capita, measured at USD 17,000 in 2021. Its population is 3.4 million, half of it living in the capital, Montevideo. Uruguay is a highly open economy. The value of exports of goods and services as a percentage of GDP was 30% in 2021 and 24% for imports.[5] Online Appendix Figure A.3 shows the composition of exports by destination (top) and by category (bottom) and how it changed between 2000 and 2019. While China accounted for just 3.4% of Uruguay's total exports in 2000, it has since become the country's largest export destination, now representing nearly 30% of total exports. This happened while the share of exports going to Brazil and Argentina decreased substantially, from 24 to 13% and from 17 to 4%, respectively.

The sectoral composition of Uruguay's exports has also changed significantly over time. The rise of ICT services exports is noticeable, increasing from 2.5% of total exports in 2000

[5] World Bank World Development Indicators (WDI), https://datacatalog.worldbank.org/search/dataset/0037712, accessed on July 19, 2024.

to 16% in 2019, making Uruguay the second-largest exporter of software per capita in Latin America. This growth is attributable to a combination of factors, including strong government support, tax exemptions for software exports, and the designation of ICT as a sector of national interest.

Exports of beef and soy have also undergone important changes. Beef exports, particularly frozen beef, increased from 8% of total exports in 2000 to nearly 12% in 2019, with the growth almost entirely driven by rising demand from China, as shown in Figure 1. Online Appendix Figure A.5 shows that soy exports also grew substantially but peaked a few years before 2019 and then declined.[6] Meanwhile, pulp exports to China have followed a steady upward trend, driven exclusively by Finnish company UPM, which operates two eucalyptus pulp mills in Uruguay. These trends may raise questions about the presence of Dutch Disease, a phenomenon where a surge in resource-based exports leads to real exchange rate appreciation, undermining the competitiveness of non-resource tradable sectors, potentially causing deindustrialization. The overall evidence for Uruguay is mixed. While indicators such as real exchange rate appreciation suggest potential vulnerabilities, these trends have not significantly impacted the industrial sector's contribution to GDP (Aboal, Lanzilotta and Rego, 2012).

2.1 Beef Industry

According to the National Meat Institute (*Instituto Nacional de Carnes*, INAC), the Uruguayan beef industry directly employs nearly 90,000 people and generates a direct economic impact of over USD 3.5 billion annually, considering both exports and domestic consumption. It also contributes nearly USD 700 million in taxes annually. The number of cattle is estimated at 12 million, about four times the country's population. Uruguay is consistently among the top 10 beef exporters in the world and the world's top per capita meat exporter, with 134 kg per capita exported in 2023 (INAC, 2024).

Uruguayan beef typically commands higher export prices than its competitors.[7] A key determinant of this price premium is Uruguay's fully computerized and mandatory traceability system, which tracks both cattle and beef products. This system, unique in the world, ensures high food safety standards, boosting Uruguay's reputation as a premium supplier.

The beef sector can be visualized as a value chain that begins in the primary phase of livestock production (which also includes different stages of production and transformation), followed by industrial processing carried out by slaughterhouses, and culminating in marketing, both domestically and through exports. The Uruguayan beef value chain exhibits the "bottleneck" structure typical of commodity sectors: a large number of producers or suppliers at the

[6] Between the 2000 and 2010 agricultural censuses, livestock areas shrank due to competition from soybean cultivation, particularly in high-productivity regions. This shift likely intensified livestock production, with greater reliance on grain-fed diets and feedlots, allowing for sustained output despite shrinking pastures.

[7] In the five years from 2018 to 2022, its export prices were 34% higher than Brazil's and 18% higher than both Argentina's and Paraguay's. Australia and the United States compete in the high-value market with grain-fed beef, Brazil is the main exporter of grass-fed beef, while India exports lower-value meat, mainly buffalo meat.

initial stages, and a narrow point of concentration at the end, where a few companies dominate processing and retail. Indeed, the 2011 agricultural census recorded 36,696 establishments with cattle stocks, occupying 14.8 million hectares and engaging in breeding, rearing, or wintering.[8] This stands in sharp contrast to the small number of slaughterhouses, with just 17 establishments accounting for 92% of processed beef volume in 2022. Beyond this sector-specific structure, it is important to note that these slaughterhouses and exporters are also the end point of much broader domestic value chains, sourcing a wide array of goods and services—ranging from transportation to professional services and ICT—from numerous firms across the economy. Available estimates indicate that services inputs account for approximately 12% of the value-added in agricultural (soft commodity) exports from developing countries (UNCTAD, 2021), consistent with broader evidence of rising *servicification* in both manufacturing and commodity exports (Miroudot and Cadestin, 2017; Bonadio et al., 2025*a*).

2.1.1 Beef Exports to China

In the 2000s, China imposed bans on beef imports from several countries due to concerns over bovine spongiform encephalopathy (BSE), commonly known as "mad cow disease." In the following years, Uruguay strengthened its animal health standards and traceability systems, particularly after 2006, when traceability became mandatory, and 2010, when it was extended to include cattle. These efforts secured access to China's beef market, but exports only took off in 2013, when Uruguay's beef exports to China surged by 455% in volume and 522% in value compared to the previous year.[9] By 2019, China had established itself as Uruguay's top beef export market, accounting for USD 1.13 billion and 60% of total beef exports, as shown in Figure 1.

The specific composition of beef cuts exported to China allowed Uruguayan exporters to scale production rapidly. Unlike the European Union or the United States, which primarily demand specific premium steaks or manufacturing beef for grinding, China imports a wide array of industrial cuts, trimmings, and offal that have limited demand in Western markets but are highly valued in Chinese cuisine for use in hot pots and stews. Because China absorbs a more diverse range of the carcass, Uruguayan slaughterhouses were able to leverage approximately 35-45% of idle capacity that existed in the early 2010s (INAC, 2024).[10]

Uruguay's beef export boom was part of a broader, China-driven surge in Latin American beef exports, fueled by rising demand from China's growing middle class. Between 2014 and 2023, the region's exports to China quintupled, accounting for over 75% of its beef imports (Ray, Albright and Dussel Peters, 2024). The trend accelerated after 2018, when China imposed

[8]In beef production, breeding involves selecting and mating cattle to improve traits like growth and meat quality, rearing refers to raising calves to a target age or weight, and wintering ensures cattle health during cold months by providing shelter and supplemental feed when grazing is limited.

[9]MercoPress, https://en.mercopress.com/2013/09/19/china-has-become-uruguay-s-main-market-for-beef-taking-25-of-exports, accessed on November 28, 2024.

[10]See Section 3.4 and Online Appendix Figure A.9 for our own validation of these figures.

tariffs on U.S. agriculture and faced a meat supply shock from African swine fever, further boosting demand for Latin American beef.

Online Appendix Figure A.4 contextualizes Uruguay's experience by plotting the value of beef exports to China over time across several major beef-exporting countries. While Brazil, Argentina, and Australia exhibit higher absolute export values, their economies are significantly larger than Uruguay's. Indeed, when considering beef exports to China as a share of total exports (panel c) and share of GDP (panel d), Uruguay stands out. In 2019, beef exports to China accounted for 1.7% of Uruguay's GDP, far surpassing the figures for other countries, which remained well below 0.5%.

After 2020, the dynamics partially shifted. China lifted restrictions on other beef suppliers, slowed its meat imports due to economic deceleration, and diversified its supply chains. In response, Uruguay, alongside other Latin American countries, began expanding into new markets, particularly North America. By August 2024, the US, Canada, and Mexico collectively accounted for 32% of Uruguay's total beef export revenue, generating USD 390.8 million from 97,375 tonnes, according to INAC. In comparison, China's share dropped to 30%, with USD 371.5 million from 115,324 tonnes.[11]

3 Data

In this section, we introduce the data we use in the analysis. All the data except customs belong to the Uruguayan tax authority (*Dirección General Impositiva*, DGI). All information was anonymized by the DGI and the data merged and processed at their facility.

3.1 Sources

Firm Registry The first source of information is the firm registry, which is a list of all firms that are legally registered in the country. From the registry, we keep the (anonymized) tax ID of the firm as well as the 5-digit sector it belongs to.

Firm-To-Firm Transaction Records The bulk of our analysis relies on data from domestic transactions between Uruguayan firms, which we gather from two main sources. The first pertains to the filing of VAT (*Impuesto al Valor Agregado*, IVA), which requires firms to declare all transactions covering at least 90% of the value of their sales and purchases, along with the identity of their trading counterpart.[12] This mandate applies to companies that belong to the

[11] Valor Agro, https://www.valoragro.com.py/ganaderia/carne-vacuna-en-la-busqueda-de-una-menor-dependencia-de-china-uruguay-sale-adelante/, accessed on November 28, 2024.

[12] Compared to the richest countries, lower-income economies typically rely more heavily on indirect taxation, particularly value-added taxes VAT (Bachas, Jensen and Gadenne, 2024). Until recently, this was also the case in Uruguay, where VAT remains the dominant source of tax revenue, accounting for approximately 50% of total tax collection, excluding social security contributions.

group of *Grandes Contribuyentes and CEDE*, meaning large taxpayers and companies subject to enhanced monitoring on behalf of the tax authority, and thus facing stricter reporting procedures. The second source of transaction-level data comes from the filing of the Farming Goods Sale Tax (*Impuesto a la Enajenación de Bienes Agropecuarios*, IMEBA), which is akin to VAT but applies to transactions of agricultural goods, including livestock. These two data sources together detail the universe of all domestic transactions involving medium and large firms, thus also including those between smaller firms and medium and large ones. The electronic filing of VAT and IMEBA was implemented progressively over time. The requirement to declare at least 90% of transaction values was established by the tax authority through Resolution No. 941/013, issued on March 22, 2013, and enforced starting in July 2013. As a result, transaction-level data coverage became near universal and stable by 2014. Given this, and for the purpose of this analysis, we focus on the period from 2014 to 2019.

Income Tax Records To study the evolution of employment-related variables, we gather information on workers and wages from personal income tax (*Impuesto a la Renta de las Personas Físicas*, IRPF) filings. Using the corresponding forms submitted by employers, we construct an employer-employee matched dataset, which allows us to derive information on the number of employees and their compensation. Since IRPF was introduced in 2007, these data are available starting in 2008.[13]

Customs Records We complement these data with information on all international transactions—imports and exports—made by Uruguayan firms and individuals as recorded by customs. The data is publicly available and provides the tax ID of the company or individual. The DGI anonymized these tax IDs and merged them with the other data sources to make them available for analysis.

Corporate Tax Records To validate sales data and probe the robustness of our findings, we also use balance sheet information. This comes from the filing of corporate tax (*Impuesto a las Rentas de las Actividades Económicas*, IRAE), which is mandatory for all corporate firms and all firms with sales higher than a given threshold, equal to approximately USD 115,000. While focusing on larger firms only, the balance sheet data cover the universe of this subpopulation, and is available continuously since 2008.

3.2 Descriptives

Our transaction-level data provide a unique opportunity to map the domestic network of firm-to-firm linkages and track its evolution over time. Table 1 presents several summary statistics.

[13] A progressive personal income tax was introduced as part of a broader tax reform aimed at increasing the role of direct taxation. Revenues from IRPF currently represent 12.5% of total tax revenue, making it the second most important source of revenue after VAT (Bergolo et al., 2021).

Table 1: Firm Linkages

	All Transactions	Sales to Beef Sector
# of Dyads	13,871,164	109,664
# of Sellers	247,963	36,505
# of Sellers' 4d Sectors	413	347
# of Buyers	879,106	94
# of Buyer's 4d Sectors	419	1
# of Buyers per Seller (p50)	2,252	5
# of Sellers per Buyer (p50)	142	4,743

Notes. The table reports some summary statistics on the network of firm-to-firm linkages that we trace from administrative transaction-level data.

Across all years from 2014 to 2019, we observe approximately 14 million distinct supplier-buyer relationships, comprising around 250,000 unique sellers and 900,000 unique buyers, spanning 413 and 419 different 4-digit sectors, respectively. The median seller transacts with over 2,000 buyers, while the median buyer sources from 142 sellers. This suggests that, at the aggregate level, the firm network is more concentrated upstream than downstream, with a relatively small number of suppliers serving a much larger pool of buyers.

The second column of Table 1 focuses on transactions where the buyer is a firm in the beef sector (ISIC4 1010 – Processing and Preserving of Meat). Over the six years of data, we identify 94 distinct buyers in the beef sector, each sourcing from a large number of suppliers, with a median of just under 5,000. In total, we count about 110,000 unique buyer-supplier relationships, involving 36,505 different sellers. However, in contrast to the overall economy, where supplier concentration is higher, firms selling to the beef sector serve a median of only five distinct buyers. This highlights a key structural difference: while the broader economy exhibits greater concentration upstream, the beef sector is more concentrated downstream, a pattern that aligns with the background evidence in Section 2.1.

Online Appendix Table A.1 provides other statistics on domestic sales to the beef sector. The average number of suppliers across buyers and years is 530, spread across 65 different 4-digit sectors. The purchases of beef sector buyers are on average concentrated, yet this varies substantially across buyer-years (average HHI equal to 0.34 with a standard deviation of 0.42). Across buyers and years, the average number of suppliers in the agricultural sector is 490. Purchases from this sector are less concentrated than those from other sectors, where the average number of suppliers per buyer-year is much smaller, down to 39 for suppliers in transportation and six for suppliers in ICT services. Yet, the total purchases from these sectors are still sizeable, almost comparable to those from the agricultural sector.

3.3 Total Sales and Validation

For each firm in the data, we aggregate up all domestic sales from transaction-level data as well as external sales from customs data to derive total sales in each year from 2014 to 2019. For the subset of large firms, we can validate this information using the balance sheet data.

Online Appendix Figure A.6 shows that, on average and for sales exceeding a given threshold, the total sales value derived from transaction-level and customs data aligns closely with the figures reported in corporate tax data. Online Appendix Table A.2 confirms this finding by showing the coefficient estimate that we obtain from a simple regression of the (log) sales from corporate tax data over the (log) sales from domestic transactions and customs data, implemented separately for the years 2014 and 2019. The coefficient estimate is precise, and while we reject the null hypothesis that it equals one, we cannot reject that it is equal to 0.9. This finding is consistent with the VAT reporting mandate, which requires firms to declare at least 90% of their sales and purchases for tax purposes, as discussed earlier. For employment-related outcomes, we perform a similar validation exercise by comparing the total wage bill obtained from personal income tax data with the one recorded in balance sheet data, showing very similar results.[14]

3.4 Sources of Variation

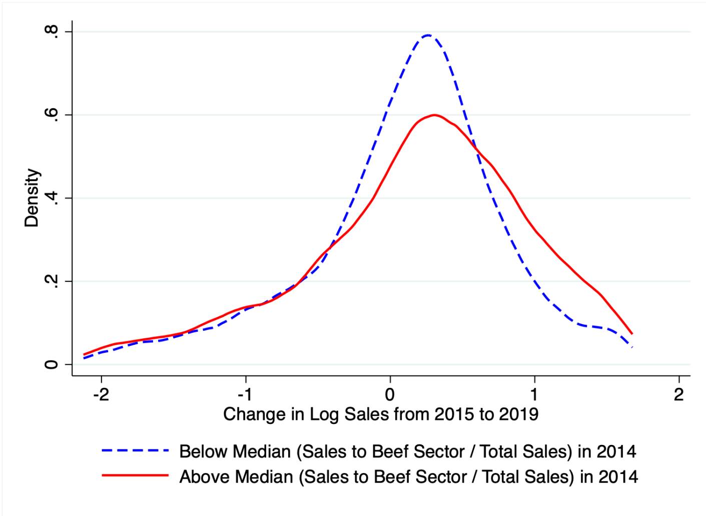
In the first part of the analysis, we achieve identification by leveraging variation across firms in their linkages to beef exporters and the broader beef sector, combined with time variation in exports to China across beef exporters. We measure firm linkages to the beef sector in 2014, the year when VAT data coverage stabilized. For each firm in the data, we take the ratio between sales to the beef sector and overall sales (including direct exports). Panel a and b of Online Appendix Figure A.7 shows the overall variation in this beef sector linkage measure across and within 4-digit sectors, showing substantial variation across firms.

Tighter links to the beef sector in 2014 predict higher sales growth over the period 2015 to 2019. Figure 2 provides graphical evidence of this by plotting the distribution of sales growth separately for firms with beef sector linkages above and below the median at baseline. The distribution of sales growth for firms with tighter links with the beef sector is shifted towards the right, indicating higher average and median sales growth.

Next, we measure the linkages of each supplier with specific beef exporters. We consider all firms in the beef sector exporting any amount at any point in time between 2015 and 2019 and calculate for each of their suppliers the ratio between sales to beef exporters and overall sales in the baseline year 2014. This means we have several observations per firm, each one corresponding to a different supplier-beef exporter relationship. Panel c of Figure A.7 shows

[14] When analyzing the impact on beef exporters' suppliers' sales, we will conduct a robustness exercise using sales information from corporate tax records and balance sheets to impute total sales for all firms, yielding results that closely align with the baseline estimates.

Figure 2: Linkages to the Beef Sector and Sales Growth



Notes. The figure plots the distribution of sales growth from 2015 to 2019 separately for firms with beef sector linkages above and below the median in the baseline year 2014.

that substantial variation exists within suppliers in their ties to different beef exporters.

In Online Appendix Figure A.8, we explore the variation among beef exporters in their exports to China, exports to the rest of the world, and domestic sales over the years 2009 to 2019. The left panel plots the change in the value of exports to China against the corresponding change in exports towards the rest of the world. The figure shows how different the changes were in the exporting profile of different beef exporters. Some of them substituted away from exports towards the rest of the world in order to increase exports to China. Some others increased exports to China by as much as 100 million Uruguayan pesos—more than 2 million USD—while keeping exports to the rest of the world essentially unchanged. Several beef exporters expanded along both dimensions. The right panel of Figure A.8 instead plots the change in the value of exports to China against the change in domestic sales, where domestic sales are computed by subtracting total exports from total sales reported in corporate tax records. Domestic sales seldom declined; by 2019, most beef exporters had increased their exports to China while maintaining domestic sales at least at their 2009 levels in value. Overall, evidence shows that there is substantial variation to exploit for identification, both in linkages to beef exporters among suppliers at baseline and in the extent to which these suppliers engaged with the surge of beef exports to China.

The expansion we observe in both domestic and foreign sales across different destination countries is at least partly attributable to the large idle capacity in the industry, estimated at 35-45% in the early 2010s (INAC, 2024). To benchmark these figures, we produced our own estimates. Using total monthly production time series data at the exporter level from 2005 to 2014, made publicly available by INAC, we calculated for each exporter the 99th and 95th percentiles of production over this period—which we take as proxies for full capacity—and then computed the average percentage difference across all months. Online Appendix Figure A.9

displays these results by exporter, with the overall averages highlighted on the y-axis—falling indeed between 35 and 45%, depending on whether we use the 99th or 95th percentile. The close alignment of our estimates with those disseminated by INAC is reassuring.

Finally, preliminary evidence suggests that firm linkages to beef exporters evolved over time. Online Appendix Figure A.10 plots the distribution of changes in the number of suppliers per beef exporter from 2014 to 2019. The distribution is largely skewed toward positive values, indicating that nearly all beef exporters expanded their supplier base and established new connections over this period. However, Online Appendix Figure A.11 reveals that this pattern varies across sectors. On average, beef exporters increased their number of suppliers in the agricultural sector, as well as among retailers, professional service providers, and firms classified under "other services." In contrast, in manufacturing, construction, and information and communication, the distribution of changes is centered around zero, suggesting that while some firms formed new ties, others reduced or discontinued relationships with most of their baseline suppliers. The data thus show that the production network changed during the boom in beef exports to China in a way that was not uniform across sectors. In Section 5, we will quantitatively assess the aggregate implications of these changes using a simple network-based accounting framework.

4 Reduced-Form Analysis

In this section, we estimate the reduced-form impact of rising beef exports to China on the production network. We focus on firms that supplied goods or services to beef exporters in 2014 and compare outcomes between those with strong versus weak ties over time, as beef exporters expanded trade with China. We provide evidence of effects on both first- and second-order links, as well as their heterogeneity across sectors.

4.1 Estimation Samples

Our analysis starts by focusing on all firms that sell any amount of good and services to any beef exporter in 2014. We follow these firms through time from 2015 to 2019. The resulting dataset of supplier-year observations (about 70,000) constitutes our first estimation sample. Table 2 shows the distribution of the 15,208 individual firms across sectors. The majority of them (9,594 firms) are in agriculture—which includes livestock, forestry, and fishing. Yet, 5,614 of them are outside this sector, and spread among retail (2,509), manufacturing (730), transportation (705), professional (mostly legal) services (624), among others. The services altogether account for about 30% of the sample.[15]

In a second step, we extend our analysis to second-order links, meaning firms that supply

[15]Online Appendix Table A.3 reports the summary statistics for the estimation sample of all the variables we use in the empirical analysis.

Table 2: Suppliers to Beef Exporters by Sector

	Observations	Frequency (%)
Agriculture, Forestry, and Fishing	9,594	63.09
Construction	161	1.06
Financial Services	26	0.17
Information and Communication	92	0.60
Manufacturing	730	4.80
Mining	13	0.09
Other Services	553	3.64
Professional Services	624	4.10
Real Estate Services	183	1.20
Retail	2,509	16.50
Transportation	705	4.64
Utilities	18	0.12
Total	15,208	100.00

Notes. The table shows the distribution of suppliers to beef exporters across sectors. We identify beef exporters as firms in the beef sector exporting any amount at any point in time between 2015 and 2019, and define our estimation sample by identifying the suppliers of these firms in 2014.

goods and services to the suppliers of beef exporters. We examine these firms primarily by analyzing the purchases made by first-order suppliers but also by directly studying the sample of second-order suppliers. This constitutes our second estimation sample, which includes 46,458 firms, as detailed in Online Appendix Table A.4. Interestingly, though not unexpectedly, firms in this sample are far less concentrated in the agricultural sector (3,589 firms). Instead, they are predominantly found in retail (16,355), professional services (6,606), manufacturing (5,858), and transportation (4,498).

4.2 Empirical Strategy

Our identification strategy combines variation across firms at baseline in their linkages to beef exporters with changes over time in these exporters' trade with China. For each firm i in our sample belonging to sector s, and for each year t, we compute

$$CBE_{ist} = \sum_{m} s_{im}\, x^{c}_{mt} \tag{1}$$

where s_{im} is share of sales of firm i to beef exporter m in the baseline year 2014 and thus fixed at the beginning of the data period, while x^{c}_{mt} is the value of exports to China of exporter m in year t. The CBE variable is a Bartik-type instrument that captures the extent to which suppliers to beef exporters are affected by the surge of exports to China over time. In the language of Borusyak, Hull and Jaravel (2025), x^{c}_{mt} are shifts that are common to all units (firms) while s_{im} are sets of exposure shares that vary across units.

Upon defining this variable, we implement the reduced-form regression specification

$$\ln Y_{ist} = \beta\, CBE_{ist} + \theta_i + \psi_{st} + u_{ist} \tag{2}$$

where Y_{ist} is the outcome of interest of firm i in sector s in year t, and CBE is the (indirect) China beef export shock defined as above. We include the full set of firm fixed effects θ_i as well as 4-digit sector $\times$ year fixed effects ψ_{st}, which allow for fully flexible differential trends across narrowly defined sectors. This means we compare firms over time within narrowly defined sectors. u_{ist} captures any residual determinants of the outcome of interest. We cluster the standard errors at the 4-digit sector level, thus allowing such residuals to be correlated among observations belonging to the same sector.

Our coefficient of interest is β, which captures the impact of the China beef export shock on the suppliers to beef exporters. Causal identification requires this variable to be as good as randomly assigned to firm-level outcomes, conditional on the included regressors. The identifying assumption is that absent the China beef shock, the evolution of firm-level outcomes would have been similar across firms with tighter vs. looser links at baseline with beef exporters that trade more with China over time.[16] This assumption is satisfied if the shifts x^c_{mt} are orthogonal to firm (supplier)-level outcomes. This is true even if the shares s_{im} are endogenous, in the sense that firms with strong vs. weak ties to beef exporters may have systematically different unobservables (Borusyak, Hull and Jaravel, 2025).

To strengthen identification, we augment the baseline regression specification with two sets of controls, designed to account for potential shift-level and unit-level confounders. First, we include firm-level control variables that account for direct export and import shocks, which could be correlated with both the residual u_{ist} and the China beef export shock CBE_{ist}. We compute

$$E_{ist} = s_{ie} X_{st} \qquad I_{ist} = s_{im} M_{st} \tag{3}$$

where s_{ie} and s_{im} are, respectively, the ratio between exports and total sales and the ratio between imports and total purchases in the baseline year 2014. X_{st} and M_{st} are the total exports and imports of sector s in year t.

Second, we control for the indirect effect of beef exports to the rest of the world, using the same exposure shares as in the construction of the main regressor. We define

$$ROWBE_{ist} = \sum_m s_{im}\, x^r_{mt} \tag{4}$$

which is similar to the CBE variable but considers now the value of exports to the rest of the world (excluding China) of exporter m in year t. Notice, however, that exports to China and exports to the rest of the world may correlate with each other as exporters make different

[16] Notice that the specification in equation 2 includes 4-digit sector $\times$ year fixed effects, implying that this assumption must hold when comparing firms within 4-digit sectors.

strategic decisions and assume different trading profiles (see Online Appendix Figure A.8). The $ROWBE$ variable may therefore be a bad control. Yet, we show that our main results are only marginally affected by the inclusion of this variable as an additional regressor in equation 2.

Before continuing, note that we can also support our empirical strategy with an alternative path to identification based on the exogeneity of shares s_{im} (Goldsmith-Pinkham, Sorkin and Swift, 2020). The key assumption is that the shares satisfy parallel trends. That is, in the absence of the surge of beef trade with China, average changes in outcomes would have been similar across firms regardless of their baseline linkages to beef exporters. Note that exposure shares are "tailored" to the research question and treatment of interest and that the inclusion of firm fixed effects further boosts the plausibility of share exogeneity. In Section 4.3.2, we will empirically assess the overall validity of our research design by analyzing pre-trends.

A related concern is that beef exporters might strategically select their suppliers, implying that firms more exposed to rising exports to China were poised to perform well regardless of their baseline linkages—even if they were not already on a differential trend before the trade surge. We address this in Section 4.3.3, where we construct an alternative "double" shift-share exposure variable that leverages Brazilian beef exports to China as the shift.[17]

4.3 Impact on Beef Sector Suppliers

4.3.1 Effect on Sales

We begin with estimating the impact of rising beef exports to China on suppliers' total sales. Table 3 presents the estimates obtained from implementing the specification in equation 2 on the sample of beef exporters' suppliers and having the log of total sales as dependent variable. Column 1 reports the baseline estimate. We standardize the (indirect) China beef export shock variable by dividing it by its standard deviation. A one standard deviation increase in exposure to the China beef export shock increases total sales by about 8%. The estimate is significant at the 1% level. Including the (direct) export and import shocks as controls in columns 2 and 3 does not change the magnitude of the main estimated effect. In columns 4 to 6, we also control for exposure to beef exports towards the rest of the world. The coefficient of interest increases slightly in magnitude and remains highly significant.

[17] As discussed earlier, we extend our analysis in a second step to second-order links—firms that supply goods and services to the suppliers of beef exporters. We primarily examine these firms by analyzing the purchases made by first-order suppliers. We also consider the sample of second-order suppliers and define

$$CBE_{ist}^{(2)} = \sum_j s_{ij}\, CBE_{jt} = \sum_j s_{ij} \sum_m s_{jm}\, x_{mt}^c \tag{5}$$

That is, we multiply the share of sales of firm i to beef exporters' supplier firm j by the value of j's China beef export shock, as defined above. When both variables—CBE_{ist} and $CBE_{ist}^{(2)}$—are included in equation 2, the coefficient on $CBE_{ist}^{(2)}$ captures the second-order impact of beef exports to China, leveraging variation in indirect linkages to beef exporters while controlling for direct linkages and relying on identifying assumptions that mirror those specified above.

Table 3: Effect on Sales

	Log of Total Sales					
	(1)	(2)	(3)	(4)	(5)	(6)
China Beef Export Shock	0.0819*** (0.0193)	0.0819*** (0.0193)	0.0821*** (0.0193)	0.0919*** (0.0188)	0.0920*** (0.0188)	0.0921*** (0.0189)
Export Shock		-0.0205*** (0.00472)	-0.0208*** (0.00476)		-0.0205*** (0.00470)	-0.0208*** (0.00474)
Import Shock			0.0417 (0.0325)			0.0421 (0.0326)
ROW Beef Export Shock				-0.0802*** (0.0180)	-0.0802*** (0.0180)	-0.0803*** (0.0180)
Firms FE	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓
Observations	69,712	69,712	69,712	69,712	69,712	69,712
R^2	0.871	0.871	0.871	0.871	0.871	0.871

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the log of total sales, which we calculate from transaction-level and customs data as the sum of domestic and external sales. The independent variables are defined in Section 4.2. Standard errors are clustered at the ISIC 4-digit sector level.

We then investigate whether the effect is heterogeneous across suppliers according to sales at baseline. We split the sample into the four quartiles of the distribution of total sales in 2014, then implement the specification in equation 2 separately in each subsample. Online Appendix Figure A.12 shows graphically the estimated coefficients. A one standard deviation increase in exposure to the China beef export shock increases sales differentially more for initially smaller suppliers. The effect is 10% and 7.5% respectively for firms in the first and second quartile of the initial sales distribution, significant at the 1% level. It is instead closer to zero and insignificant for firms in the third and fourth quartiles of baseline sales.

Next, we estimate the effect of the China beef export shock separately on suppliers in agriculture, manufacturing, and services. Table 4 shows the corresponding results. The effect on sales is 6.5% and significant at the 1% level for the average supplier in the agricultural sector, which represents more than half of the sample. The magnitude of the effect is more than double for suppliers in manufacturing and services. For manufacturing, the effect is equal to 17% and significant at the 5% level. For suppliers in services, which account for about one-third of the sample, the effect is estimated at 14%, significant at the 1% level.[18]

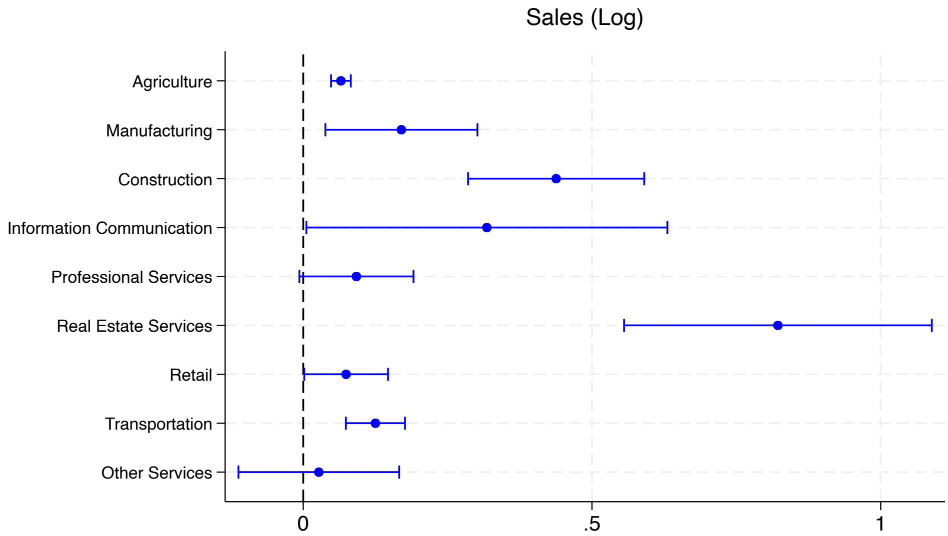
[18] As explained above, firms must report at least 90% of their sales and purchases for tax purposes. The validation in Section 3.3 suggests this is unlikely to bias our estimates. To explore this possibility, for each sector, we focus on the large firms for which we have corporate tax records, compute the median discrepancy between our sales measure and the one balance sheet data, then use it to impute total sales for all firms. Online Appendix Table A.5 shows that results using the log of imputed sales are very similar to those in Table 4.

Table 4: Effect on Sales by Industry

	Log of Total Sales								
	Agriculture			*Manufacturing*			*Services*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
China Beef	0.0653***	0.0651***	0.0651***	0.170**	0.170**	0.169**	0.137***	0.137***	0.138***
Export Shock	(0.00989)	(0.0101)	(0.0101)	(0.0790)	(0.0791)	(0.0797)	(0.0454)	(0.0454)	(0.0454)
Export Shock		0.361***	0.368***		-0.0278	-0.0187		-0.0232***	-0.0234***
		(0.113)	(0.120)		(0.0620)	(0.0522)		(0.00357)	(0.00362)
Import Shock			0.447			0.592***			0.0277
			(0.843)			(0.114)			(0.0286)
Firms FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	43,439	43,439	43,439	3,437	3,437	3,437	21,999	21,999	21,999
R^2	0.831	0.831	0.831	0.912	0.912	0.912	0.904	0.904	0.904

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the log of total sales, which we calculate from transaction-level and customs data as the sum of domestic and external sales. Estimates are obtained separately for the subsamples of suppliers in the agricultural, manufacturing, and service sector. The independent variables are defined in Section 4.2. Standard errors are clustered at the ISIC 4-digit sector level.

Figure 3: Sales Effect Heterogeneity by Sector



Notes. The figure shows graphically the estimated coefficients of the China beef export shock variable and their 90% confidence intervals, obtained when implementing the specification in equation 2 separately for suppliers grouped into specific sectors, which we construct by aggregating ISIC 4-digit classifications.

To gain more insights into this heterogeneity, we split the sample further and look at a finer sector classification. Figure 3 shows the estimated coefficients of the China beef export shock variable and 90% confidence intervals. We find large effects for suppliers in construction (161 firms) and real estate services (183), consistent with beef exporters expanding their facilities to accommodate the increased production volume. The effect is significant at the 10% level for several service sectors, from transportation (705 firms) to retail (2,509), professional services (624), and information and communication (92).

Overall, evidence shows that sales increase significantly for suppliers more exposed to the China beef export shock. The effect is present across many sectors and is large and significant also outside the agricultural sector, particularly in services.

4.3.2 Pre-Trends and Placebo Estimates

As explained in Section 4.2, identification relies on the assumption that absent the China beef shock, the evolution of firm-level outcomes would have been similar across suppliers with tighter vs. looser links at baseline with beef exporters that trade more with China over time. This assumption must hold when comparing firms within 4-digit sectors since we always obtain our estimates conditioning on 4-digit sector $\times$ year fixed effects.

To assess whether this assumption is plausible, we look at pre-trends in firm-level sales, using data from before 2014. As we made clear in Section 3.1, the coverage of the transaction-level data that we use to calculate total sales became universal and stable only in that year. Yet, for the larger firms, we have data on sales from corporate tax records and balance sheets that go back to 2008. We can, therefore, test for pre-trends at least in this subsample of larger firms.

We begin by showing that the baseline results that we obtain with our measure of domestic plus external sales are unchanged when we use the sales information from balance sheet data. The validation exercise in Section 3.3 suggests that this is the case. Online Appendix Table A.6 makes this explicit by reporting the estimates that we obtain when implementing the same specification over the same sample and using the two different sales measures as dependent variables. We can only do this for firms that file corporate taxes, which are larger than average. Consistent with Online Appendix Figure A.12, the average effect of the China beef shock is smaller on them, equal to 2.5%, but still significant at the 10% level.

Upon establishing that the results are unchanged when using sales data from corporate tax records, we test for pre-trends by looking at sales for these same firms in the years from 2009 to 2013 and attributing to each observation the value of the China export shock variable as measured five years later. If firms with tighter links with beef exporters were already on a differential trend, the coefficient of this *placebo* shock variable would be positive and significant. Online Appendix Table A.7 shows that this is not the case. Online Appendix Table A.8 and Table A.9 report the results from this same exercise when focusing on service sector suppliers. The estimated effect on sales is higher than the one in Table A.6 and highly significant, consistent with the findings in Table 4. The placebo estimates in Table A.9 are close to zero, negative, and insignificant. Evidence from this subsample of large firms shows that firms with tighter links at baseline with beef exporters were not on a differential sales trend prior to 2014, providing support to our empirical strategy.

4.3.3 Brazil-Based Shift-Share Estimates

Even in the absence of pre-trends, it could still be the case that firms more exposed to rising exports to China were poised to perform well regardless of their baseline linkages to beef exporters. This might occur if, in anticipation of growing beef exports to China, Uruguayan beef exporters had already established tighter links with firms they expected to perform strongly, and those expectations were subsequently fulfilled. Such a scenario would undermine our identification strategy.

However, as discussed several times before, the available evidence strongly suggests that the surge was driven by rising demand from China, as beef exports increased simultaneously for several major beef exporters across Latin America and beyond—see Online Appendix Figure A.4. It is therefore unlikely that Uruguayan exporters were anticipating the boom in trade with China and strategically selecting suppliers on that basis.

This same cross-country evidence provides a way to address the concern more directly. We implement an alternative "double" shift-share strategy that exploits Brazilian beef exports to

China as the shift. Specifically, we compute for each supplier i in sector s and year t

$$BRCBE_{ist} = \sum_{m} s_{im} e_m brx_t^c \tag{6}$$

where s_{im} denotes firm i's share of sales to beef exporter m in the baseline year 2014 (i.e., the same shares used in the original shift-share variable in equation 1), e_m represents exporter m's share of total Uruguayan beef exports in 2014, and brx_t^c is the total volume of Brazilian beef exports to China in year t. We then replace $BRCBE$ as the main independent variable in equation 2 and compare the resulting estimates to our baseline. Since Brazilian beef exports are independent of any strategic decisions by Uruguayan exporters, finding similar estimates would alleviate the identification concerns highlighted above.[19] Online Appendix Tables A.10 and A.11 present the corresponding results, which are indeed similar to those reported in Tables 3 and 4.

4.3.4 Effects on Employment, Wages, and Sales per Worker

After estimating the effect of the China beef export shock on suppliers' sales, we turn to examining its impact on employment-related variables derived from personal income tax data.

Table 5 shows the results. We estimate the coefficient separately for each dependent variable and for suppliers in agriculture, manufacturing, and services. We find that a one standard deviation increase in exposure to the China beef export shock increases both employment and average wage by 0.6-0.7% for suppliers in the agricultural sector. Sales per worker also increases by 3.5%, the effect being significant at the 1% level. The estimates for the manufacturing sector are positive for employment and sales per worker, and negative for average wages, but always imprecise and never significant. For suppliers in the service sector, the effects are large and precisely estimated. A one standard deviation increase in exposure to the China beef export shock increases employment and average wage by 3%, and sales per worker by almost 7%. All the estimates are significant at the 5% level. These findings indicate that the employment, wage, and productivity gains from rising beef exports to China are concentrated among service sector suppliers, underscoring their pivotal role in transmitting the shock throughout the economy.

Online Appendix Figure A.14 exploits the richness of the IRPF employer–employee matched data to decompose these employment effects into changes along the intensive and extensive margins of labor demand. Specifically, we distinguish between incumbent workers—those already employed at the firm in 2014—and new hires, defined as workers who appear in the IRPF records in subsequent years. This decomposition reveals that the employment gains documented above reflect both higher retention of incumbent workers and increased hiring, with important differences across sectors.

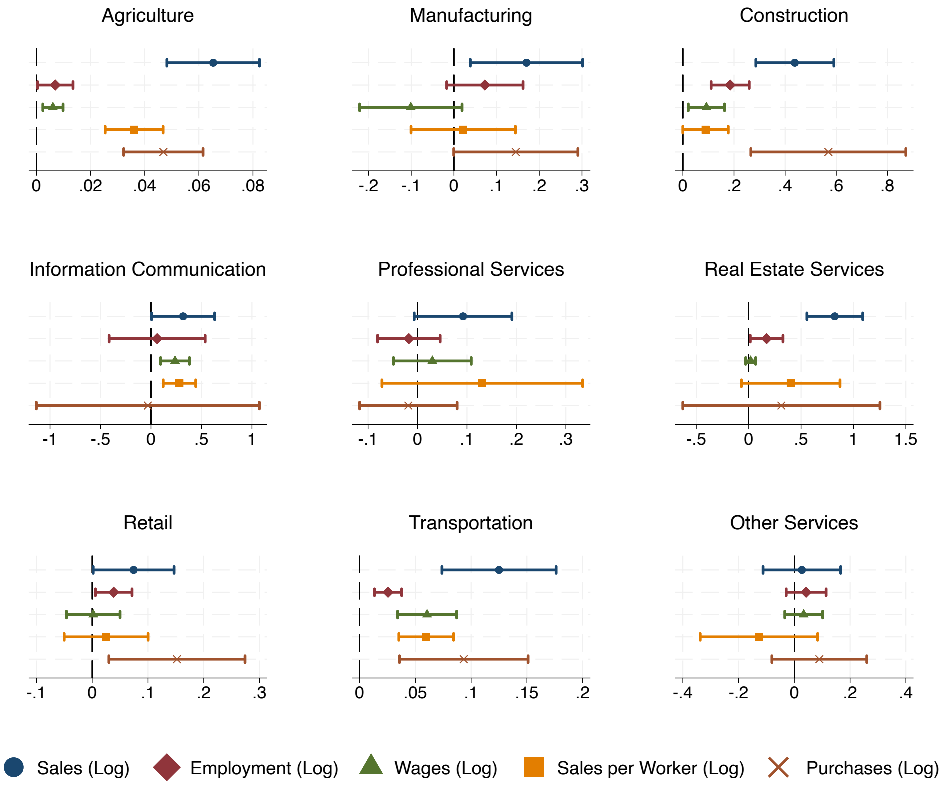
[19] This approach is similar to that employed by Autor, Dorn and Hanson (2013) on the import side, where they use changes in Chinese imports by other high-income countries to identify impacts on U.S. local labor markets.

Table 5: Effect on Employment, Wages, and Sales per Worker by Industry

	Agriculture			*Manufacturing*			*Services*		
Log of	Employment	Avg. Wage	Sales/Empl.	Employment	Avg. Wage	Sales/Empl.	Employment	Avg. Wage	Sales/Empl.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
China Beef	0.0071*	0.0061**	0.0356***	0.0722	-0.102	0.0191	0.0321**	0.0340**	0.0679**
Export Shock	(0.00374)	(0.00218)	(0.00623)	(0.0537)	(0.0719)	(0.0734)	(0.0140)	(0.0160)	(0.0342)
Export Shock	-0.129***	-0.0494	0.544***	-0.0351***	0.0194	-0.0391	0.0007	0.0288***	0.0009
	(0.0271)	(0.108)	(0.158)	(0.00644)	(0.0318)	(0.0768)	(0.00108)	(0.00559)	(0.00152)
Import Shock	-0.110	0.346	0.0003	0.0749	0.0882	0.624***	-0.0138	0.0111	-0.0385
	(0.215)	(0.521)	(0.897)	(0.0475)	(0.0588)	(0.184)	(0.0196)	(0.0354)	(0.0271)
Firms FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	31,411	31,411	31,411	2,804	2,804	2,804	16,715	16,715	16,718
R^2	0.924	0.761	0.762	0.946	0.881	0.905	0.945	0.850	0.908

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the log of employment, average wage, and sales per worker. Estimates are obtained separately for the subsamples of suppliers in the agricultural, manufacturing, and service sector. The independent variables are defined in Section 4.2. Standard errors are clustered at the ISIC 4-digit sector level.

Figure 4: Effect Heterogeneity by Sector and Outcome



Notes. The figure shows graphically the estimated coefficients of the China beef export shock variable and their 90% confidence intervals, obtained when implementing the specification in equation 2 separately for suppliers grouped into specific sectors—which we construct by aggregating ISIC 4-digit classifications—and having as dependent variables the log of sales, log of employment, log of wages, log of sales per worker, and log of total purchases.

In services, the positive employment effect is present for both incumbent workers and new hires, indicating that firms both retain their existing workforce and expand by bringing in new employees. In agriculture, the effects are smaller, consistent with the overall modest employment response in that sector, while estimates for manufacturing remain imprecise along both margins. Taken together, these patterns suggest that the employment expansion in response to the China beef export shock operates through a combination of improved worker retention and net job creation, with both forces operating most strongly in the service sector.

Finally, Figure 4 shows graphically the impact of the China beef export shock on several outcome variables, estimated separately for suppliers grouped into more narrowly defined sectors. In some sectors—such as construction, IT, and transportation—the increase in sales per worker is matched by a wage effect of approximately the same magnitude. This is not the case for suppliers in agriculture, suggesting a lower pass-through.[20]

[20] Online Appendix Figure A.13 provides the same information but allows for a direct comparison across sectors.

Table 6: Effect on Service Suppliers' Imports of High-Quality Products

	Log of Import Value					
	(1)	(2)	(3)	(4)	(5)	(6)
China Beef Export Shock	0.0743** (0.0291)	0.0743** (0.0291)	0.0751** (0.0292)	0.0781** (0.0316)	0.0782** (0.0316)	0.0790** (0.0317)
Export Shock		0.0427*** (0.00292)	0.0422*** (0.00409)		0.0428*** (0.00292)	0.0423*** (0.00409)
Import Shock			0.0581 (0.302)			0.0582 (0.302)
ROW Beef Export Shock				-0.0340 (0.0433)	-0.0344 (0.0433)	-0.0347 (0.0433)
Firms FE	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓
Observations	20,762	20,762	20,762	20,762	20,762	20,762
R^2	0.814	0.814	0.814	0.814	0.814	0.814

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a service supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the total imports of high-quality products, defined as imported products whose unit price belongs to the top quartile of the HS6 product code-year price distribution. The independent variables are defined in Section 4.2. Standard errors are clustered at the ISIC 4-digit sector level.

4.3.5 Effect on High-Quality Imports

One way to further probe the productivity gains documented above is to examine whether more exposed firms increased their use of sophisticated imported inputs. A large literature in international trade and development argues that access to higher-quality intermediate inputs can improve production efficiency, product quality, and organizational capabilities (Verhoogen, 2023). Existing evidence, however, has focused primarily on manufacturing firms directly engaged in export markets. In our setting, service suppliers benefiting from the expansion of beef exports to China may have responded not only by scaling up employment and sales, but also by increasing their demand for high-quality imported products.

To explore this mechanism, we construct measures of imports of high-quality products using customs data. Specifically, we define a product as high quality if its unit price belongs to the top quartile of the distribution of prices within the same HS6 product code and year. We then compute, for each firm-year observation, the log value of imports of high-quality products. We focus on service suppliers, for which the effects on wages and sales per worker were strongest.[21]

Table 6 reports the corresponding estimates. Service suppliers more exposed to the China beef export shock significantly increased the value of imports of high-quality products. A one-standard-deviation increase in exposure raises imports of high-quality products by approximately 8%. The magnitude of the estimate is stable across specifications and remains statis-

[21] We report the results for all sectors in Online Appendix Table A.12.

tically significant after controlling for direct export and import shocks as well as exposure to beef exports to the rest of the world.

The increase in imports of high-quality products may partly reflect scale effects associated with expanding production rather than a compositional shift toward higher-quality inputs. Yet this increase occurs alongside sizable gains in sales per worker and wages among service-sector suppliers. Moreover, the imported products experiencing the largest increases include packaging materials, industrial plastics, aluminum profiles, sorting and grading machinery, industrial tools, and transport-related equipment.[22] These products are closely associated with logistics, handling, storage, maintenance, and other operational activities required to support an expanding export sector. Taken together, these findings suggest that commodity export booms can stimulate the expansion and upgrading of domestic service providers connected to the export sector, inducing firms not only to scale up production, but also to adopt more sophisticated operational inputs and equipment as their activities expand.

4.4 Broader Impact on the Production Network

4.4.1 Effects on Purchases and Higher-Order Links

The analysis thus far has focused on the direct effects of the China beef export shock on suppliers to beef exporters, including their sales, employment, productivity, and input upgrading. We now turn to the broader implications for the domestic production network. A natural starting point is to examine whether more exposed firms also increased their purchases from other firms in the economy, thereby propagating the shock through higher-order linkages.

To do so, we implement the specification in equation 2 replacing the dependent variable with the log of total purchases made by suppliers to beef exporters. Table 7 reports the corresponding results, once again separately for suppliers in agriculture, manufacturing, and services. A one standard deviation increase in exposure to the China beef export shock increases agricultural suppliers' purchases by almost 5%. The impact on purchases among manufacturing suppliers is large but statistically insignificant. For suppliers in services, we estimate a 10% increase in purchases following higher exposure to the China beef export shock. These patterns closely mirror those observed for sales and employment outcomes in Tables 4 and 5: more exposed suppliers scale up and increase sales, employment, and purchases.[23]

In addition, we look separately at purchases from specific sectors by replacing as dependent variable the value of total purchases from firms in specific sectors. Figure 5 summarizes the results, showing large and significant effects on purchases of financial services, information and communication, professional services, retail, transportation, and other services. The estimates on purchases from the agricultural and manufacturing sector are instead insignificant.

[22] These are products whose imports rank among the top 20 in terms of the increase in high-quality imports relative to non-high-quality imports between 2015 and 2019.

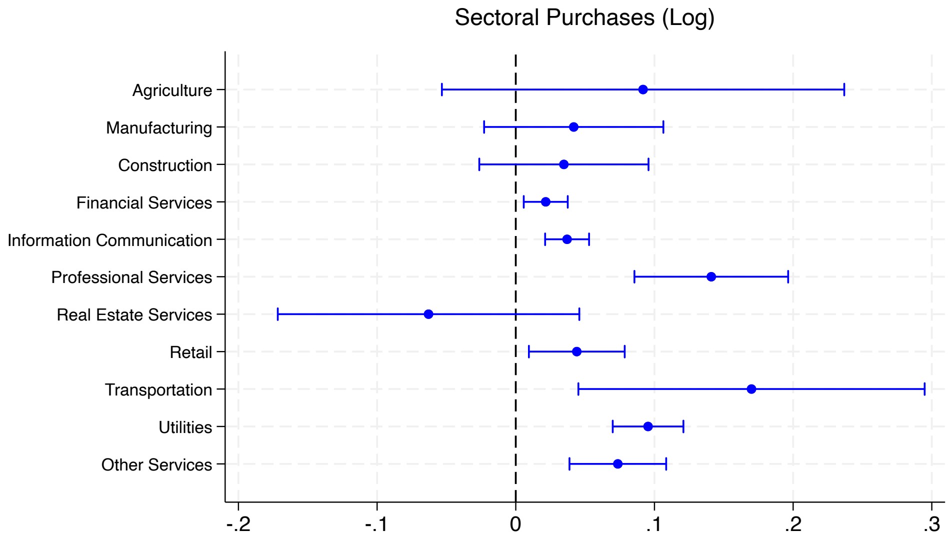
[23] We show graphically the impact on purchases together with the effects on the other outcomes by more narrowly defined sectors in Figure 4 and Online Appendix Figure A.13.

Table 7: Effect on Purchases by Industry

	Log of Total Purchases								
	Agriculture			*Manufacturing*			*Services*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
China Beef Export Shock	0.0469***	0.0469***	0.0468***	0.145	0.142	0.142	0.0967***	0.0967***	0.0990***
	(0.00848)	(0.00848)	(0.00846)	(0.0873)	(0.0876)	(0.0871)	(0.0341)	(0.0340)	(0.0342)
Export Shock		0.133**	0.161***		-0.315**	-0.328**		-0.0214***	-0.0229***
		(0.0477)	(0.0366)		(0.154)	(0.157)		(0.00660)	(0.00674)
Import Shock			1.863**			0.360*			0.170***
			(0.739)			(0.186)			(0.0554)
Firms FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sector $\times$ Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	42,421	42,421	42,421	3,407	3,407	3,407	20,762	20,762	20,762
R^2	0.858	0.858	0.858	0.901	0.901	0.901	0.906	0.906	0.906

Notes. * p-value$<$ 0.1; ** p-value$<$0.05; *** p-value$<$0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the log of total purchases, which we calculate from transaction-level and customs data as the sum of domestic and external purchases. Estimates are obtained separately for the subsamples of suppliers in the agricultural, manufacturing, and service sector. The independent variables are defined in Section 4.2. Standard errors are clustered at the ISIC 4-digit sector level.

Figure 5: Effect on Sectoral Purchases



Notes. The figure shows graphically the estimated coefficients of the China beef export shock variable and their 90% confidence intervals, obtained when implementing the specification in equation 2 over the entire sample but considering separately as dependent variable all purchases from specific sectors, which we construct by aggregating buyers according to their ISIC 4-digit classifications.

We interpret this evidence as showing that the service sales effects remain high on higher-order links and thus propagate further up the value chain.[24]

4.4.2 Downstream Spillovers

We can exploit the richness of our firm-to-firm transaction data to investigate how the China beef export shock affected other clients of the suppliers to beef exporters. These downstream effects could materialize through several channels (productivity spillovers, diversion of resources, etc.) and could be positive or negative. To examine this, we consider all firms that, in 2014, purchased any goods or services from suppliers to beef exporters. For each of these firms j, we compute

$$DOWNCBE_{jst} = \sum_{i} p_{ji} CBE_{it} \tag{7}$$

where p_{ji} denotes firm j's share of purchases from supplier i in the baseline year 2014, and CBE_{it} is supplier i's China beef export shock as defined in equation 1. We then estimate the specification in equation 2 on this sample, replacing the main independent variable with $DOWNCBE_{jst}$ and also controlling for firm j's own China beef export shock CBE_{jt}, allow-

[24] We also directly estimate the second-order impact of beef exports to China. We consider all firms that supply goods and services to the suppliers of beef exporters, i.e., the second estimation sample discussed in Section 4.1, and implement the augmented regression specification discussed in footnote 17. Online Appendix Figures A.15 and A.16 show graphically the results, showing more evidence of the higher-order effects of beef exports to China on service sector firms.

ing us to disentangle direct effects from downstream spillovers.[25]

Online Appendix Table A.13 presents the corresponding results, which provide no evidence of negative downstream spillovers on sales. Importantly, the estimated direct effect of the China beef export shock in columns 4 to 6 remains very similar to the baseline reported in Table 3. Online Appendix Table A.14 reports the results for employment-related outcomes. Interestingly, while we find a positive and significant effect on average wages—albeit small in magnitude—there is no evidence of impacts on employment or sales per worker. Overall, our estimates cannot reject the hypothesis of zero spillovers from the China beef export shock on other clients of the suppliers to beef exporters.

4.4.3 Changes in the Network and Sectoral Dynamics

Our analysis thus far has examined the impact of rising beef exports to China on the direct and indirect suppliers of beef exporters, using a measure of exposure that held network linkages fixed at their 2014 values. We now turn to investigating whether the China beef export shock led to structural changes in firm linkages themselves.

We begin by focusing on the sample of suppliers to beef exporters and estimate the effect on the number of their suppliers, maintaining the specification in equation 2. Columns 1 to 3 of Table 8 show that suppliers to beef exporters that are more exposed to the China beef export shock engage with a greater number of suppliers. This leads to diversification in firm purchases, with the HHI decreasing significantly, as shown in columns 4 to 6 of Table 8. As suppliers to beef exporters scale up operations to meet rising demand, they expand their own suppliers' network.

Next, we examine broader sectoral dynamics. We aggregate our data to the 4-digit sector level, constructing a panel dataset where the unit of observation is the sector over time. We then implement the sector-level counterpart of the regression specification in equation 2, using as the main regressor a new Bartik-type variable that combines variation across sectors in their overall linkages to beef exporters with time variation in these exporters' trade with China.[26] Table 9 presents the corresponding results. Columns 1 to 6 confirm the firm-level findings, showing that sector-level exposure to beef trade with China leads to higher sales and purchases at the sector level. However, columns 7 to 9 reveal a significant decline in the number of firms in sectors more exposed to the China beef export shock. Online Appendix Table A.15 also shows that firm-level exposure is systematically associated with lower exit probabilities. Taken together, these results suggest a reallocation of economic activity within more exposed sectors, favoring firms with tighter links to beef exporters that expanded trade with China.

[25] The CBE variable is positive for firms that are themselves suppliers to beef exporters in 2014 and zero otherwise.

[26] We include sector and year fixed effects separately as we can no longer use sector $\times$ year fixed effects.

Table 8: Effect on Number of Suppliers and Purchase Concentration

Log of	Number of Suppliers			HHI of Purchases		
	(1)	(2)	(3)	(4)	(5)	(6)
China Beef Export Shock	0.0266***	0.0266***	0.0268***	-0.00773***	-0.00773***	-0.00765***
	(0.00555)	(0.00554)	(0.00561)	(0.00252)	(0.00252)	(0.00254)
Export Shock		-0.0168***	-0.0174***		-0.00560**	-0.00586**
		(0.00245)	(0.00259)		(0.00279)	(0.00281)
Import Shock			0.0676***			0.0276
			(0.0178)			(0.0205)
Firms FE	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓
Observations	67,478	67,478	67,478	67,478	67,478	67,478
R^2	0.926	0.926	0.926	0.834	0.834	0.834

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the log of number of suppliers (columns 1 to 3) and the log of HHI of purchases (columns 4 to 6). The independent variables are defined in Section 4.2. Standard errors are clustered at the ISIC 4-digit sector level.

4.5 Summary

The reduced-form analysis shows that suppliers to beef exporters are significantly impacted by the China beef export shock. Their sales increase significantly, particularly for suppliers outside of agriculture. Employment, wages, and sales per worker also increase, markedly so for service sector suppliers. More exposed service suppliers also increase their imports of high-quality products. While these import patterns may simply reflect scale effects, they occur alongside gains in sales per worker and wages, suggesting firm-level upgrading among service suppliers. The same pattern holds when looking at suppliers' purchases. Evidence shows that the service sales effects propagate further up the value chain, and that firm linkages themselves change as a result of the shock. These sectoral dynamics and shifts in the production network may play a crucial role in shaping the aggregate impact of the China beef export shock on the economy. In the next section, we explicitly account for these structural changes and quantify their aggregate implications through counterfactual analysis.

Table 9: Sector-Level Effects on Sales, Purchases and Number of Firms

	Log of Total Sales			Log of Total Purchases			Log of Number of Firms		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
China Beef	0.0411*	0.0402*	0.0404*	0.0291*	0.0281*	0.0292*	-0.0176*	-0.0178*	-0.0187*
Export Shock	(0.0229)	(0.0229)	(0.0229)	(0.0158)	(0.0158)	(0.0158)	(0.00974)	(0.00971)	(0.00966)
Export Shock		0.0739**	0.0738**		0.0906***	0.0898***		0.0148	0.0154
		(0.0349)	(0.0349)		(0.0274)	(0.0264)		(0.0168)	(0.0174)
Import Shock			0.0179			0.145***			-0.111*
			(0.0288)			(0.0547)			(0.0624)
Sector FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1,495	1,495	1,495	1,495	1,495	1,495	1,495	1,495	1,495
R^2	0.977	0.977	0.977	0.966	0.966	0.966	0.990	0.990	0.990

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is an ISIC 4-digit sector. The table reports the coefficient estimates obtained when implementing the sector-level homolog of equation 2, with separate fixed effects for each sector and year. The dependent variables are the log of aggregate total sales (columns 1 to 3), the log of aggregate purchases (columns 4 to 6), and the log of number of firms (columns 7 to 9) in each sector. The independent variables are defined in Section 4.2 but calculated now at the sector level. Standard errors are clustered at the ISIC 4-digit sector level.

5 Aggregate Effects

This section quantifies the aggregate impact of rising beef exports to China on the Uruguayan economy. The objective is twofold: first, to measure the indirect effect on aggregate firm sales that materializes through the network of firm-to-firm linkages, and second, to assess how changes in the linkages themselves influence these effects.

5.1 Model

Consider a finite number of firms i producing output x_i according to

$$x_i = z_i k_i^{\alpha} l_i^{\beta} m_i^{\gamma} \tag{8}$$

where z_i is firm productivity and k_i, l_i and m_i are the capital, labor, and intermediate inputs. The latter is an aggregator of goods and services produced by other firms j in the economy according to $m_i = \prod_j x_{ji}^{\omega_{ij}}$ where x_{ji} is the amount of good j used by firm i in production.

Let p_i be the price of the good produced by firm i, which the firm itself and other firms take as given.[27] Firm profit maximization implies

$$\gamma\omega_{ij} = \frac{p_j x_{ji}}{p_i x_i} \tag{9}$$

so that $\gamma\omega_{ij}$ is the value of spending on input j per unit value of production of good i.

Equilibrium market clearing implies that all firm output is either used as input by other firms or consumed by final domestic consumers or foreign firms and consumers whose demand is "external" to the production network. This means that $x_i = \sum_{j\neq i} x_{ij} + c_i$ where c_i is the value of *external demand* for good i. Multiplying both sides by p_i we get $p_i x_i = \sum_{j\neq i} p_i x_{ij} + p_i c_i$ which combined with equation 9 implies $p_i x_i = \gamma \sum_{j\neq i} \omega_{ji} p_j x_j + p_i c_i$.

We can thus express each firm sales $s_i = p_i x_i$ as a linear function of all other firms' sales and the value of firm i's external demand $\xi_i = p_i c_i$. Specifically, let s be the vector of firm sales, $\boldsymbol{\xi}$ be the vector of external demand, and $\boldsymbol{\Omega}$ be the firm-level input-output matrix with $\gamma\omega_{ij}$ as entries. We have

$$\mathrm{s} = \boldsymbol{\Omega}'\mathrm{s} + \boldsymbol{\xi} \tag{10}$$

5.2 Estimation and Counterfactual Analyses

Equation 10 describes the equilibrium of this economy. Firm sales s and firm-to-firm transactions and thus $\boldsymbol{\Omega}$ are observable every year from 2014 to 2019. We can obtain the vector of external demand in each year as $[\mathbf{I} - \boldsymbol{\Omega}_t']\,\mathrm{s}_t = \boldsymbol{\xi}_t$ which is equivalent to subtracting sales to other firms from total sales. To calculate the aggregate impact of beef exports to China, we can

[27] While the assumption of perfectly competitive markets can be relaxed, as discussed below, it serves as a useful starting point for mapping the technological parameters $\gamma\omega_{ij}$ to the data as expenditure shares.

derive counterfactual external demand $\tilde{\boldsymbol{\xi}}_t$ by subtracting the value of exports to China from ξ_{it} for each observation belonging to beef exporters. We can then obtain counterfactual sales $\tilde{s}_{it}$ for each firm in the economy by solving

$$\tilde{\mathbf{s}}_t = [\mathbf{I} - \boldsymbol{\Omega}'_t]^{-1} \tilde{\boldsymbol{\xi}}_t \tag{11}$$

so that we can compute for each firm the difference between actual sales and counterfactual sales in the absence of the China beef export shock. While this exercise fully accounts for the equilibrium relationship between domestic firms' sales, it does not constitute a fully general equilibrium analysis unless external demand is explicitly modeled as endogenous to domestic consumption. However, if we assume that external demand consists solely of exports and is truly exogenous, then this framework does capture the full general equilibrium effects. This assumption is internally consistent, as firm sales are calculated as the sum of domestic sales to other firms plus exports, with the latter plausibly treated as exogenous.

Combining equations 10 and 11, we can obtain the impact of beef exports to China on aggregate sales and disentangle direct effects and network (indirect) effects as follows

$$\underbrace{\boldsymbol{\iota}'(\mathbf{s}_t - \tilde{\mathbf{s}}_t)}_{\text{aggregate effects}} = \underbrace{\boldsymbol{\iota}'\boldsymbol{\Omega}'_t(\mathbf{s}_t - \tilde{\mathbf{s}}_t)}_{\text{network effects}} + \underbrace{\boldsymbol{\iota}'(\boldsymbol{\xi}_t - \tilde{\boldsymbol{\xi}}_t)}_{\text{direct effects}}. \tag{12}$$

5.2.1 Changing Network Effects

The previous effects are measured while keeping the production network fixed to its actual structure in each year t. However, changes in the network structure over time are worth investigating in their own right. These changes are reflected in the data through variations in expenditure shares, which, from the model's perspective, can arise for several reasons: (i) shifts in technology, as captured by factor shares $\gamma\omega_{ij}$; (ii) variations in markups or markdowns, which would be reflected in expenditure shares; (iii) market distortions, which alter the shadow price of both inputs and output and can similarly manifest in expenditure share adjustments; and (iv) the formation and disruption of firm linkages, driven, for instance, by variations in bilateral trading fixed costs.

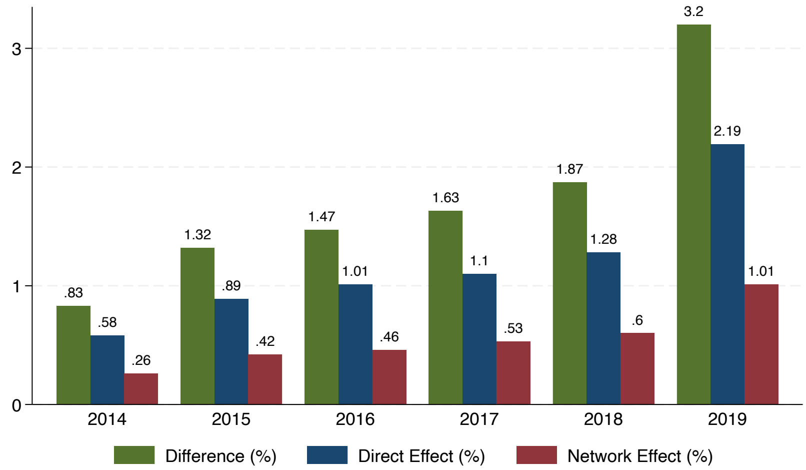
To pin down how these adjustments shape network effects, we can hold the $\boldsymbol{\Omega}$ matrix fixed to its 2014 structure and derive

$$\dot{s}_t = [\mathbf{I} - \boldsymbol{\Omega}'_{2014}]^{-1} \tilde{\boldsymbol{\xi}}_t \tag{13}$$

which gives the value of counterfactual sales we would have observed had the production network remained unchanged throughout the period. This means we can further decompose network effects as follows

$$\underbrace{\boldsymbol{\iota}'\boldsymbol{\Omega}'_t(\mathbf{s}_t - \tilde{\mathbf{s}}_t)}_{\text{network effects}} = \underbrace{\boldsymbol{\iota}'(\boldsymbol{\Omega}'_t\mathbf{s}_t - \boldsymbol{\Omega}'_{2014}\dot{\mathbf{s}}_t)}_{\text{baseline network effects}} + \underbrace{\boldsymbol{\iota}'(\boldsymbol{\Omega}'_{2014}\dot{\mathbf{s}}_t - \boldsymbol{\Omega}'_t\tilde{\mathbf{s}}_t)}_{\text{changing network effects}} \tag{14}$$

Figure 6: Aggregate Effects



Notes. The figure illustrates the results from the counterfactual analysis presented in Section 5.2. Aggregate counterfactual sales correspond to those we would have observed had China beef exports been equal to zero in each year. It shows the percentage difference between actual and counterfactual sales, along with the decomposition into direct and network effects, as outlined in equation 12.

The baseline network effects capture the difference between actual sales and the sales we would have observed in the absence of the China beef export shock, assuming the network remained fixed at its 2014 structure. The changing network effects isolate the impact of network evolution by measuring the difference that would have arisen in a scenario without rising exports to China, driven solely by changes in the network structure over time.

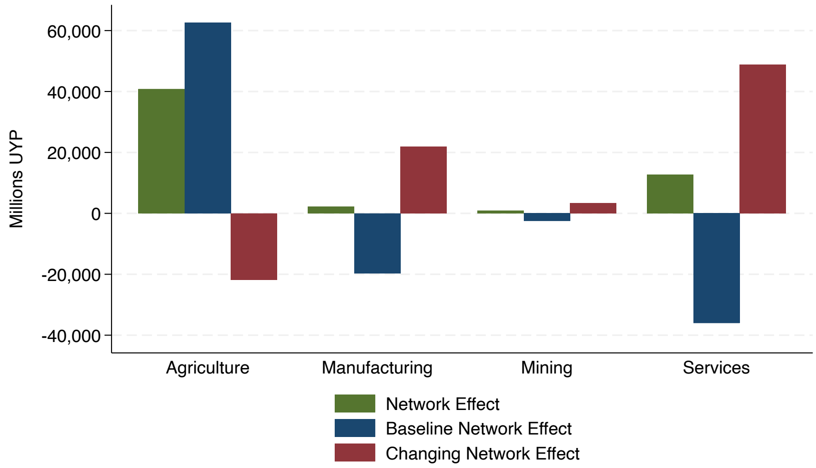
5.3 Results

Figure 6 and Online Appendix Table A.16 present the results from the main counterfactual analysis. For each year and overall throughout the period, it reports the value of aggregate actual sales and counterfactual sales—i.e., the sales that would have been observed had China beef exports been zero. Additionally, it displays the value and percentage difference between the two, along with the decomposition into direct and network effects, following equation 12.

The results indicate that beef exports to China increased Uruguayan aggregate sales by 1.79% on average annually over the period 2014 to 2019. The direct value of exports accounts for 1.22%, approximately two-thirds of the total effect, while the remaining 0.57% arises from indirect effects and propagation through firm linkages—equivalent to about USD 1.6 billion. Put differently, for every dollar of beef exports to China, the economy generated an additional 46 cents of domestic sales through the production network. These relative proportions remain fairly stable over time. In 2019 alone, the total effect was 3.20%, with 2.19% attributable to direct exports and 1.01% to network-mediated effects.

In Figure 7 and Online Appendix Table A.17, we further break down the aggregate network effects by sector, pooling data across all years. While agriculture captures the largest share of these effects, services contribute a substantial 22%. To understand the underlying mechanisms,

Figure 7: Network Effects by Sector



Notes. The figure illustrates the results from the decomposition of network effects into baseline and changing network effects, as discussed in Section 5.2.1. Values are aggregated over the whole period from 2014 to 2019.

we decompose total network effects into two components—baseline and changing network effects—as defined in equation 14. The contrast across sectors is stark: in agriculture, most of the gains come from the pre-existing 2014 structure of firm linkages (baseline effects), with changes in the latter yielding relatively small losses. In services, however, the pattern is reversed. Had the production network remained frozen at its 2014 configuration and beef exports to China not occurred, the service sector would have achieved higher aggregate sales than what we observe. This reflects an opportunity cost from restructuring. Nevertheless, the positive and larger changing network effects indicate that service firms actively adjusted their linkages, and that these new connections, together with the export boom, ultimately delivered greater gains than what was lost by abandoning the original structure. Put differently, our results show that, for services, changes in network structure generated aggregate sales gains only insofar as they occurred jointly with the external demand shock. In short, while agriculture benefited passively from initial conditions, the service sector's gains were driven by proactive adaptation.

These findings also underscore the importance of accounting for network dynamics when quantifying the aggregate effects of trade shocks. Relying solely on the initial 2014 network structure would effectively isolate baseline network effects and lead to a markedly different conclusion: namely, that the commodity boom generated gains in agriculture at the expense of services and manufacturing, consistent with a reallocation of activity toward the primary sector. Once we incorporate how firm linkages evolve over time, these negative effects are reversed. Ignoring such adjustments would therefore mischaracterize the impact of commodity booms. From a policy perspective, this highlights that accurate evaluation of trade shocks requires data and methods that capture the endogenous evolution of production networks over time.

To delve deeper into the aggregate patterns, we examine the firm-level correlates of sales gains. We aggregate actual and counterfactual sales over time at the firm level, then regress the log difference between the two on an indicator for whether the firm was a supplier to a beef exporter in 2014. These suppliers constitute the sample used in our main reduced-form analysis in the first part of the paper. Column 1 of Online Appendix Table A.18 shows that, on average, sales gains were positive even for non-suppliers, amounting to 0.55%. Gains for suppliers were 8.75 percentage points higher, bringing their average to approximately 9.3%. Column 2 demonstrates that these gains were larger for initially smaller firms, consistent with our earlier reduced-form findings. In column 3, we regress log sales gains on an indicator for whether the firm exited the data over the study period, finding a significant association with lower sales gains. Column 4 includes all these correlates simultaneously, confirming the individual patterns observed in the previous columns.

To conclude, we further disentangle the extent to which the sales gain of those firms that are suppliers to beef exporters in 2014 stem from baseline versus changing network effects, overall and by sector. Online Appendix Table A.19 reports the results. Column 1 shows average sales gains, column 2 reports the average log difference between actual sales and counterfactual sales under a network fixed at its 2014 structure, and column 3 compares the two counterfactual scenarios, isolating the contribution of network changes over time. On average for suppliers across all sectors and for those in agriculture, adjustments in the network act to partially offset the gains from rising beef exports to China. This is due to beef exporters expanding their supplier networks—see Online Appendix Figure A.10 and the top left panel of Online Appendix Figure A.11—which may have come at the expense of firms that were already suppliers in 2014. Yet manufacturing and services show markedly different patterns from agriculture. In these sectors, the typical supplier would have recorded higher sales in the absence of beef trade with China and had firm linkages remained fixed. The restructuring of these linkages allowed suppliers to capitalize on the export boom—in the case of services, generating gains that more than offset the initial losses. This is consistent with Online Appendix Figure A.11, which for manufacturing and services often shows not a net increase in the number of suppliers, but rather evidence of consolidation. The results of this firm-level analysis highlight the role of production network restructuring in mediating the impact of the China beef export shock, as well as the heterogeneity between agriculture and non-agriculture, validating the aggregate patterns summarized in Figure 7.

6 Conclusions

The rise in exports of both hard and soft commodities to China is a worldwide phenomenon that affects many countries in the Global South. This paper shows that this commodity export boom can foster production service growth in these countries.

Combining customs and tax data, we show that the rapid surge of Uruguayan beef exports to China has large positive effects on the suppliers of beef exporters, particularly those in services. More exposed service suppliers not only increase sales and employment, but also increase their imports of high-quality inputs, achieve higher sales per worker, and pay higher wages. These indirect effects have meaningful aggregate implications. Our calculations indicate that beef exports to China increased Uruguayan aggregate sales by 1.79% from 2014 to 2019, with indirect linkages accounting for one-third of this effect and the service sector capturing 22% of these network-mediated gains. We also show that over time, the service sector actively repositioned itself to capitalize on rising beef exports, strengthening its capacity to benefit from expanding trade with China. Importantly, these conclusions hinge on accounting for the evolution of production networks over time: relying on the initial network structure alone would suggest losses outside agriculture and thus mismeasure both the magnitude and the sectoral incidence of the gains.

As poor countries seek pathways to sustained economic growth, rising economic nationalism undermines export manufacturing as a development strategy. As Rodrik and Sandhu (2024) put it, "the future of developing countries lies in services." Our findings suggest that commodity exports to China can help make domestic economies more service-intensive, fostering growth and superior technology adoption (Goldberg and Reed, 2023) in production services. The production network mechanisms we identify can be reinforced by income effects linking sectors from the demand side. This highlights how commodity booms can yield broader structural gains, especially through strong service linkages. Entering a new market—as Uruguay did with China—can prompt key adjustments, helping explain the pronounced spillovers into services like customs, legal, and ICT.

Our results have clear policy implications: identifying and supporting service activities closely tied to commodity exports can amplify the benefits of trade, enhancing their transmission throughout the economy.

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ONLINE APPENDIX

Beefing Up the Service Sector: Commodity Exports to China and Production Network Spillovers

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Table A.1: Beef Sector Statistics

	Obs.	Mean	St. Dev.	Min	Max	Obs.	Mean	St. Dev.	Min	Max
	All Sectors					*Transportation*				
# of Suppliers	449	530.49	741.88	1	3220	298	39.33	37.62	1	166
# of Suppliers' 4d Sectors	449	65.03	60.96	1	194	298	6.52	4.26	1	16
HHI of Purchases	449	0.34	0.42	0	1	298	0.37	0.29	0.05	1
Log of Total Purchases (UYP)	446	16.05	5.18	4.65	23.50	298	15.55	3.06	6.70	19.87
	Agriculture, Forestry, Fishing					*ICT Services*				
# of Suppliers	276	490.64	544.56	1	2283	315	6.49	5.54	1	25
# of Suppliers' 4d Sectors	276	9.11	5.05	1	19	315	3.41	2.03	1	8
HHI of Purchases	276	0.15	0.28	0	1	315	0.57	0.29	0.12	1
Log of Total Purchases (UYP)	276	18.38	3.73	1.51	23.40	315	12.75	2.15	6.01	16.75
	Manufacturing					*Professional Services*				
# of Suppliers	313	50.51	43.25	1	164	297	28.61	29.88	1	121
# of Suppliers' 4d Sectors	313	25.80	17.97	1	64	297	5.98	2.97	1	12
HHI of Purchases	313	0.35	0.25	0	1	297	0.33	0.30	0	1
Log of Total Purchases (UYP)	312	16.08	3.24	5.91	21.66	296	15.09	2.59	6.69	19.25

Notes. The table reports some summary statistics on the network of firm-to-firm linkages that we trace from administrative transaction-level data, focusing on the domestic sales to the beef sector. The unit of observation is a buyer in the beef sector in a given year from 2014 to 2019.

Table A.2: Validation of Total Sales

	Log of Sales (IRAE)	
	2014	2019
Log of Sales	0.913***	0.903***
(Domestic + Exports)	(0.005)	(0.005)
Observations	15,423	19,243

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The table reports the coefficient estimates that we obtain from a simple regression of the (log) sales from corporate tax data over the (log) sales from domestic transactions and customs data, implemented separately for the years 2014 and 2019. Motivated by the evidence in Figure A.6, we restrict the sample to observations of (log) sales higher than 15.

Table A.3: Summary Statistics

	Obs.	Mean	St. Dev.	Min	Max
Sales (Millions UYP)	69,712	11,200,000	20,400,000	77.27	141,000,000
Log of Sales	69,712	14.844	1.976	4.347	18.767
Domestic Sales (Millions UYP)	69,569	10,800,000	19,500,000	77.27	132,000,000
Log of Domestic Sales	69,569	14.834	1.969	4.347	18.698
Exports	69,569	65,564.51	1,690,940	0	120,000,000
Log of Exports	69,569	0.168	1.504	0	18.603
Purchases	67,478	3,908,745	9,448,054	160	63,600,000
Log of Purchases	67,478	12.722	2.579	5.075	17.968
Domestic Purchases	67,185	3,148,550	7,450,233	160	52,700,000
Log of Domestic Purchases	67,185	12.653	2.510	5.075	17.780
Imports	67,185	523,254.2	3,169,247	0	58,100,000
Log of Imports	67,185	1.093	3.876	0	17.877
Employment	54,518	14.968	86.465	1	5,584
Log of Employment	54,518	1.761	1.178	0	8.628
Average Wage	52,239	2,129,666	3,296,343	1	20,100,000
Log Average Wage	52,239	13.619	1.481	0	16.818
Firms	15,208				
4d Sectors	227				

Notes. The table reports the summary statistics for the estimation sample of all the variables we use in the empirical analysis. The unit of observation is a supplier-year in the period from 2015 to 2019. Values in Uruguayan Pesos (1 USD equals 25 UYP in 2014; 1 USD equals 38 UYP in 2019).

Table A.4: Second-Order Effect Estimation Sample: Firms by Sector

	Observations	Frequency (%)
Agriculture, Forestry, and Fishing	3,589	7.73
Construction	1,886	4.06
Financial Services	337	0.73
Information Communication	1,340	2.88
Manufacturing	5,858	12.61
Mining	83	0.18
Other Services	4,958	10.67
Professional Services	6,606	14.22
Real Estate Services	815	1.75
Retail	16,355	35.20
Transportation	4,498	9.68
Utilities	133	0.29
Total	46,458	100.00

Notes. The table shows the distribution of second-order links (suppliers of suppliers to beef exporters) across sectors.

Table A.5: Robustness: Effect on Sales by Industry Including Imputed Final Consumer Sales

	Log of Total Sales								
	Agriculture			*Manufacturing*			*Services*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
China Beef	0.0639***	0.0637***	0.0637***	0.196**	0.196**	0.191**	0.133***	0.133***	0.134***
Export Shock	(0.00827)	(0.00844)	(0.00843)	(0.0866)	(0.0866)	(0.0877)	(0.0424)	(0.0424)	(0.0424)
Export Shock		0.672**	0.683**		0.00266	0.00198		-0.103***	-0.104***
		(0.313)	(0.322)		(0.00286)	(0.00253)		(0.0214)	(0.0216)
Import Shock			0.416			0.650***			0.0292
			(0.898)			(0.146)			(0.0333)
Firms FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	43,767	43,767	43,767	3,691	3,691	3,691	21,881	21,881	21,881
R^2	0.840	0.840	0.840	0.923	0.923	0.923	0.910	0.910	0.910

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the log of predicted total sales obtained as the sum of domestic and external sales and imputed final consumer sales. Estimates are obtained separately for the subsamples of suppliers in the agricultural, manufacturing, and service sector. The independent variables are defined in Section 4.2 where shares of sales are calculated using predicted total sales that include imputed final consumer sales. Standard errors are clustered at the ISIC 4-digit sector level.

Table A.6: Effect on Sales: IRAE Firms

	Log of Sales (Domestic + Exports)			Log of Sales (IRAE)		
	(1)	(2)	(3)	(4)	(5)	(6)
China Beef	0.0262*	0.0262*	0.0262*	0.0253*	0.0253*	0.0253*
Export Shock	(0.0157)	(0.0157)	(0.0157)	(0.0131)	(0.0132)	(0.0132)
Export Shock		0.0565*	0.0563*		0.0915*	0.0915*
		(0.0305)	(0.0305)		(0.0490)	(0.0490)
Import Shock			-0.00602			0.00117
			(0.0186)			(0.0155)
Firms FE	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓
Observations	14,077	14,077	14,077	14,077	14,077	14,077
R^2	0.929	0.929	0.929	0.952	0.953	0.953

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the log of sales from domestic transaction-level and customs data (columns 1 to 3) and the log of sales from corporate tax data (columns 4 to 6). The sample is restricted to those firm-year observations that appear in the two datasets. The independent variables are defined in Section 4.2. Standard errors are clustered at the ISIC 4-digit sector level.

Table A.7: Placebo Estimates: IRAE Firms

	Log of Total Sales (2009-2013)					
	(1)	(2)	(3)	(4)	(5)	(6)
China Beef	-0.00824	-0.00824	-0.00829	-0.00308	-0.00308	-0.00314
Export Shock $t + 5$	(0.0121)	(0.0121)	(0.0122)	(0.0138)	(0.0138)	(0.0138)
Export Shock $t + 5$		0.0109	0.0106		0.0105	0.0102
		(0.0510)	(0.0510)		(0.0508)	(0.0507)
Import Shock $t + 5$			-0.0106			-0.0105
			(0.0288)			(0.0289)
ROW Beef				-0.0388	-0.0388	-0.0387
Export Shock $t + 5$				(0.0258)	(0.0258)	(0.0258)
Firms FE	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓
Observations	14,077	14,077	14,077	14,077	14,077	14,077
R^2	0.923	0.923	0.923	0.923	0.923	0.923

Notes. * p-value$<$ 0.1; ** p-value$<$0.05; *** p-value$<$0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the log of sales from domestic transaction-level and customs data (columns 1 to 3) and the log of sales from corporate tax data (columns 4 to 6) looking at the period 2009 to 2013. The sample is restricted to those firm-year observations that appear in the two datasets. The independent variables are defined in Section 4.2, and take their value in year $t + 5$. Standard errors are clustered at the ISIC 4-digit sector level.

Table A.8: Effect on Sales: IRAE Service Firms

	Log of Sales (Domestic + Exports)			Log of Sales (IRAE)		
	(1)	(2)	(3)	(4)	(5)	(6)
China Beef	0.0624**	0.0623**	0.0623**	0.0631***	0.0630***	0.0631***
Export Shock	(0.0257)	(0.0258)	(0.0257)	(0.0203)	(0.0203)	(0.0204)
Export Shock		0.0941**	0.0940**		0.151	0.151
		(0.0358)	(0.0358)		(0.103)	(0.103)
Import Shock			-0.000404			0.00808
			(0.0178)			(0.0157)
Firms FE	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓
Observations	7,922	7,922	7,922	7,922	7,922	7,922
R^2	0.937	0.937	0.937	0.965	0.965	0.965

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the log of sales from domestic transaction-level and customs data (columns 1 to 3) and the log of sales from corporate tax data (columns 4 to 6). The sample is restricted to the service sector and to those firm-year observations that appear in the two datasets. The independent variables are defined in Section 4.2. Standard errors are clustered at the ISIC 4-digit sector level.

Table A.9: Placebo Estimates: IRAE Service Firms

	Log of Total Sales (2009-2013)					
	(1)	(2)	(3)	(4)	(5)	(6)
China Beef	-0.0148	-0.0147	-0.0149	-0.0161	-0.0161	-0.0163
Export Shock $t+5$	(0.0256)	(0.0256)	(0.0257)	(0.0243)	(0.0243)	(0.0244)
Export Shock $t+5$		-0.0348	-0.0355		-0.0351	-0.0358
		(0.0598)	(0.0591)		(0.0602)	(0.0594)
Import Shock $t+5$			-0.0117			-0.0118
			(0.0297)			(0.0297)
ROW Beef				0.0132	0.0135	0.0136
Export Shock $t+5$				(0.0706)	(0.0707)	(0.0707)
Firms FE	✓	✓	✓	✓	✓	✓
Sector $\times$ Year FE	✓	✓	✓	✓	✓	✓
Observations	7,922	7,922	7,922	7,922	7,922	7,922
R^2	0.934	0.934	0.934	0.934	0.934	0.934

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the log of sales from domestic transaction-level and customs data (columns 1 to 3) and the log of sales from corporate tax data (columns 4 to 6) looking at the period 2009 to 2013. The sample is restricted to the service sector and to those firm-year observations that appear in the two datasets. The independent variables are defined in Section 4.2, and take their value in year $t+5$. Standard errors are clustered at the ISIC 4-digit sector level.

Table A.10: Brazil-Based Shift-Share: Effect on Sales

	Log of Total Sales					
	(1)	(2)	(3)	(4)	(5)	(6)
Brazil-China Beef	0.0741***	0.0742***	0.0743***	0.0742***	0.0742***	0.0743***
Export Shock	(0.0129)	(0.0129)	(0.0130)	(0.0135)	(0.0135)	(0.0135)
Export Shock		-0.0208***	-0.0211***		-0.0208***	-0.0211***
		(0.00468)	(0.00472)		(0.00469)	(0.00473)
Import Shock			0.0419			0.0419
			(0.0326)			(0.0326)
ROW Beef				0.0007	0.0007	0.0007
Export Shock				(0.0218)	(0.0218)	(0.0218)
Firms FE	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓
Observations	69,712	69,712	69,712	69,712	69,712	69,712
R^2	0.871	0.871	0.871	0.871	0.871	0.871

Notes. * p-value$<$ 0.1; ** p-value$<$0.05; *** p-value$<$0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 replacing the Brazil-based double shift-share $BRCBE$ in equation 6 as main independent variable and having as dependent variable the log of total sales, which we calculate from transaction-level and customs data as the sum of domestic and external sales. Standard errors are clustered at the ISIC 4-digit sector level.

Table A.11: Brazil-Based Shift-Share: Effect on Sales by Industry

	Log of Total Sales								
	Agriculture			*Manufacturing*			*Services*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brazil-China Beef	0.0655***	0.0653***	0.0653***	0.127**	0.127**	0.127**	0.101**	0.101**	0.102**
Export Shock	(0.0074)	(0.0075)	(0.0075)	(0.0576)	(0.0578)	(0.0580)	(0.0419)	(0.0419)	(0.0419)
Export Shock		0.351***	0.359***		-0.0262	-0.0170		-0.0235***	-0.0237***
		(0.113)	(0.120)		(0.0611)	(0.0512)		(0.0035)	(0.0035)
Import Shock			0.481			0.595***			0.0261
			(0.850)			(0.112)			(0.0286)
Firms FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	43,439	43,439	43,439	3,437	3,437	3,437	21,999	21,999	21,999
R^2	0.831	0.831	0.831	0.912	0.912	0.912	0.904	0.904	0.904

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 replacing the Brazil-based double shift-share $BRCBE$ in equation 6 as main independent variable and having as dependent variable the log of total sales, which we calculate from transaction-level and customs data as the sum of domestic and external sales. Estimates are obtained separately for the subsamples of suppliers in the agricultural, manufacturing, and service sector. Standard errors are clustered at the ISIC 4-digit sector level.

Table A.12: Effect on Imports of High-Quality Products by Industry

	Log of Import Value								
	Agriculture			*Manufacturing*			*Services*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
China Beef Export Shock	-0.00257	-0.00408	-0.00422	-0.152	-0.156	-0.153	0.0743**	0.0743**	0.0751**
	(0.00292)	(0.00321)	(0.00331)	(0.182)	(0.184)	(0.185)	(0.0291)	(0.0291)	(0.0292)
Export Shock		2.474***	2.526***		-0.412**	-0.355*		0.0427***	0.0422***
		(0.257)	(0.282)		(0.181)	(0.181)		(0.00292)	(0.00409)
Import Shock			3.437			-1.535***			0.0581
			(3.667)			(0.444)			(0.302)
Firms FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	42,421	42,421	42,421	3,407	3,407	3,407	20,762	20,762	20,762
R^2	0.474	0.477	0.477	0.790	0.790	0.791	0.814	0.814	0.814

Notes. * p-value$<$0.1; ** p-value$<$0.05; *** p-value$<$0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing equation 2 and having as dependent variable the log value of imports of high-quality products. High-quality products are defined as imported products whose unit price belongs to the top quartile of the HS6 product code-year price distribution. Estimates are obtained separately for the subsamples of suppliers in the agricultural, manufacturing, and service sector. The independent variables are defined in Section 4.2. Standard errors are clustered at the ISIC 4-digit sector level.

Table A.13: Downstream Spillover Effect on Sales

	Log of Total Sales					
	(1)	(2)	(3)	(4)	(5)	(6)
Downstream China Beef Export Shock	-0.00492	-0.00498	-0.00500	-0.00938	-0.00943	-0.00947
	(0.00653)	(0.00655)	(0.00655)	(0.00614)	(0.00617)	(0.00617)
Export Shock		-0.0226***	-0.0228***		-0.0232***	-0.0235***
		(0.00547)	(0.00550)		(0.00537)	(0.00541)
Import Shock			0.0381			0.0427
			(0.0349)			(0.0347)
China Beef Export Shock				0.0713***	0.0714***	0.0715***
				(0.0212)	(0.0212)	(0.0212)
Firms FE	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓
Observations	56,344	56,344	56,344	56,344	56,344	56,344
R^2	0.872	0.872	0.872	0.872	0.872	0.872

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a firm that, in 2014, purchased any goods or services from suppliers to beef exporters. The table reports the coefficient estimates obtained when implementing equation 2 having both the downstream shift-share $DOWNCBE$ in equation 7 and the original shift-share CBE as independent variables and having as dependent variable the log of total sales, which we calculate from transaction-level and customs data as the sum of domestic and external sales. Standard errors are clustered at the ISIC 4-digit sector level.

Table A.14: Downstream Spillover Effect on Employment, Wages, and Sales per Worker

Log of	*Employment*			*Average Wage*			*Sales Per Worker*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Downstream China	-0.000197	-0.000201	-0.000198	0.00638**	0.00642**	0.00642**	0.00252	0.00253	0.00253
Beef Export Shock	(0.00288)	(0.00288)	(0.00288)	(0.00270)	(0.00270)	(0.00270)	(0.00694)	(0.00694)	(0.00694)
Export Shock		-0.00256	-0.00250		0.0300***	0.0300***		0.00297	0.00309
		(0.00367)	(0.00369)		(0.00512)	(0.00521)		(0.00762)	(0.00761)
Import Shock			-0.0123			0.0110			-0.0257
			(0.0220)			(0.0363)			(0.0355)
Firms FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	44,948	44,948	44,948	44,948	44,948	44,948	44,948	44,948	44,948
R^2	0.937	0.937	0.937	0.820	0.820	0.820	0.857	0.857	0.857

Notes. * p-value$<$ 0.1; ** p-value$<$0.05; *** p-value$<$0.01. The unit of observation is a firm that, in 2014, purchased any goods or services from suppliers to beef exporters. The table reports the coefficient estimates obtained when implementing equation 2 having the downstream shift-share $DOWNCBE$ in equation 7 as main independent variable and having as dependent variable the log of employment, average wage, and sales per worker. Standard errors are clustered at the ISIC 4-digit sector level.

Table A.15: Effect on Firm Exit

	Exit $\{0,1\}$		
	(1)	(2)	(3)
China Beef Export Shock	-0.1040***	-0.1040***	-0.1050***
	(0.0366)	(0.0366)	(0.0360)
Export Shock		0.0038***	0.0025
		(0.0014)	(0.0016)
Import Shock			-0.1400**
			(0.0636)
Sector FE × $\ln t$	✓	✓	✓
Observations	67,730	67,730	67,730

Notes. * p-value< 0.1; ** p-value<0.05; *** p-value<0.01. The unit of observation is a supplier to a beef exporter in a given year. The table reports the coefficient estimates obtained when implementing a logit regression specification having a dummy for firm exit as dependent variable, the same main regressors as in equation 2, and sector-specific duration dependence modeled as the interaction of sector fixed effects with $\ln t$ where t is the time period variable equal to 1 in 2014, 2 in 2015, etc. Standard errors are clustered at the ISIC 4-digit sector level.

Table A.16: Aggregate Effects

	2014	2015	2016	2017	2018	2019	Total
Actual Sales (Millions UYP)	1,419,782	1,573,081	1,564,832	1,680,643	1,940,057	1,976,130	10,154,525
Counterfactual Sales (Millions UYP)	1,408,041	1,552,646	1,542,138	1,653,735	1,904,358	1,914,880	9,975,798
Difference (Millions UYP)	11,741	20,435	22,694	26,908	35,699	61,251	178,728
Direct Effect (Millions UYP)	8,112	13,885	15,559	18,148	24,317	41,978	121,999
Network Effect (Millions UYP)	3,629	6,549	7,135	8,760	11,382	19,273	56,728
Difference (%)	0.83	1.32	1.47	1.63	1.87	3.20	1.79
Direct Effect (%)	0.58	0.89	1.01	1.10	1.28	2.19	1.22
Network Effect (%)	0.26	0.42	0.46	0.53	0.60	1.01	0.57

Notes. The table reports the results from the counterfactual analysis presented in Section 5.2. Aggregate counterfactual sales correspond to those we would have observed had China beef exports been equal to zero in each year. The table reports the value and percentage difference between actual and counterfactual sales, along with the decomposition into direct and network effects, as outlined in equation 12.

Table A.17: Network Effects by Sector

	Millions UYP	%	Baseline	Changing
Agriculture	40,845	72.00	62,638	-21,793
Mining	882	1.55	-2,525	3,407
Manufacturing	2,267	4.00	-19,654	21,921
Services	12,734	22.45	-36,035	48,769
Total	56,728	100.00	4,424	52,304

Notes. The table reports the results from the decomposition of network effects into baseline and changing network effects, as discussed in Section 5.2.1. Values are aggregated over the whole period from 2014 to 2019.

Table A.18: Counterfactual Analysis – Firm-Level Correlates

	$\ln S/\tilde{S}$			
	(1)	(2)	(3)	(4)
Supplier	0.0875***			0.1190***
	(0.0015)			(0.0012)
Initial Log Sales		-0.0022***		-0.0080***
		(0.0001)		(0.0002)
Exit			-0.0211***	-0.0260***
			(0.0008)	(0.0008)
Constant	0.0055***	0.0400***	0.0211***	0.1100***
	(0.0004)	(0.0018)	(0.0005)	(0.0020)
Observations	223,325	130,410	223,325	130,410
R^2	0.015	0.002	0.003	0.085

Notes. The table reports estimated coefficients and standard errors from regressions that include all firms in the data. The dependent variable is the log difference between actual and counterfactual sales aggregated over time at the firm level, i.e., $S_i = \sum_t s_{it}$ and $\tilde{S}_i = \sum_t \tilde{s}_{it}$. Regressors include an indicator for whether the firm was a supplier to a beef exporter in 2014, initial log sales (when available), and an indicator for whether the firm exited during the period 2014 to 2019.

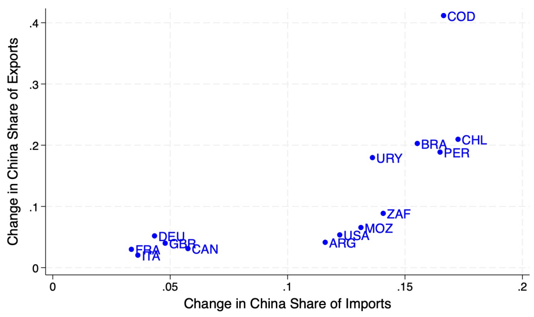
Table A.19: Counterfactual Analysis – Suppliers' Averages by Sector

	$\mathbb{E}\{\ln S/\tilde{S}\}$	$\mathbb{E}\{\ln S/\dot{S}\}$	$\mathbb{E}\{\ln \dot{S}/\tilde{S}\}$
All Suppliers	0.093	0.109	-0.016
Agriculture	0.144	0.184	-0.039
Manufacturing	-0.024	-0.105	0.081
Services	0.009	-0.007	0.015

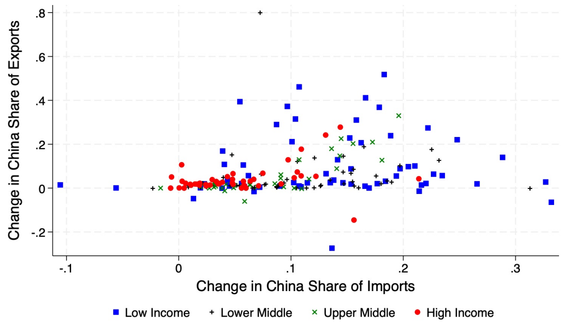
Notes. The table reports average log differences across baseline suppliers to beef exporters. Actual and counterfactual sales, defined in Section 5.2, are aggregated over time at the firm level, i.e., $S_i = \sum_t s_{it}$, $\tilde{S}_i = \sum_t \tilde{s}_{it}$, and $\dot{S}_i = \sum_t \dot{s}_{it}$. The first column shows the average log difference between actual and counterfactual sales when the network is held fixed at its actual structure in each year t. The second column reports the average log difference when the network is instead fixed at its 2014 structure. The third column presents the average log difference between the two counterfactual scenarios, comparing results with the network fixed at its 2014 structure versus its evolving actual structure over time.

Figure A.1: China Share of Imports and Exports: Changes 2000 to 2017

(a) Selected Countries

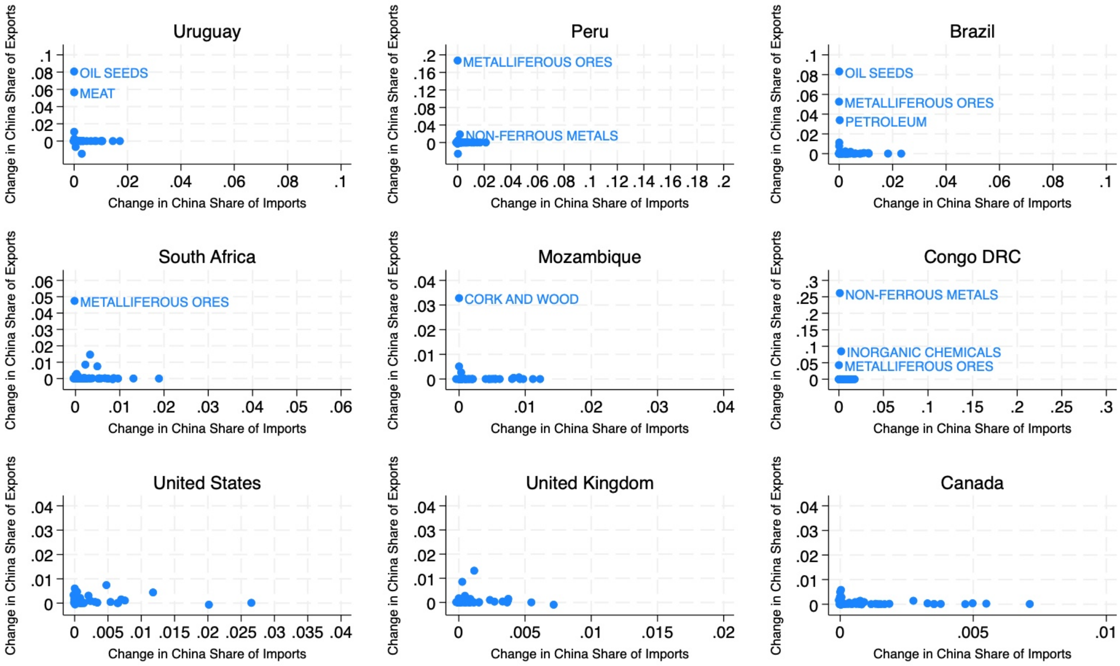


(b) All Countries



Notes. The left panel plots, for selected countries, the change in the Chinese share of exports against the change in the Chinese share of imports over the period 2000 to 2017. The right panel plots the same changes in Chinese export and import shares for all countries for which data are available, split by income group. Data from COMTRADE via The Growth Lab at Harvard University (2019).

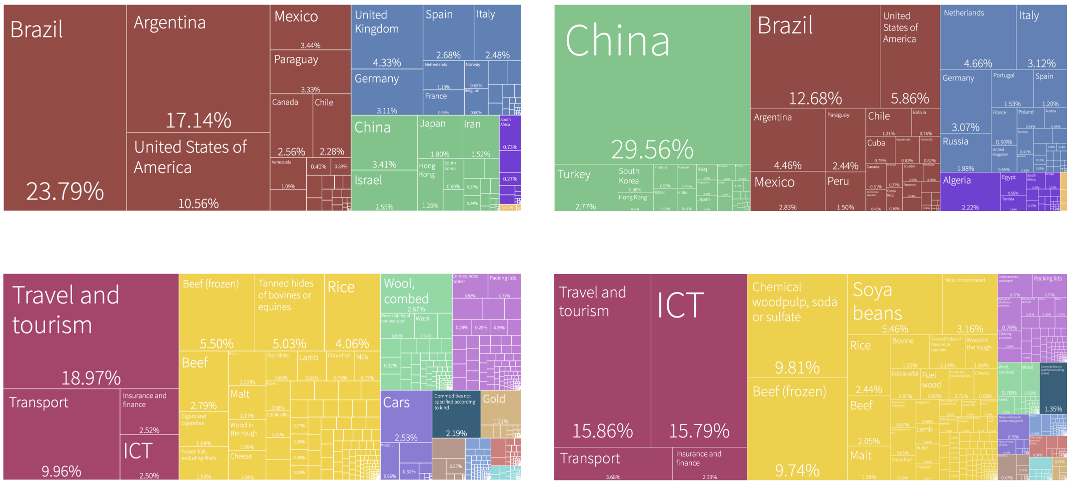
Figure A.2: China Share of Imports and Exports by Sector: Changes 2000 to 2017



Notes. The figures plot, for selected countries, the change in the Chinese share of exports against the change in the Chinese share of imports by 2-digit sector over the period 2000 to 2017. Data from COMTRADE via The Growth Lab at Harvard University (2019).

Figure A.3: Uruguay Exports

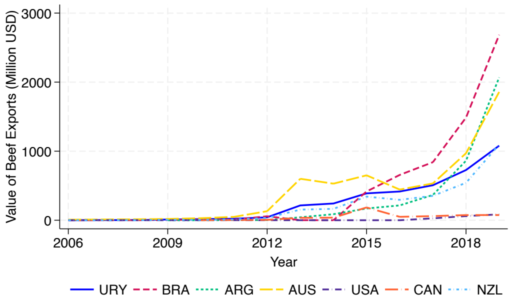
2000 2019



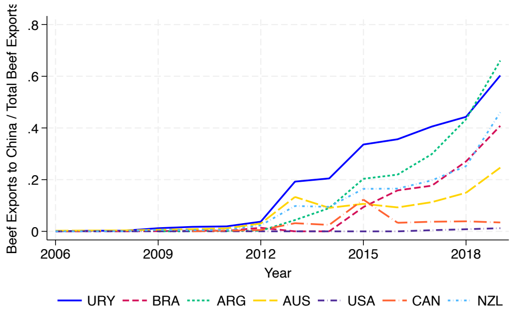
Notes. The figure shows the composition of exports by destination (top) and by category (bottom) and in the years 2000 (left) and 2019 (right). Data from The Growth Lab at Harvard University (2019).

Figure A.4: Beef Exports to China Across Countries

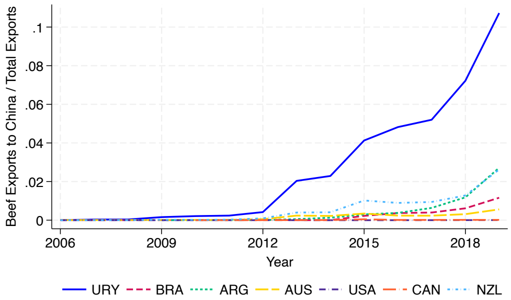
(a) Value of Beef Exports to China



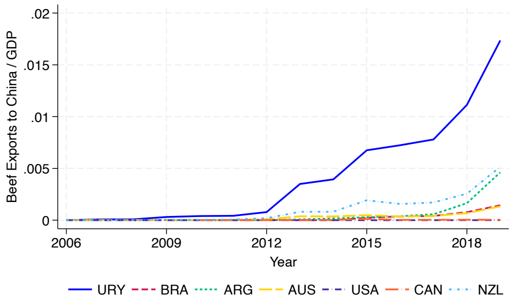
(b) Beef Exports to China as Share of All Beef Exports



(c) Beef Exports to China as Share of All Exports

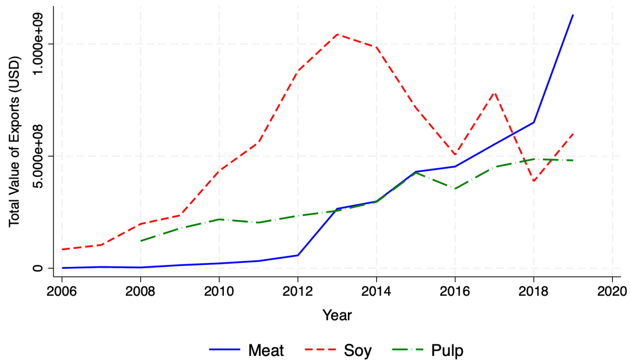


(d) Beef Exports to China as Share of GDP



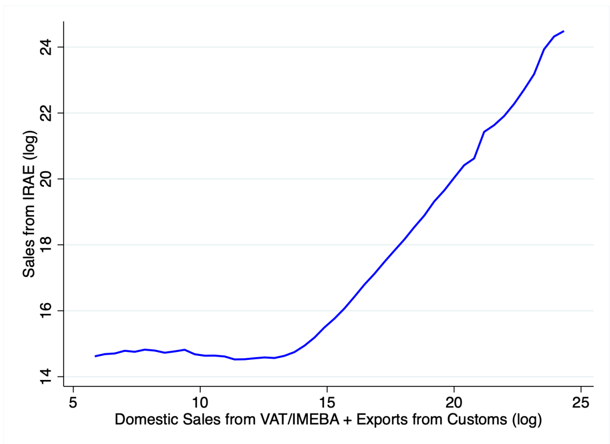
Notes. The figures show the evolution of beef exports to China over time in value and in relationship to the aggregate value of beef exports, aggregate value of exports, and country's GDP.

Figure A.5: Uruguay Exports to China



Notes. The figure plots the value of meat, soy, and pupl exports to Chna over time. Values are in Uruguayan Pesos. Data from COMTRADE via The Growth Lab at Harvard University (2019).

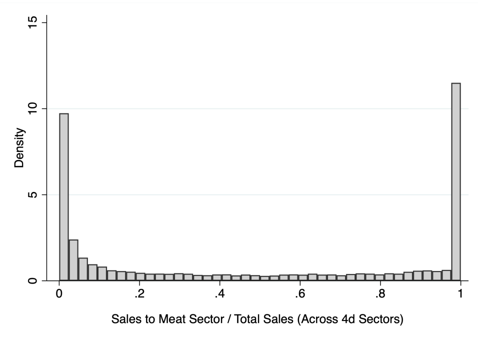
Figure A.6: Validation of Total Sales



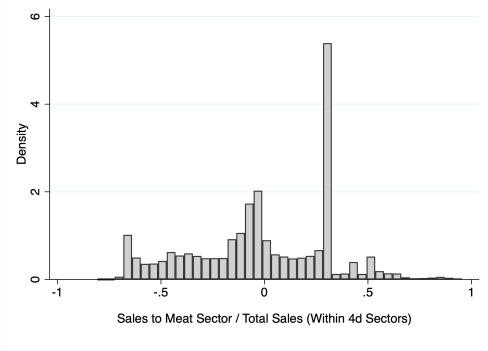
Notes. The figure plots the local polynomial smoothing of the relationship between (log) sales from corporate tax data against the (log) sales from domestic transactions and customs data for all years from 2014 to 2019.

Figure A.7: Linkages to Beef Sector and Beef Exporters

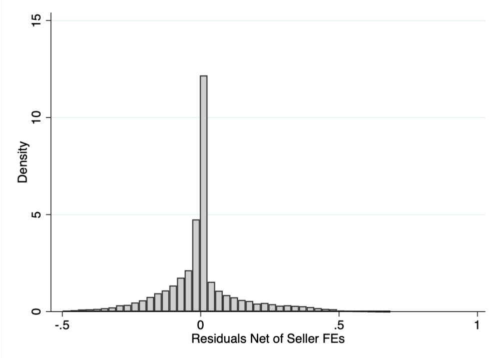
(a) Across Sectors



(b) Within Sectors

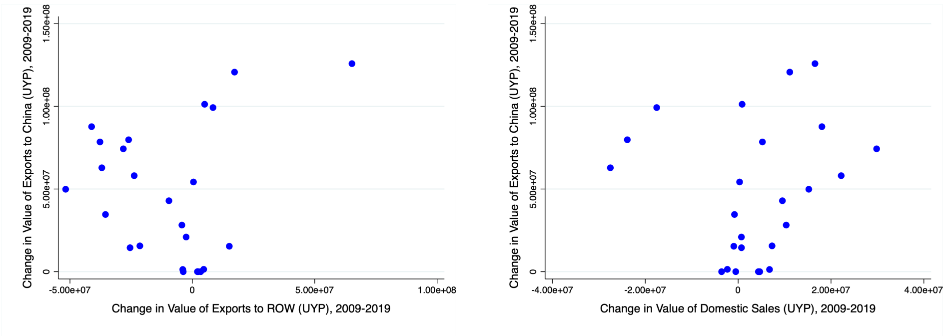


(c) Within Firms



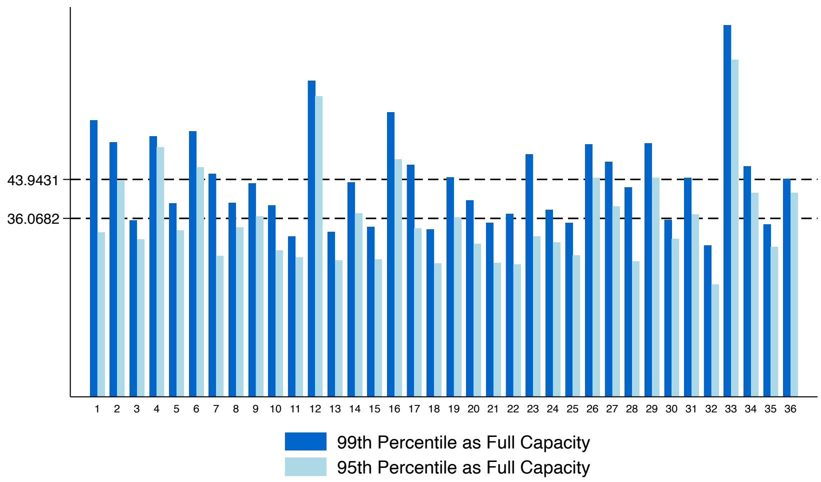
Notes. The figure in panel a plots the distribution of the beef sector linkage measure across sectors, excluding firms with no linkages with the beef sector. The figure in panel b plots the residuals of the same measure after netting out 4-digit sector fixed effects. The figure in panel c plots instead the distribution of the exporter specific linkage measure, showing the residuals net of supplier fixed effects.

Figure A.8: Exports and Domestic Sales Over Time: Variation Across Exporters



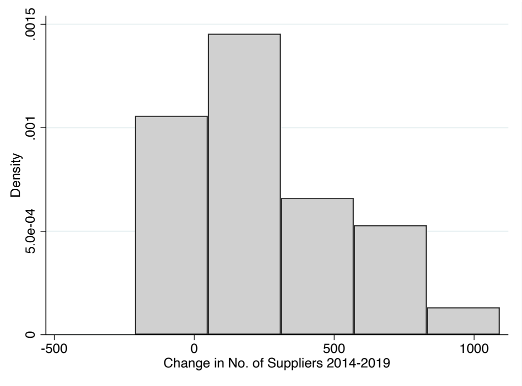
Notes. The left panel plots for each beef exporters the change in the value of exports to China against the corresponding change in exports towards the rest of the world between the years 2009 and 2019. The right panel shows instead the change in the value of exports to China against the corresponding change in the value of domestic sales over the same time period.

Figure A.9: Idle Capacity Estimates by Exporter



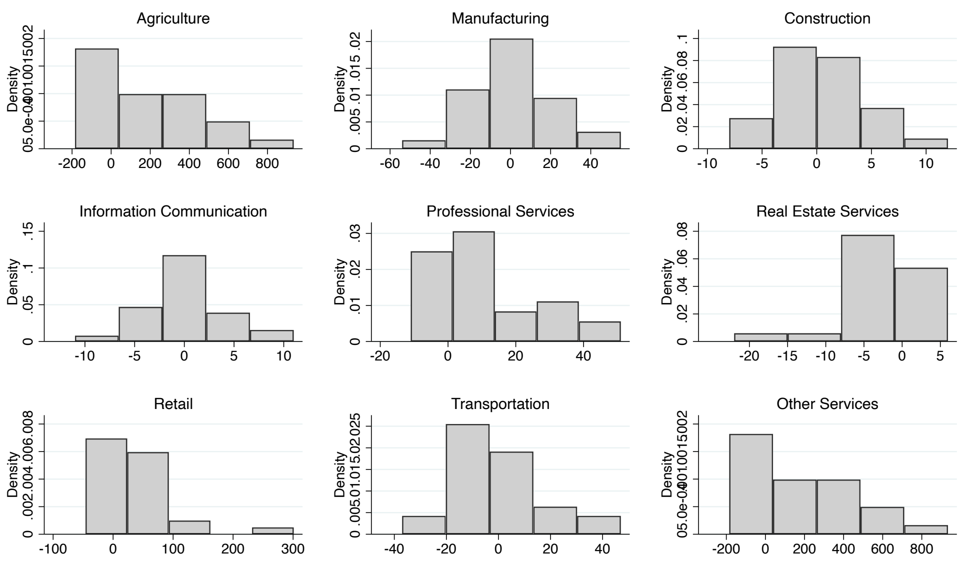
Notes. The figure plots our estimates of idle capacity by exporter in 2014, which we obtained by calculating, for each exporter, the 99th and 95th percentiles of production over the period—taken as proxies for full capacity—and then computing the average percentage difference across all months. The overall averages are highlighted on the y-axis.

Figure A.10: Suppliers to Beef Exporters: Changes 2014-2019



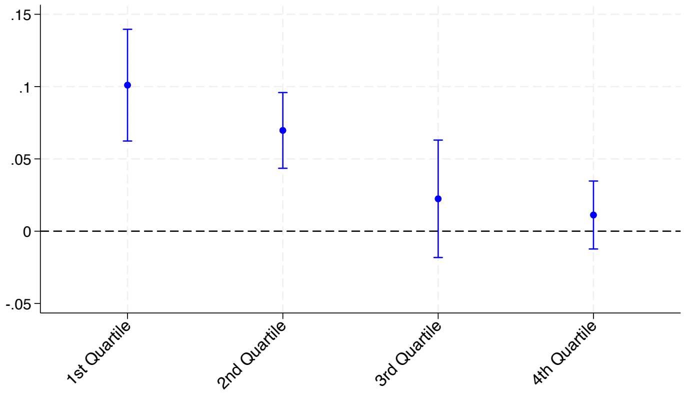
Notes. The figures plots the distribution across beef exporters of the change in the number of suppliers between 2014 and 2019.

Figure A.11: Suppliers to Beef Exporters by Sector: Changes 2014-2019



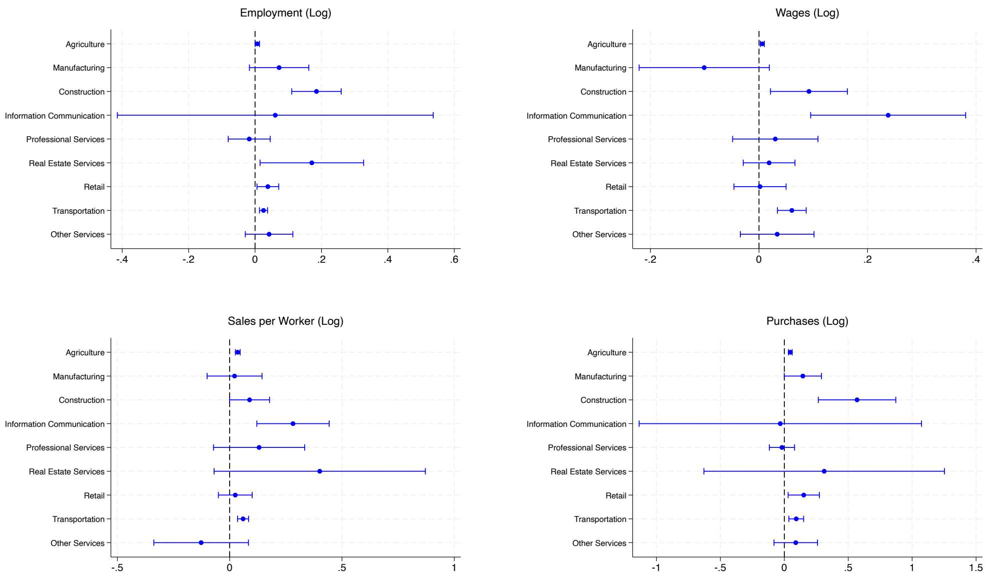
Notes. The figures plots the distribution across beef exporters of the change in the number of suppliers between 2014 and 2019, separately by sector as defined by aggregating ISIC 4-digit classifications.

Figure A.12: Sales Effect Heterogeneity by Initial Size



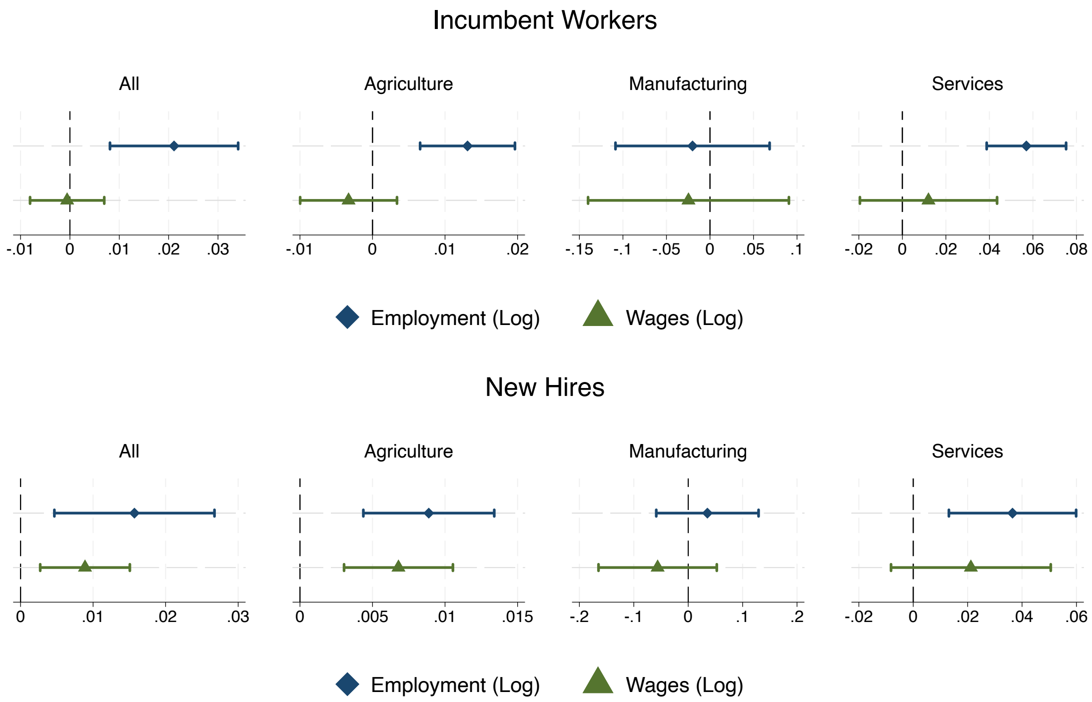
Notes. The figure shows graphically the estimated coefficients of the China beef export shock variable and their 90% confidence intervals, obtained when implementing the specification in equation 2 separately in each quartiles of the distribution of suppliers' total sales in the baseline year 2014.

Figure A.13: Effect Heterogeneity by Sector for Other Outcomes



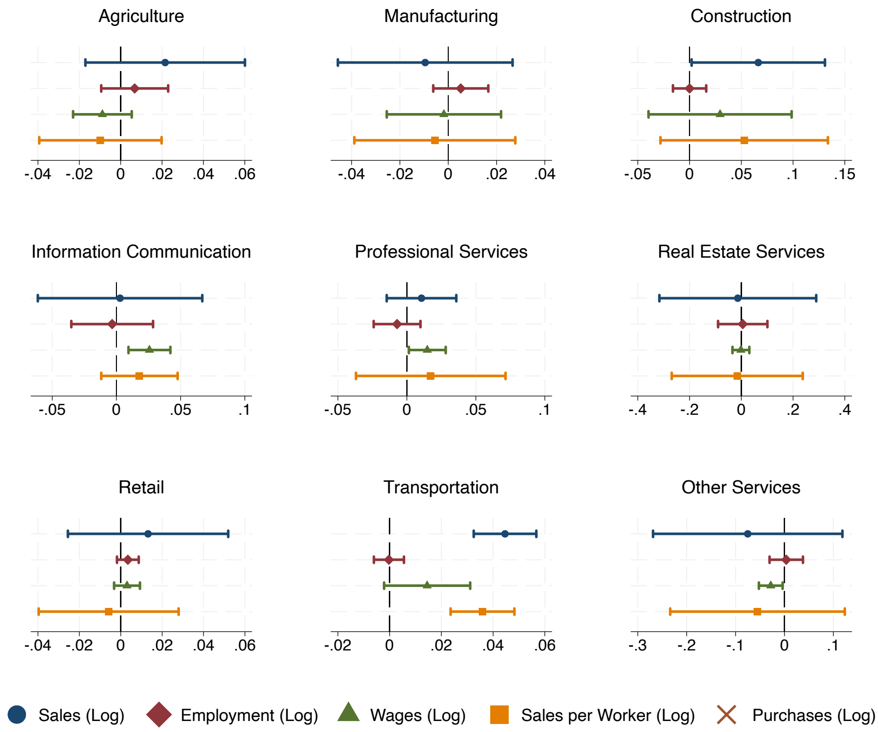
Notes. The figure shows graphically the estimated coefficients of the China beef export shock variable and their 90% confidence intervals, obtained when implementing the specification in equation 2 separately for suppliers in specific sectors—which we construct by aggregating ISIC 4-digit classifications—and having as dependent variables the log of employment (top left figure), the log of wages (top right), the log of sales per worker (bottom left), and the log of total purchases (bottom right).

Figure A.14: Employment and Wage Effect: Incumbent Workers vs. New Hires



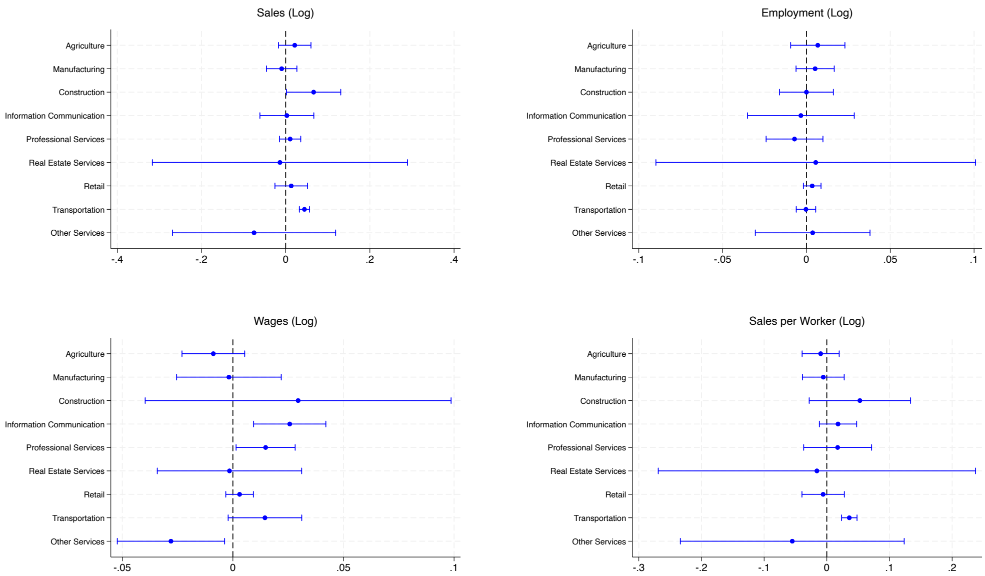
Notes. The figure shows graphically the estimated coefficients of the China beef export shock variable and their 90% confidence intervals, obtained when implementing the specification in equation 2 having as dependent variables the log of employment and wages of incumbent workers (top panel) and new hires (bottom panel).

Figure A.15: Second-Order Effect Heterogeneity by Sector and Outcome



Notes. The figure shows graphically the estimated coefficients of the China beef export shock variable and their 90% confidence intervals, obtained when implementing the augmented regression specification discussed in footnote 17 in the end of Section 4.2 separately for suppliers in specific sectors—which we construct by aggregating ISIC 4-digit classifications—and having as dependent variables the log of sales, log of employment, log of wages, log of sales per worker, and log of total purchases.

Figure A.16: Second-Order Effect Heterogeneity by Sector



Notes. The figure shows graphically the estimated coefficients of the China beef export shock variable and their 90% confidence intervals, obtained when implementing the augmented regression specification discussed in footnote 17 in the end of Section 4.2 separately for suppliers in specific sectors—which we construct by aggregating ISIC 4-digit classifications—and having as dependent variables the log of employment (top left figure), the log of wages (top right), the log of sales per worker (bottom left), and the log of total purchases (bottom right).