WORKING PAPER Nº IDB-WP-1685

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Evidence from Costa Rica

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Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Gomez-Trejos, Felipe.
Market power, industry concentration and trade liberalization: evidence from Costa Rica / Felipe Gomez-Trejos, Daniela Córdoba Solano, Alberto Vindas Quesada.
p. cm. — (IDB Working Paper Series ; 1685)
Includes bibliographical references.
1. Industrial organization (Economic theory). 2. Commercial policy-Econometric models-Costa Rica. 3. Industries-Econometric models-Costa Rica. 4. Tariff-Econometric models-Costa Rica. 5. Free trade-Econometric models-Costa Rica. I. Córdoba Solano, Daniela. II. Vindas Quesada, Alberto. III. Inter-American Development Bank. Department of Research and Chief Economist. IV. Title. V. Series.
IDB-WP-1685

http://www.iadb.org

Abstract

Research about trade liberalization's impact on markups has focused on manufacturing due to data availability considerations. How do these effects vary across sectors? Which industries become more and less competitive as trade barriers are eliminated? We leverage firm-level tax records from the universe of formal-sector businesses in Costa Rica with the 2009 trade liberalization as a natural experiment to evaluate its industry-specific effects on markups across all industries. We find negative effects on markups in agriculture, mining, electricity, water supply, and business services. Alternatively, the reform led to markup increases in accommodations and food services, information and communications, real estate, finance and insurance, and education, health, and social work. We do not observe statistically significant effects in manufacturing, transportation and storage, construction, and wholesale and retail trade. Our findings represent a more comprehensive evaluation of the potential pro-competitive effects from trade liberalization than existing studies exclusively focusing on manufacturing firms.

JEL classifications: D22, L11, F13, F14
Keywords: Market power, Markup, Costa Rica, Latin America, Trade, Liberalization, Tariff

Felipe Gomez-Trejos, Daniela Córdoba Solano, and Alberto Vindas Quesada. Acknowledgments: The authors acknowledge financial support for this project provided by the Latin America and Caribbean Research Network of the Inter-American Development Bank (IDB) under grant project number RG – K1198.
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1 Introduction

One of the longest-standing questions in trade literature concerns the impact of liberalization on markups. It is widely known that increased trade exposure due to liberalization fundamentally affects industry dynamics that influence market power capabilities. For instance, it changes industry structure by facilitating firm entry (Krugman (1980)). In addition, it influences industry composition by affecting firm sizes (Hopenhayn (1992)) and forcing attrition of the least efficient firms (Melitz (2003)). Free trade proponents have long argued that liberalization enhances economic efficiency by removing barriers to competitive incentives across markets.

Still, the direction of change in firm-level markups from increased trade exposure is theoretically indeterminate and must be revealed through the data. This is due to the complex interaction of economic forces that originate from trade liberalization. As indicated by Melitz (2003), entry of new foreign firms into the domestic market increases local supply, which drives down prices and markups. The subsequent exit of the least efficient firms amplifies this effect, as market recomposition towards higher average productivity firms boosts demand for labor, capital, and materials, which raises factor prices and increases firm-level marginal production costs. Nonetheless, a reduction in tariffs decreases net marginal production costs, which, if firms are unable to fully pass cost shocks onto consumers through prices, leads to higher markups *ceteris paribus*.

Most importantly, these effects may vary significantly across industries, depending on their degree of export orientation and pre-reform exposure to trade tariffs. As shown by Melitz (2003) and subsequent work (e.g., Raval (2023), De Loecker et al. (2020), De Loecker et al. (2016), De Loecker and Warzynski (2012), De Loecker (2011)), this is because firm selection into export status is critical for generating industry heterogeneity, as exporting firms tend to be more productive, capital-intensive, diversified, and oriented towards high-skilled labor. How does trade liberalization affect firm-level markups? How do these effects vary based on industry sector? Which industries become more and less competitive as the economy eliminates trade barriers?

We address these key policy questions by using detailed microdata from 2005–2022 firm-level administrative tax records, sourced from the entire universe of Costa Rican businesses, to estimate firm-level markups over time. The analysis closely follows the production function estimation approach developed by De Loecker and Warzynski (2012), which does not require assumptions about firms' demand curves, constant returns to scale in technology, or observation of the user cost of capital. Our detailed microdata allow accounting for variation in labor, capital, materials, and energy demand (i.e., electricity consumption) at the firm level, thereby enabling us to explicitly isolate and control for unobserved productivity shocks and potential measurement error from output data in our estimates. We then use these production function estimates to determine firm-level output-input elasticities (for labor, capital, raw materials, and energy) and calculate time-specific markups backed up from the firm's cost minimization first-order condition. This means that our empirical strategy critically relies on cost-minimizing behavior as its key identifying assumption.

Subsequently, we leverage our markup estimates in conjunction with the 2009 trade liberalization episode in Costa Rica—resulting from the free trade agreement with the United States—as a natural experiment to empirically evaluate the industry-specific impact of trade liberalization on firm-level markups within a triple difference-in-differences (DiD) framework. For identification, we exploit *industry-specific* variation in *pre-reform* firm-level markups *between treated and non-treated* firms dating back to 2006 before the trade reform was announced (where we consider treated firms as those who engaged in trade with foreign entities after implementation of the trade reform), and compare it to *post-reform* variation while explicitly controlling for potential selection of firms into treatment status (i.e., whether firms adjust their export or import status in response to the trade reform). Therefore, our empirical approach delivers a robust identification strategy that effectively isolates the industry-specific effects of trade liberalization from firms' anticipatory behavior and other economically relevant confounding factors as non-observable industry heterogeneity and potential selection into treatment. In addition, by encompassing the full spectrum of businesses and industries in the formal economy, our data allow us to uncover the complete distribution of average trade reform effects on firm-level markups segmented by industry sector, thereby quantifying the heterogeneity in trade liberalization impacts across the economy.

Our analysis delivers four key findings. First, the trade liberalization episode had statistically significant negative effects on average markups in five industry sectors: agriculture; mining; electricity, gas, steam, and air conditioning; water supply, and business services. This implies that the reduction in markups attributable to decreased output prices (resulting from the entry of foreign firms into the domestic market and its recomposition towards more productive firms) and the increase in marginal production costs (due to more productive firms competing for labor) outweigh the impact of reduced import tariffs on markups. In contrast, the trade reform increased average markups in five other sectors: accommodations and food services, information and communications, real estate; finance and insurance; and education, health, and social work—i.e., implying that the reduction of import tariffs predominantly drives the direction of the change in markups. Quantitatively, our results uncover a significant degree of heterogeneity in the trade reform effects across these sectors (e.g., a $\sim$20% *increase* in average markups in accommodations and food services compared to a $\sim$10% *decrease* in agriculture), even among industries where average markups were affected in the same direction. Last, we do not observe significant trade reform effects on average markups in manufacturing, transportation and storage; construction, and wholesale and retail trade, indicating that the previously described economic forces tend to offset each other in such industries.

This paper enhances our understanding of the relationship between trade liberalization, market power, and industry organization. In doing so, it establishes a new connection between the extensive literature on market power fundamentals and empirical work that examines the impact of trade policy on market power behavior. On one hand, a dominant section of recent literature about market power has traditionally focused on analyzing markup fundamentals (e.g., Ganapati and McKibbin (2023), Preonas (2023), De Loecker et al. (2020), Loertscher and Marx (2019), Thomassen et al. (2017), Hottman et al. (2016), DeSouza (2009)). Another leading portion of this literature has investigated the effects of market power on efficiency and welfare distribution (e.g., Ball and Mankiw (2023), Berger et al. (2022), Allen et al. (2019), Hortacsu et al. (2019), Ito and Reguant (2016)). Other recent research efforts examine the effects of market power on product quality and diversity (e.g.,Dhingra and Morrow (2019) and Matsa (2011)), as well as the interaction between market power and information asymmetries (e.g., Lester et al. (2019), Crawford et al. (2018), Glode and Opp (2016)). On the other hand, studies that investigate the impact of trade policy on market power have focused on empirically assessing the competitive effects of reductions in output and input tariffs (e.g., De Loecker et al. (2016), De Loecker (2011), Goldberg et al. (2009), and Amiti and Konings (2007)).

Within these strands of literature, the closest work to our paper is that of De Loecker et al. (2016), Lu and Yu (2015) and De Loecker (2011). Similar to our approach, these studies empirically assess the impact of trade liberalization on markups by *specifically* relying on manufacturing data due to broader accessibility considerations. For instance, De Loecker et al. (2016) leverages manufacturing data from Indian firms, while De Loecker (2011) and Lu and Yu (2015) draw on textile data from Belgian firms and manufacturing data from Chinese firms, respectively.

Unlike De Loecker et al. (2016), Lu and Yu (2015) and De Loecker (2011), we provide policy-relevant evidence on the significant degree of heterogeneity in trade liberalization effects on markups across industries. By exploiting firm-level variation in tax records data across the entire universe of formal Costa Rican businesses, we are able to i) uncover the heterogeneity of firm-level markups within and across industries, and ii) identify and estimate the industry-specific causal effects of the trade liberalization reform on average firm-level markups. This advancement enables us to assess which industries became more and less competitive as trade barriers were eliminated, providing a more comprehensive evaluation of potential pro-competitive effects from trade liberalization than existing studies that focus exclusively on manufacturing firms.

The rest of this paper is as follows. Section 2 provides an overview of the 2009 trade liberalization experience in Costa Rica. Section 3 describes the tax records data used in the empirical analysis. Section 4 details the methodology for measuring firm-level markups and the research design used to estimate the effects of trade liberalization on markups. Section 5 discusses our empirical findings. Section 6 offers concluding remarks.

2 Institutional Background: The 2009 Trade Reform

The 2009 trade reform, known as the Central America-Dominican Republic-United States Free Trade Agreement (CAFTA-DR), was initiated with the intention to enhance economic integration and promote trade among the signatory countries. Following private negotiations, an initial and preliminary draft of the

CAFTA-DR agreement was signed by the Costa Rican executive branch in 2004. This agreement implied a multilateral commitment to a trade partnership with the United States, Costa Rica's primary trading partner, through the comprehensive elimination of tariff and non-tariff barriers.

However, the agreement required formal ratification by the Costa Rican legislative branch to become law. Following three years of intense public debate, the free trade agreement was narrowly approved through a national referendum in October 2007, with 51.6% of the electorate voting in favor. This approval signaled the incorporation of the agreement into Costa Rica's legal framework. After the referendum and several rounds of amendments to the initial draft, the legislative branch formally ratified the agreement in September 2008. This ratification enabled the agreement's official implementation, which took effect on January 1, 2009. Furthermore, this historical timeline establishes the announcement period of the trade liberalization reform between October 2007 and September 2008.

Among the central features of the agreement, three key aspects defined the trade liberalization policy. First, the trade reform involved a significant and comprehensive bilateral reduction of both tariff and non-tariff barriers. This included the gradual lowering of customs duties on a broad range of goods and services and the removal of quotas. This was particularly significant for Costa Rican trade with the United States, considering that approximately 40% of Costa Rica's exports and imports were with the United States by the time that the trade reform came into effect. Specifically, starting in January 2009, the implementation of CAFTA-DR led to the immediate elimination of tariffs on 80% of imported goods from the United States For the remaining traded products, bilateral tariff reductions followed a longer, more gradual schedule, until tariffs were completely eliminated by the end of 2015. We focus on investigating the *short-term* effects of the trade liberalization episode resulting from the immediate and comprehensive tariff elimination phase that took effect in January 2009.

Other important provisions of the agreement included monopoly deregulation and investment protections. The agreement contained provisions for ending state-owned monopolies in the telecommunications and insurance sectors. Additionally, the agreement sought to enhance the enforcement of investor and property rights. This included measures to protect foreign direct investments with the aim of incentivizing capital flows from the United States into the Costa Rican economy.

To contextualize the significance of the 2009 trade liberalization episode within the Costa Rica-U.S. trade relationship, we present an overview of key stylized facts concerning economy-wide production patterns in Costa Rica and trade flows with the United States over the past two decades. This overview provides essential background for interpreting the empirical context that frames the main findings discussed in Section 5. Additionally, it underscores our motivation to examine the heterogeneity in pro-competitive effects of trade liberalization across industries in the context of the Costa Rican economy.

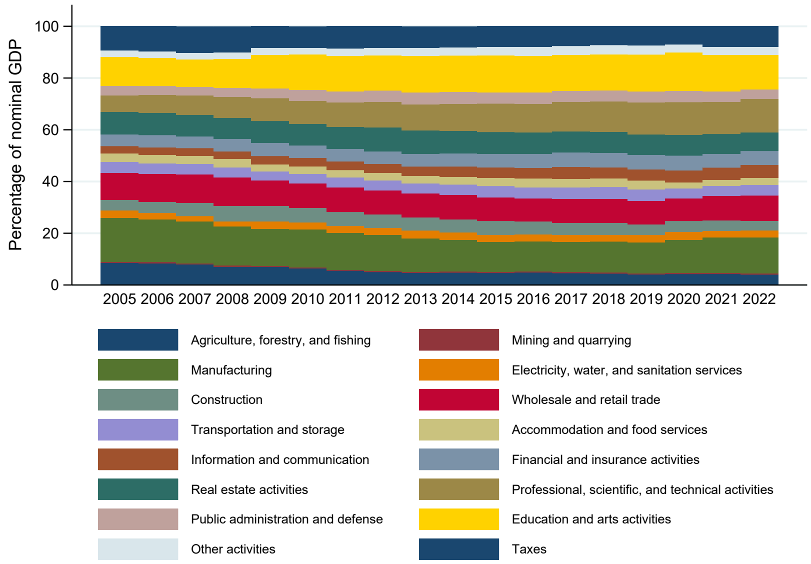


Figure 1: **GDP Decomposition by Industry Sector, 2005–2022**

Note: This figure shows year-by-year GDP decomposition by industry sector. Each participation weight is calculated by obtaining the ratio of industry-specific value of trade to nominal GDP.

Figure 1 shows the composition of economic activities contributing to Costa Rica's GDP. Notably, the manufacturing and education sectors have played a quantitatively significant role over the past two decades. This is particularly relevant given that manufacturing was among the key industries impacted by the bilateral trade tariff phase-out between Costa Rica and the United States in 2009.

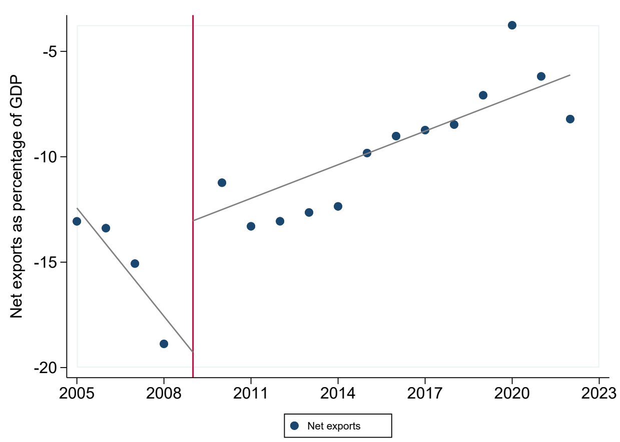
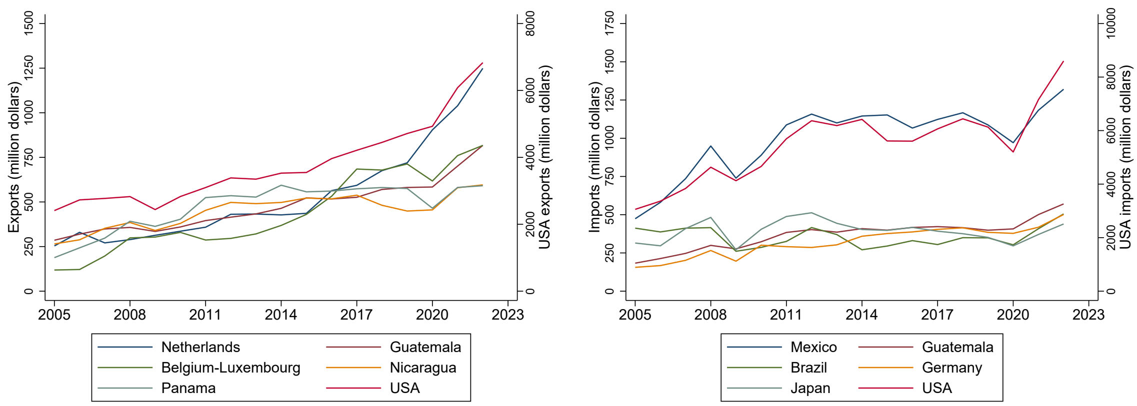


Figure 2: **Trade Deficit as Percentage of GDP, 2005–2022**

Note: This figure shows the evolution of the trade deficit as a percentage of annual GDP (in nominal terms). Negative net exports indicate that the country's imports exceeded exports.

Figure 2 illustrates the trajectory of Costa Rica's trade deficit as a percentage of GDP over time. The empirical trend shows a consistent reduction in the trade deficit following the 2009 trade liberalization episode. The significant increase in the trade deficit in 2008 may reflect an anticipatory response to the initial phase of tariff reductions under the U.S.–Costa Rica free trade agreement, which commenced in 2009. However, this pattern is also confounded by a decline in exports to the United States in the aftermath of the 2007 U.S. financial crisis.



(a) **Exports by country**

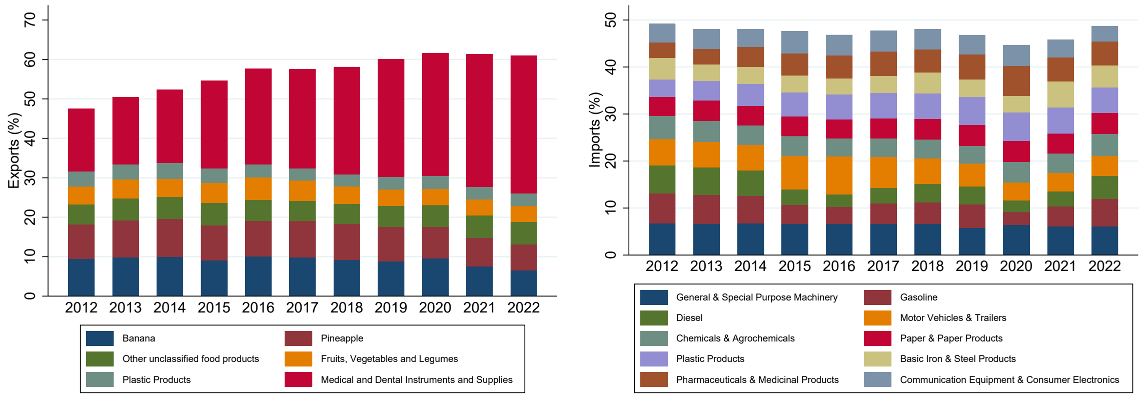
(b) **Imports by country**

Figure 3: **Decomposition of Exports and Imports by Main Trade Partners, 2005–2022**

Note: This figure shows the decomposition of imports and exports (in nominal terms) by main trade partners. Values regarding exports to the United States and imports from the United States are measured in the right vertical axis. The values associated with the rest of trading partners are measured in the left vertical axis.

Figure 3 shows that a significant share of Costa Rica's export and import value originates from trade with the United States. Additionally, the considerable disparity in trade volumes between the United States and Costa Rica's other major trading partners is quantitatively notable. This suggests that the scope of bilateral tariff reductions, following the implementation of the free trade agreement, is likely substantial enough to induce significant impacts on markup dynamics across markets.

To further complement the exposition of the previously presented empirical facts, Figure 4 presents a decomposition of Costa Rica's imports and exports by major product categories. The data reveal a significant and sustained shift toward increased specialization in the export of medical and dental instruments, alongside a corresponding decline in agricultural exports, such as bananas and pineapples. In contrast, imports continue to display a diversified composition, encompassing a wide range of manufactured goods as well as energy-related commodities.



(a) **Exports by product**

(b) **Imports by product**

Figure 4: **Decomposition of Exports and Imports by Main Trade Products, 2012–2022**

Note: This figure shows the decomposition of exports and imports (in nominal terms) by main trade products. Participation weights are calculated as the ratio of commodity-specific value of trade to total exports/imports.

3 Data

We leverage detailed microdata on firm-level characteristics and firm-to-firm annual transactions from multiple sources. The primary data source for this paper is the Revec database, which encompasses a rich set of interconnected datasets, including matched employer-employee data, corporate tax return information, firm-to-firm transactions, and customs data spanning the period from 2005 to 2022. The matched employer-employee data are collected on a monthly basis by the Caja Costarricense de Seguro Social (CCSS), Costa Rica's Social Security Administration, which encompasses the universe of workers employed in the formal economy. Specifically, the dataset draws extensively from the "Security, Sickness and Maternity" (Seguridad, Enfermedad y Maternidad or SEM) program, which mandates participation for all salaried workers, self-employed individuals, and retirees under the national pension schemes. This dataset provides critical insights into the labor landscape of the country, detailing information on worker-specific employment affiliations and labor income. Revec aggregates these figures annually to furnish each firm in the database with year-by-year information on average number of employees and total wage expenditures.

In conjunction with employer-employee data, Revec leverages corporate tax return data collected by the Ministry of Finance to construct a comprehensive firm-level dataset spanning the years 2005 to 2022. The corporate tax return data compiles essential balance sheet variables as total revenue and value-added metrics, along with other firm-specific characteristics as regional location and the firm's four-digit ISIC4 code. These tax records data are collected from mandatory yearly declarations—known as form D-101 or the "Affidavit of Income Tax"—which businesses submit to the Ministry of Finance and contain financial information regarding total sales, net assets, operational costs, and profits. The breakdown of total net assets includes cash reserves, stocks and bonds, inventories, and fixed assets, while total costs are disaggregated into administrative expenses, material inputs, depreciation, interest outlays, and miscellaneous expenditures.

Our database also incorporates firm-to-firm transaction data extracted from the D-151 form. This form is also collected by the Ministry of Finance and requires firms to report the value of total transactions exceeding 2.5 million colones throughout the fiscal year. We use this information to construct a measure of firm-level electricity bill by considering reported transactions where the supplier's ISIC code is 3510 (i.e., Electric power generation, transmission and distribution). We also use the Central Bank of Costa Rica's electricity producer price index time series to deflate the nominal value of firm-level electricity bills, thereby constructing the corresponding quantity index.

Last, our database also integrates customs data encompassing the universe of transactional entries recorded through Costa Rica's customs regime, which is jointly administered by the Ministry of Foreign Trade (COMEX) and the Ministry of Finance. This information contributes to the construction of year-by-year firm-level import and export values. The resulting database contains firm-level data on economic activity, number of employees and payroll, assets, income, input expenditures, imports, exports, foreign ownership and status for firms that operate under a special tax regime (i.e., Free Trade Zones). The key advantage of this dataset lies in its integration of administrative sources, which mandate reporting from the entire population of Costa Rican firms, thereby providing comprehensive coverage unmatched by any external database. However, two limitations of the dataset should be noted: i) it is restricted to formal firms, which represent approximately 60% of total employment, and ii) it captures the aggregate value of firm-to-firm transactions but does not detail transaction-level data.

To provide further insight into the properties of our data, we report key summary statistics in Figure 5 and Figure 6, as well as in Table 1 and Table 2. Figure 5 and Figure 6 shows summary statistics on firm-level market share by year. These market shares are determined as the ratio of firm-level revenues to the overall market-level value of trade, with the market defined as an industry sector within the framework of the system of national accounts—i.e., "Agriculture, forestry and fishing," "Manufacturing and other industry," "Construction," "Trade, transport, accommodation and food," "Information and communication," "Finance and insurance," "Real estate activities," "Business services," "Education, human health and social work," and "Other services." For the purposes of the empirical analysis in Section 5, we use more detailed ISIC classifications to further disaggregate several of the aforementioned industry sectors, allowing for a more granular capture of heterogeneity within these broad industry categories.

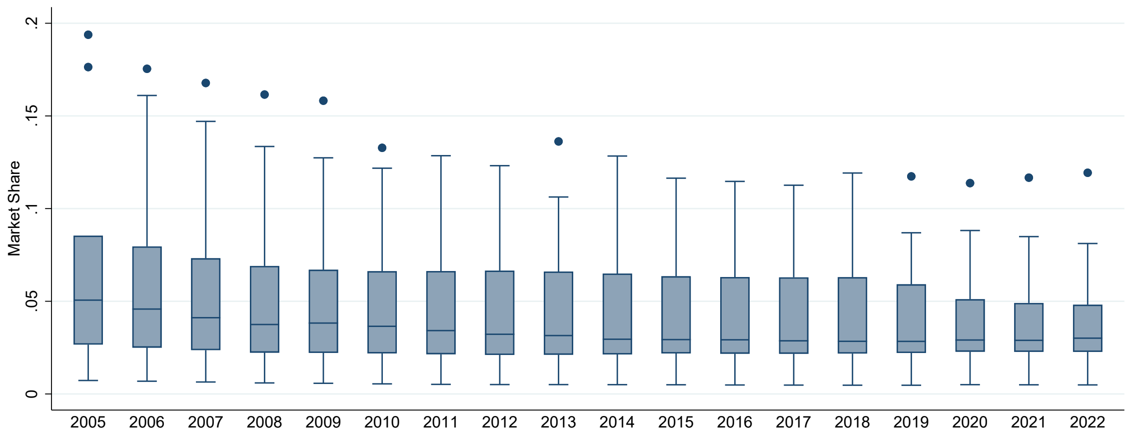


Figure 5: **Key Moments of Market Shares Over Time, 2005–2022**

Note: This boxplot reports key moments of the distribution of firm-level market shares by year from 2005 to 2022. The market shares are determined as the ratio of firm-level revenues to the overall market-level value of trade, with the market defined as an industry sector within the framework of the system of national accounts. The line within each box represents the median. The box width spans from the 1st quartile to the 3rd quartile and reflects the interquartile range. Whiskers extend from the box to the smallest and largest data points within 1.5 times the interquartile range. Points outside the whiskers are considered outliers. All sector-specific values are revenue-weighted.

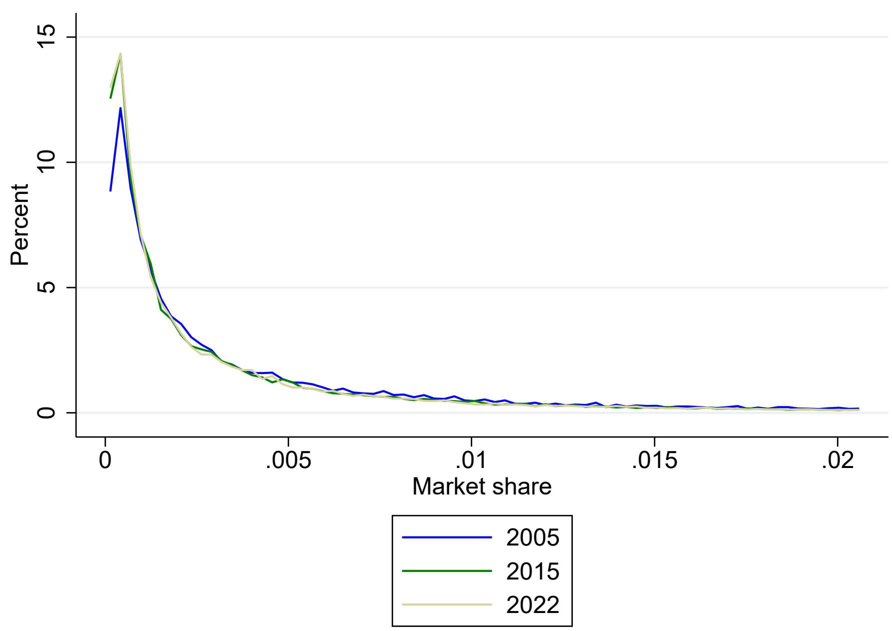


Figure 6: **Kernel Density of Market Shares by Year**

Note: This figure shows the kernel density function of firm-level market shares for the universe of firms in the Revec registry during the years 2005, 2015, and 2022.

Table 1: **Distribution of Firms by Year and Industry Classification, 2005–2022**

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
2005	3,725	3,933	2,246	13,773	567	516	1,171	3,757	1,763	1,388	32,839
2006	3,782	4,001	2,600	14,543	621	570	1,256	4,054	1,882	1,526	34,835
2007	3,843	4,235	3,114	15,506	680	596	1,366	4,423	1,994	1,644	37,401
2008	3,749	4,487	3,443	16,812	749	619	1,448	4,866	2,179	1,791	40,143
2009	3,636	4,516	2,965	17,404	785	632	1,492	5,131	2,338	1,865	40,764
2010	3,643	4,574	2,935	18,422	821	753	1,510	5,398	2,570	2,106	42,732
2011	3,645	4,670	3,149	19,365	885	778	1,508	5,671	2,732	2,252	44,655
2012	3602	4,755	3,306	19,725	902	812	1,503	5,809	2,927	2,448	45,789
2013	3,550	4,730	3,167	19,829	941	734	1,514	5,952	3,180	2,510	46,107
2014	3,535	4,695	3,250	19,936	996	779	1,539	5,952	3,547	2,646	46,875
2015	3,482	4,582	3,341	20,182	1,036	859	1,575	6,049	3,647	2,767	47,520
2016	3,462	4,605	3,387	20,646	1,042	872	1,585	6,183	3,813	2,906	48,501
2017	3,423	4,614	3,554	20,958	1,082	888	1,589	6,245	3,933	3,010	49,296
2018	3,389	4,594	3,666	21,213	1,104	839	1,587	6,292	4,103	3,225	50,012
2019	3,282	4,529	3,567	21,284	1,150	852	1,691	6,294	4,334	3,487	50,470
2020	3,254	4,391	3,545	20,001	1,134	879	1,956	6,048	4,188	3,337	48,733
2021	3,245	4,406	3,551	20,311	1,178	857	2,037	6,178	4,202	3,368	49,333
2022	3,117	4,409	3,364	20,528	1,232	838	2,077	6,253	4,356	3,282	49,456

Note: This table shows summary statistics of firms included in the REVEC database which are used for estimating firm-level markups. The table provides the empirical distribution of total firms by broad industry sector as defined within the framework of national accounts on a per year basis. The numbers on the labels line correspond to the following industry classifications: 1 "Agriculture, forestry and fishing," 2 "Manufacturing and other industry," 3 "Construction," 4 "Trade, transport, accommodation and food," 5 "Information and communication," 6 "Finance and insurance," 7 "Real estate activities." 8 "Business services," 9 "Education, human health and social work," and 10 "Other services."

Table 2: **Summary Statistics of Firm-level Economic Variables**

	Observations	**Mean**	**Std. Deviation**
Before 2009 Trade Reform (2008)			
Total Sales	9,316	4,470	54,900
Number of workers	10,114	81.51	984.65
Wage Bill	10,114	640	12,700
Exports	1,088	7.47	31.3
Imports	3,439	4.42	48.2
Value Added	8,960	1,190	35,300
Materials	4,583	3,630	31,400
Capital	8,810	6,340	116,000
After 2009 Trade Reform (2010)			
Total Sales	9,391	4,680	65,800
Number of workers	10,114	83.43	1,088
Wage Bill	10,114	689	14,600
Exports	1,238	5.93	29.7
Imports	3,424	3.54	36.7
Value Added	9,266	1,430	46,800
Materials	4,496	3,270	28,000
Capital	8,772	6,950	101,000

Note: This table reports summary statistics of the main firm-level economic variables used in the markup estimation procedure of Section 4.2. Numbers are in millions of local currency units (in 2008 constant prices), except for figures regarding"Observations" and "Number of workers."

Figure 5 and Figure 6 provide evidence about the dynamics of firm-level market shares over time. Specifically, both figures show a modest increase in the concentration of market shares towards the lower end of the distribution. In addition, Table 2 provides summary statistics that describe key moments of the main firm-level economic variables used for estimation of individual markups (see Section 4 for details). The standard deviation figures on the rightmost column indicate an important degree of heterogeneity among firms, which may be significantly influenced by fundamental organizational differences across industries. We investigate in Section 5 the quantitative relevance of this margin on the trade reform effects on markups.

4 Estimating the Effect of Trade Liberalization on Market Power

4.1 Measuring Industry Concentration

We begin by defining the mapping criterion that allows us to classify and assign firms into sectors for which we compute a Herfindahl-Hirschman Index (HHI). These measures will provide additional context to the empirical findings on markup dynamics from Section 5. We define this "classification function" by identifying each industry sector as established within the system of national accounts as our definition of "market." This industry sector category aggregates sections as defined within the 4-digit ISIC classification system. Firms in the data are then classified into industry sectors accordingly with their 4-digit ISIC classification from tax records data. This allows us to build a comprehensive panel of firms mapped into 10 sectors that spans the full spectrum of industry sectors and firms within the formal economy throughout our period of interest.

Subsequently, we exploit data on firm-level revenues in conjunction with the previously described classification function to compute firm-level market shares and sector-level HHI estimates. This procedure follows standard definitions in the literature,

$$S_{ijt} := \frac{r_{ijt}}{\sum_{i=1}^{I_{jt}} r_{ijt}} \qquad \text{HHI}_{jt} := \sum_{i=1}^{I_{jt}} S_{ijt}^2 \tag{1}$$

where r_{ijt} and S_{ijt} represent revenues and market share, respectively, of firm i in market j at period t. In definition (1), the variable HHI_{jt} stands for the HHI estimate associated with market j in year t. Following Gutiérrez and Philippon (2017), we are interested in computing firm-level market shares S_{ijt} in relation to domestic consumption. This allows us to separate true concentration from changes in trade dynamics in our HHI estimates. To do so, we modify the basic definition of market share in (1) to provide concentration estimates in Section 5 that use three alternative measures: i) raw HHI, ii) adjusted HHI[4], and iii) net exports adjusted HHI[5].

[4]Numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports.
[5]Numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

As previously described in Section 3, data on firm-level revenues, imports, and exports, as well as total firms per industry sector I_{jt}, was directly obtained from firm-level tax records. Hence, this procedure allows us to: i) estimate 10 market-level HHI measures for each year of observed data, i.e., from 2005 through 2022, while ii) accounting for the universe of firms and industry sectors in the formal economy. This is important, as it enables us to explicitly account for the diversity in concentration trends observed across industry segments within the economy. In addition, we provide in Section 7.2 of the Appendix additional concentration measures using alternative market definitions within the 4-digit ISIC classification system. This allows us to understand how sensitive our HHI estimates are to alternative market definitions.

4.2 Estimating Firm-level Markups

We heavily draw upon the methodology in De Loecker and Warzynski (2012) to quantify market power by estimating firm-level markups. This procedure relies on estimating the firm-level technology in order to back out the corresponding time-varying markup directly from the firm's (static) FOC of the cost-minimization problem. Because of that, we drop nonprofit and public-sector firms, which have different objective functions. To do so, we start by considering a translog production function of logged gross output y_{it} from firm i in year t (measured as deflated revenues) which explicitly accounts for (potentially confounded) measurement error in observed output data and idiosyncratic productivity shocks that are unobservable to the econometrician,

$$\begin{aligned} y_{it} &= \underbrace{f(l_{it}, k_{it}, m_{it}, e_{it}; \boldsymbol{\beta})}_{\text{Translog}} + \underbrace{\omega_{it} + \varepsilon_{it}}_{=u_{it}} \longrightarrow \text{productivity shock + measurement error} \\ &= \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_e e_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{mm} m_{it}^2 + \beta_{ee} e_{it}^2 + \\ &\quad \beta_{lk} l_{it} k_{it} + \beta_{lm} l_{it} m_{it} + \beta_{le} l_{it} e_{it} + \beta_{km} k_{it} m_{it} + \beta_{ke} k_{it} e_{it} + \beta_{me} m_{it} e_{it} + \boldsymbol{\beta_z'} \mathbf{z_{it}} + \omega_{it} + \varepsilon_{it}. \end{aligned} \tag{2}$$

where $(l_{it}, k_{it}, m_{it}, e_{it})$ represents the vector of firm-level (logged) variable inputs—labor, capital, raw materials demand, and electricity consumption, respectively—and $\boldsymbol{\beta}$ constitutes the vector of technology parameters to estimate. In this specification, we assume $\beta_l > 0, \beta_k > 0, \beta_m > 0, \beta_e > 0$ and $\beta_{ll} < 0, \beta_{kk} < 0, \beta_{mm} < 0, \beta_{ee} < 0$, but impose no sign restrictions on the parameters associated with the interaction terms, instead allowing the data to reveal the potential relationships of complementarity and substitutability across inputs. Last, $(\omega_{it}, \varepsilon_{it})$ represents the unobserved (to the econometrician) and potentially conflated productivity shock and measurement error, respectively. Our approach treats ε_{it} as a zero-mean measurement error that is uncorrelated with production inputs.

Following De Loecker and Warzynski (2012), we account for variation in firm-level materials demand to disentangle the influence of pure productivity shocks from overall changes in variable inputs when estimating the vector of technology parameters $\boldsymbol{\beta}$. This is because firms adjust their materials demand as they become more productive and expand their operating scale even when individual labor and capital allocations remain unchanged in the short run. Consistently with Raval (2023), we also separately include energy (e_{it}) and non-energy materials demand (m_{it}) in our technology specification to accommodate fundamental differences in the relative importance of these inputs across industries.

Additional controls included in $\mathbf{z_{it}} = (z_{1it}, z_{2it})$ explicitly account for the firm's foreign ownership and tax regime status, which correlate with unobserved productivity shocks. This is due to the following reasons. First, Costa Rican firms typically operate under either of two mutually exclusive tax regimes: i) the traditional or regular regime, and ii) the "zona franca"regime. The "zona franca"constitutes a free trade zone regime established to with the intention to promote foreign investment and export-oriented industries. These areas are designated by the government to provide certain tax incentives, exemptions, and regulatory advantages to attract foreign companies to establish operations in the country. Hence, businesses operating within a "zona franca" can benefit from reduced or exempted income tax, customs duties, and other tax benefits. In order to qualify for special tax treatment under "zona franca" status, firms have to: i) be primarily export-oriented businesses, ii) meet a minimum investment requirement in infrastructure, machinery, or equipment within the "zona franca" physical area, and iii) sustain workforce levels above certain lower thresholds. Second, firms with foreign ownership status tend to typically keep a larger workforce, run capital-intensive businesses (due to the high levels of Direct Foreign Investment requirements), and inherently engage in more exports-oriented economic activities through their parent company. Therefore, *we expect firms to sort into special tax treatment provided by "zona franca" regime and foreign ownership status based on their productivity realizations over time.* By exploiting cross-sectional and time variation in both dummy variables of $\mathbf{z_{it}}$, we aim to further refine our technology parameter estimates by disentangling the influence of unobserved productivity shocks over time.

Within this framework, we adopt the structural assumption $l_{it} = x_t(k_{it}, m_{it}, e_{it}, \omega_{it}, \mathbf{z_{it}})$ for labor demand and note that, given the structural assumptions imposed on the technology, l_{it} is a strictly increasing function of the productivity shock ω_{it}. We use this monotonicity trait to invert l_t and measure productivity shocks directly from observables, i.e. $\omega_{it} = h_t(l_{it}, k_{it}, m_{it}, e_{it}, \mathbf{z_{it}})$. This allows us to rewrite (2) as,

$$y_{it} = \phi(l_{it}, k_{it}, m_{it}, e_{it}, \mathbf{z_{it}}; \boldsymbol{\beta}) + \varepsilon_{it}. \tag{3}$$

and explicitly isolate the measurement error within our estimation procedure of the production function. To do this, we have constructed the year-firm specific vector $(l_{it}, k_{it}, m_{it}, e_{it})$ by relying on firm-level data about payroll employees, (deflated) value of net assets, (deflated) expenditures in raw materials, and (deflated) electricity bill, respectively.

Subsequently, the estimation procedure is divided into two steps. First, we run the regression (3) to estimate expected output and write the productivity shock as follows,

$$\omega_{it}(\boldsymbol{\beta}) = \hat{\phi}_{it} - (\beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_e e_{it} + \beta_{ll} l_{it}^2 + \beta_{kk} k_{it}^2 + \beta_{mm} m_{it}^2 + \beta_{ee} e_{it}^2 + \\ \beta_{lk} l_{it} k_{it} + \beta_{lm} l_{it} m_{it} + \beta_{le} l_{it} e_{it} + \beta_{km} k_{it} m_{it} + \beta_{ke} k_{it} e_{it} + \beta_{me} m_{it} e_{it} + \boldsymbol{\beta_z'} \mathbf{z_{it}}). \tag{4}$$

which explicitly isolates the ω_{it} term from the effects of variable inputs on expected output. In step 2, we consider a random walk for the evolution of firm-level productivity shocks,

$$\omega_{it} = g_t(\omega_{i,t-1}) + \xi_{it}$$

and use this law of motion for productivity to recover the sequence of idiosyncratic innovations $\xi_{it}(\boldsymbol{\beta})$. Since these innovations are, by construction, orthogonal to productivity realizations in $t-1$, the procedure gives a set of 16 moment conditions,

$$\mathbb{E}\Big\{\xi_{it}(\boldsymbol{\beta}) \cdot [l_{i,t-1}, k_{it}, m_{i,t-1}, e_{i,t-1}, l_{i,t-1}^2, k_{it}^2, m_{i,t-1}^2, e_{i,t-1}^2, l_{i,t-1} \cdot k_{it}, \\ l_{i,t-1} \cdot m_{i,t-1}, l_{i,t-1} \cdot e_{i,t-1}, k_{it} \cdot m_{i,t-1}, k_{it} \cdot e_{i,t-1}, m_{i,t-1} \cdot e_{i,t-1}, \mathbf{z_{\mathit{it}}}]'\Big\} = \mathbf{0} \tag{5}$$

to exactly identify and estimate $\boldsymbol{\beta}$ via a GMM approach. This procedure allows us to arrive at an estimate of the output—labor—or *any* of the other variable inputs—elasticity θ_{it}^l that explicitly accounts for measurement error in output data and unobserved productivity shocks to the econometrician, i.e.,

$$\hat{\theta}_{it}^l = \frac{\partial y_{it}}{\partial l_{it}}\bigg|_{(\omega_{it}, \hat{\beta})} = \hat{\beta}_l + 2\hat{\beta}_{ll} l_{it} + \hat{\beta}_{lk} k_{it} + \hat{\beta}_{lm} m_{it} + \hat{\beta}_{le} e_{it}. \tag{6}$$

Last, we use our key estimate $\hat{\theta}_{it}^l$ to inform the estimation of the (time-varying) firm-level markup μ_{it}. We do so by plugging (6) into the FOC of the firm's cost-minimization problem, i.e.,

$$\theta_{it}^l = \mu_{it} \frac{w_{it} L_{it}}{R_{it}} \tag{7}$$

In equation (6), L_{it} represents labor demand from firm i in year t, w_{it} constitutes annual wages paid by firm i in year t, and R_{it} stands for annual revenues from firm i in year t. Therefore, expression (6) establishes that a cost-minimizing firm chooses labor demand in order to equate its output-labor elasticity to the product of the time-varying markup times the ratio of payroll expenses to revenues. However, since the ratio of payroll expenses to revenues is directly observable from tax records data, we directly back out the markup estimate $\hat{\mu}_{it}$ by plugging (6) into (7) to solve for $\hat{\mu}_{it}$.

The previously described estimation strategy implicitly assumes that any flexible input should recover the (same) markup. However, recent literature by Raval (2023) and De Loecker et al. (2016) provide evidence against this assumption. Therefore, we remain interested in estimating firm-level markups by also exploiting variation in other flexible inputs (e.g., materials demand and electricity consumption) due to the significant amount of evidence rejecting the premise that markups estimated with different variable inputs have the same distribution. In the subsequent sections of the paper, this multi-input analysis will inform our choice of the most suitable variable input for markup estimation by providing a better understanding of: i) substitution patterns across production inputs, and ii) potential sources of adjustment costs that are input-specific in the context of our empirical setting.

Regarding the energy input, we leverage firm-level annual variation in electricity bill and power consumption to estimate the output-energy elasticity θ^e_{it} at the business level. We do this by following an analogous procedure to the one previously described and used to obtain the output-labor elasticity θ^l_{it}. Then, we back up the firm's time-varying markup μ_{it} from the standard cost-minimization FOC,

$$\theta^e_{it} = \mu_{it}\frac{b_{it}}{R_{it}} \tag{8}$$

where b_{it} represents the electricity bill of firm i in year t. Given that firm-level electricity bill b_{it} and revenues R_{it} are observable data, equation (8) identifies the markup μ_{it} conditional on previous estimation of the output-energy elasticity θ^e_{it}. Similarly, using instead our estimate of output-materials elasticity θ^m_{it} and the cost of (non-energy) materials in place of b_{it} in equation (8) identifies the firm-level markup μ_{it} by exploiting business-level variation in m_{it}.

4.3 Using the 2009 Trade Reform as a Natural Experiment

We leverage our documented evidence regarding firm-level markups from the 2006–2022 period to empirically assess the effects of trade tariff reductions on market power. We do this by using as a natural experiment Costa Rica's trade reform following the initiation of the free trade agreement with the United States in 2009 (CAFTA–DR). As explained in Section 2, Costa Rica and the United States embarked on a phased approach to eliminate trade tariffs until full implementation was achieved in 2015. This trade reform took effect on January 1, 2009 and, among other measures, immediately eliminated tariffs on 80% of imported goods from the United States Within this context, the vast majority of textile and apparel products adhering to the agreement's rules of origin also benefited from duty-free and quota-free access to the Costa Rican market.

We use Costa Rica's trade liberalization episode as a natural experiment to uncover the distribution of causal effects from tariff eliminations on markups across the full spectrum of industry sectors. Although the trade reform was implemented in January 2009, it had been initially approved by popular vote in October 2007, with 51.6% of the votes in favor, and subsequently ratified by the Costa Rican legislative branch in September 2008. Therefore, in our research design, we designate year 2006 (i.e., $t = 0$) as the pre-treatment period which precedes both the announcement and implementation of the policy intervention (i.e., the tariff eliminations due to the trade reform). This approach prevents conflation of our causal estimates with anticipation effects that may arise if a later year were selected as the pre-treatment period. Additionally, we designate year 2010 as the post-treatment period (i.e., $t = 1$), allowing sufficient time for firms to reflect in production and pricing behavior any response to changes in the environment due to the trade reform.

To assign firms to treatment and control groups, we classify as treated firms those engaged in exporting or importing during the post-treatment period (i.e., 2010), as these firms are directly affected by the immediate tariff eliminations implemented in January 2009. Alternatively, firms that were not involved in export or import activities during the post-treatment period are designated as part of the control group. However, given this classification we acknowledge the potential for selection into treatment status, as export and import activities are endogenous decisions made by firms consistently with cost-minimizing behavior. Consequently, our empirical strategy will explicitly control for potential selection into treatment based on observable changes in firm-level export and import statuses that occurred between 2006 and 2010.

With this in mind, we estimate the causal effect of the trade reform on average firm-level markups in industry j by exploiting variation across our full sample of firms during the pre-treatment and post-treatment periods. To do this, we obtain a two-way fixed effects DiD estimate λ_j of the industry-specific effect of trade liberalization by estimating the following specification,

$$\mu_{ijt} = \eta_i + \eta_t + \sum_{s \in S} \lambda_s \cdot \mathbb{D}_t \cdot \mathbb{T}_i \cdot \mathbb{I}_s[s = j] + \delta_x \cdot d^x_{it} + \delta_m \cdot d^m_{it} + v_{ijt}, \quad t \in \{0, 1\}. \tag{9}$$

In equation (9), μ_{ijt} represents the markup of firm i from industry j in period t. We flexibly control for fixed effects (η_i, η_t) that are firm and time-specific (respectively) to account for unobserved heterogeneity in markups along these margins. Our parameter of interest, λ_j, uncovers the (industry-specific) average causal effect on firm-level markups from the trade reform as captured by the interaction term comprised by the time dummy $\mathbb{D}_t$ (=1 if $t = 1$), treatment dummy $\mathbb{T}_i$ (=1 if firm i is treated, i.e., if it exports or imports in 2010), and industry dummy $\mathbb{I}_s[s = j]$ (=1 for industry j and 0 otherwise). Therefore, in our empirical strategy we include an interaction term effect λ_j for each of the S industry sectors in the data. As previously anticipated, we also include a set of controls to explicitly account for potential selection into treatment. Specifically, we do so by considering an export status dummy d^x_{it} (=1 if firm i exports in period 1 but not in period 0) and an import status dummy d^m_{it} (=1 if firm i imports in period 1 but not in period 0) in equation (9). Therefore, our empirical strategy allows us to control for potential selection into treatment status by firms based on observable responses to the announcement and implementation of the trade liberalization.

5 Results

5.1 Estimation of Technology Parameters

Table 3 and Table 4 report estimation results for output-input elasticities, returns to scale, and average firm-level markups, categorized by industry sector and variable input. In Table 4, we consider labor, (non-energy) materials, and energy (i.e., electricity consumption) as feasible variable inputs for backing up markup estimates from the firm's cost-minimization first-order condition. We do not identify capital-based markup estimates due to data unavailability about firm-level weighted average cost of capital.

Table 3 shows empirical estimates of output-input elasticities by industry sector. We report output elasticities with respect to labor, capital, non-energy materials demand, and energy (i.e., electricity) consumption. We acknowledge that violations of the static first-order condition (7) are likely in the case of labor, given that firms in Costa Rica are legally required to provide severance payments to dismissed workers. This introduces labor adjustment costs, which in turn add a dynamic component to the firm's labor demand decisions. Therefore, as in Raval (2023), we decompose firm-level materials demand into raw materials and energy (i.e., electricity) consumption, estimating markups separately for each input. This allows us to derive markup estimates more likely to be insulated from potential model misspecification, as demand for both inputs should remain robust to labor-specific deviations from the static cost-minimization first-order condition.

Alternatively, Table 4 presents average firm-level markups segmented by industry sector. We report estimates with respect to labor, (non-energy) materials, and energy consumption as variable inputs[6]. Unlike Table 3, we omit capital-based estimates due to the unavailability of firm-level data on the weighted average cost of capital. This prevents us from calculating the ratio of input expenditures to firm revenues from the firm's cost-minimization first-order condition, which we rely on to identify firm-level markups.

Results from Table 3 and Table 4 show that there is significant heterogeneity in markup estimates across production inputs. For instance, when decomposing firm-level materials demand into raw materials and energy, we find that gross output is most responsive to changes in the demand for raw materials, adjusting significantly more than in response to variations in alternative inputs across the majority of industries. In contrast, gross output exhibits the lowest degree of responsiveness to energy consumption among all production inputs, indicating that firms may perceive it more as a fixed cost than as a variable input. As expected, average markups in the mining and electricity sectors are estimated to be below 1. In the case of electricity, this is because government-owned companies in Costa Rica provide electricity at regulated rates designed to exactly cover generation costs. As for mining, open-pit mining was legally banned in Costa Rica for most of the study period, which is reflected in the model as additional marginal extraction costs.

[6] We concentrate on a specific subset of our national dataset comprising firms with at least one employee recorded on the payroll and subsequently estimate markups for these entities. To derive energy-based markups, we confine our analysis to the period from 2009 to 2019, as firm-level electricity bill data are only available for this time window.

Table 3: **Output-input Elasticities and Returns to Scale by Industry Sector**

Industry	Labor	Capital	Materials	Energy	Returns to Scale
All sectors	0.2075	0.0748	0.7769	0.0314	1.0906
	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
Agriculture, forestry and fishing	0.5210	0.0988	0.4667	0.0081	1.0946
	(0.004)	(0.001)	(0.004)	(0.001)	(0.001)
Construction	0.1713	0.0798	0.7762	0.0228	1.0500
	(0.006)	(0.001)	(0.007)	(0.004)	(0.003)
Mining and quarrying	0.5129	0.0843	0.3752	0.2019	1.1743
	(0.021)	(0.007)	(0.013)	(0.009)	(0.012)
Manufacturing	0.2236	0.0809	0.7663	0.0046	1.0754
	(0.002)	(0.001)	(0.002)	(0.000)	(0.000)
Electricity, gas, steam, and AC	0.6788	0.1150	0.2976	0.0153	1.1067
	(0.029)	(0.009)	(0.023)	(0.006)	(0.012)
Water supply	0.2764	0.0194	0.8566	0.0114	1.1638
	(0.015)	(0.003)	(0.017)	(0.008)	(0.009)
Wholesale and retail trade	0.0865	0.0211	0.9404	0.0016	1.0496
	(0.001)	(0.000)	(0.002)	(0.000)	(0.000)
Transportation and storage	0.1889	0.1011	0.7575	0.0596	1.1071
	(0.008)	(0.003)	(0.010)	(0.004)	(0002)
Accommodations and food services	0.6952	0.0815	0.3562	0.0262	1.1591
	(0.004)	(0.001)	(0.003)	(0.001)	(0.001)
Information and communication	0.1088	0.1623	0.6200	0.1706	1.0617
	(0.008)	(0.004)	(0.008)	(0.002)	(0.002)
Finance and insurance	0.3319	0.4474	0.3792	0.0230	1.1815
	(0.009)	(0.010)	(0.009)	(0.004)	(0.007)
Real estate activities	0.3087	0.2100	0.7508	0.0687	1.3382
	(0.005)	(0.005)	(0.010)	(0.005)	(0.003)
Business services	0.2042	0.1620	0.6277	0.0648	1.5167
	(0.004)	(0.002)	(0.005)	(0.002)	(0.002)
Education, human health and social work	0.2879	0.1764	0.5689	0.0054	1.0386
	(0.007)	(0.002)	(0.008)	(0.005)	(0.002)
Other services	0.5744	0.0398	0.3987	0.0102	1.0231
	(0.011)	(0.001)	(0.010)	(0.004)	(0.004)

Note: This table reports, from left to right, estimation results by industry sector regarding average firm-level output-labor elasticity, output-capital elasticity, output-materials elasticity, and output-energy elasticity. Averages are calculated annually over the full period of study, i.e., 2005–2022, and revenue-weighted. Numbers in parenthesis are standard deviations.

Table 4: **Average Firm-level Markup by Industry Sector**

Industry	**Labor**	**Materials**	**Energy**
All sectors	2.6413	1.2674	5.0466
	(0.009)	(0.002)	(0.024)
Agriculture, forestry and fishing	3.0727	1.4514	4.7106
	(0.018)	(0.004)	(0.067)
Construction	2.1965	1.2158	9.8704
	(0.056)	(0.020)	(0.241)
Mining and quarrying	5.1111	0.6722	5.5933
	(0.150)	(0.019)	(0.228)
Manufacturing	2.7782	1.2191	3.8821
	(0.014)	(0.004)	(0.025)
Electricity, gas, steam, and AC	7.5816	0.5843	4.2829
	(0.170)	(0.055)	(0.181)
Water supply	5.1366	1.3214	2.1396
	(0.132)	(0.016)	(0.085)
Wholesale and retail trade	2.2678	1.1906	5.7192
	(0.015)	(0.002)	(0.053)
Transportation and storage	1.9019	2.1505	6.8954
	(0.062)	(0.033)	(0.353)
Accommodations and food services	4.0028	0.9395	4.2628
	(0.019)	(0.003)	(0.020)
Information and communication	1.6094	1.5217	10.4647
	(0.038)	(0.024)	(0.250)
Finance and insurance	3.1041	2.2575	7.3563
	(0.148)	(0.063)	(0.297)
Real estate activities	4.7527	1.6080	3.62205
	(0.101)	(0.029)	(0.112)
Business services	1.5807	1.5901	7.9217
	(0.042)	(0.018)	(0.162)
Education, human health and social work	1.0146	1.4865	8.7556
	(0.021)	(0.014)	(0.156)
Other services	3.3504	0.9664	5.3278
	(0.060)	(0.014)	(0.173)

Note: This table reports estimation results by industry sector regarding average firm-level markups. Estimates are shown, from left to right, for alternative production inputs as used in the firm's cost-minimization problem FOC to back up the markup. Averages are calculated annually over the full period of study, i.e., 2005–2022, and revenue-weighted. Numbers in parenthesis are standard deviations.

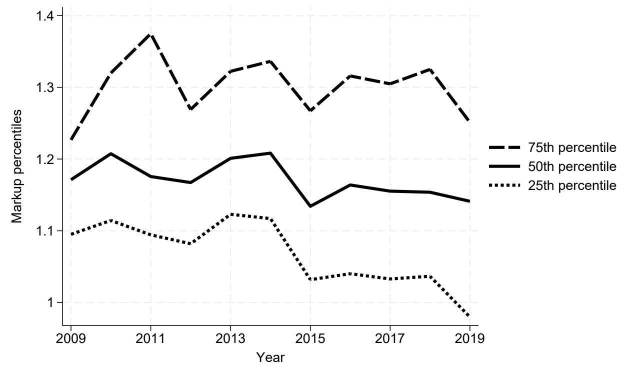
Labor-specific deviations from the firm's cost-minimization first-order condition may also account for the observed discrepancies in labor-based markup estimates compared to those based on materials and energy. Consistently with existing literature (e.g., Raval (2023), Dobbelaere and Mairesse (2013), and Petrin and Sivadasan (2013)), this is because labor demand decisions are affected by sources of adjustment costs as hiring and firing costs (e.g., severance pay), union bargaining, labor monopsony power, and labor-augmenting productivity—–all of which violate the condition (7) but do not affect materials or energy demand. In light of the previously mentioned labor and energy-specific issues, we consider materials-based markups as the leading estimates for examining the impact of trade liberalization on markups in Section 5.3.

5.2 Markups and Industry Concentration Dynamics

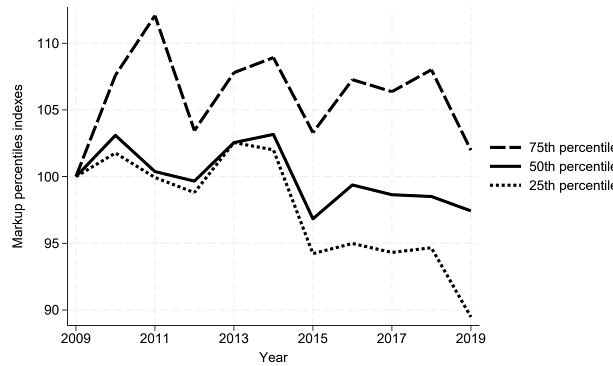
This section presents key findings on market power and industry concentration dynamics. Figure 7 illustrates the evolution of key moments in the distribution of firm-level markups over time, while Figure 8 provides further detail on the evolution of the full distribution. Additionally, Figure 9 offers a sectoral analysis, examining how industry-specific markups have shifted over the past two decades.

Figure 7 illustrates the evolution of firm-level markups, disaggregated by production inputs—i.e., raw materials, labor, and energy consumption. To account for the complex dynamics of markups across the entire spectrum of Costa Rican firms, we decompose the results by percentiles of the markup distribution. Specifically, we present findings for the median, as well as the 25th and 75th percentiles of the firm-level markup distribution. Our analysis reveals that the median firm-level markup decreased over the study period. This finding is consistent across different production inputs used to identify markups. However, our results also indicate significantly heterogeneous dynamics at the tails of the markup distribution across different flexible inputs. For instance, while labor-based markups consistently decline across the 25th, 50th, and 75th percentiles, we observe that materials-based markups exhibit an increase at the 75th percentile and a decrease at the 25th percentile. Conversely, for energy-based markups, the pattern is reversed: the 75th percentile decreases, while the 25th percentile significantly increases over the study period. These conflicting results across production inputs align with cross-country evidence provided by Raval (2023), who finds that time trends in markups identified from different production inputs exhibit negative correlation patterns. Unlike Raval (2023), our findings reveal that these negative correlations over time are more prevalent at the tails of the national markup distribution.

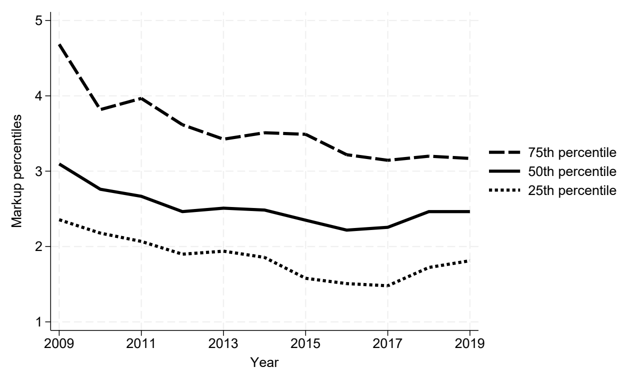
Figure 8 presents the evolution of the national distribution of firm-level markups over the years. Our findings are segmented by production input used to identify firm-level markups—i.e., raw materials, labor, and energy consumption. Panel (a) shows a leftward shift in the distribution of labor-based markups, whereas panel (b) reveals the opposite pattern for materials-based markups. Additionally, labor-based markups exhibit significantly greater dispersion compared to materials-based markups. Both stylized facts are consistent with cross-country evidence documented by Raval (2023).



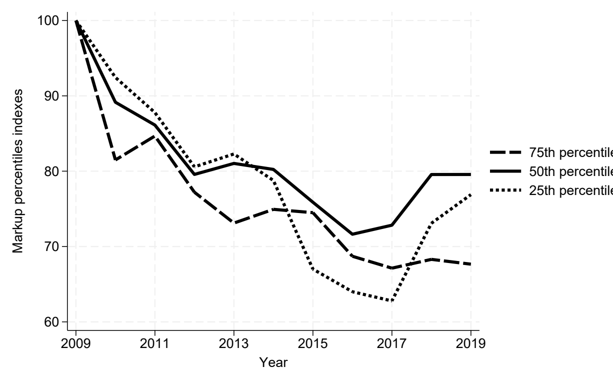
(a) **Levels − Materials**



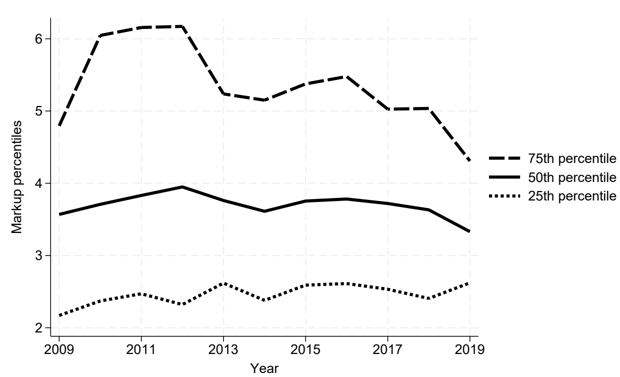
(b) **Indexes − Materials**



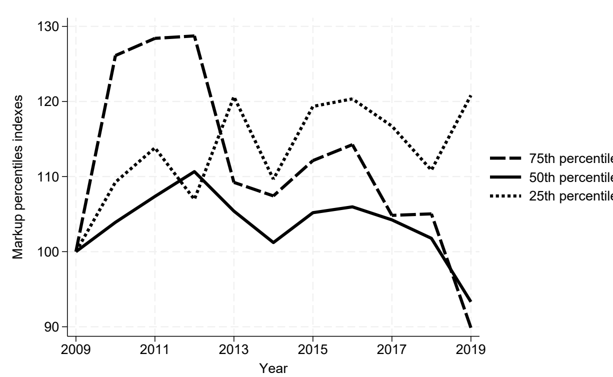
(c) **Levels − Labor**



(d) **Indexes − Labor**



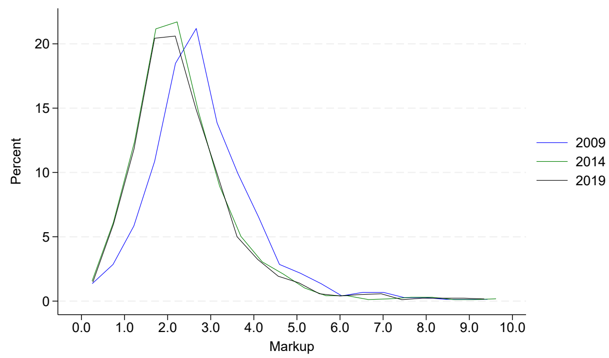
(e) **Levels − Energy**



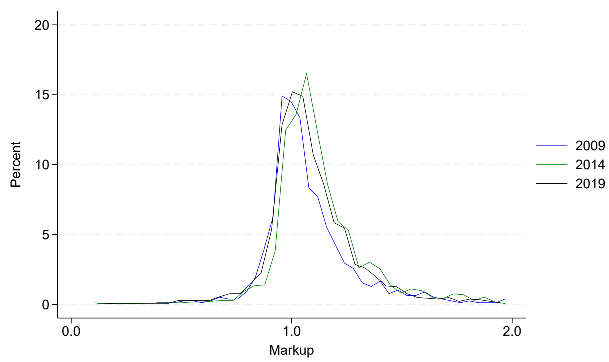
(f) **Indexes − Energy**

Figure 7: **Evolution of Firm-level Markups, 2009–2019**

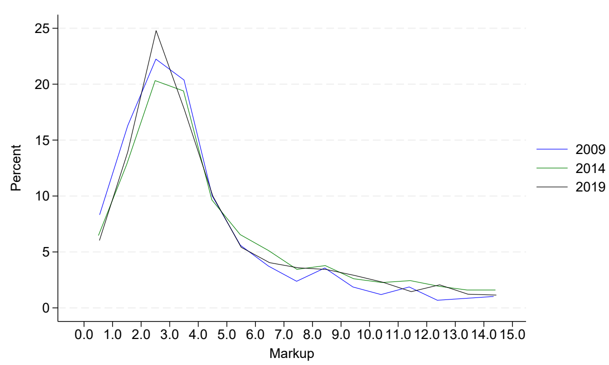
Note: This figure shows the evolution over time of key moments from the distribution of firm-level markups. Panels (a) and (b) illustrate the dynamics of markups, with material demand selected as the variable input for calculation. Panels (c) and (d) report the dynamics of markups, with labor selected as the variable input. Last, panels (e) and (f) report the dynamics of markups, with energy consumption selected as the variable input for computation. All observations for computing key moments are revenue-weighted at the industry level.



(a) **Labor**



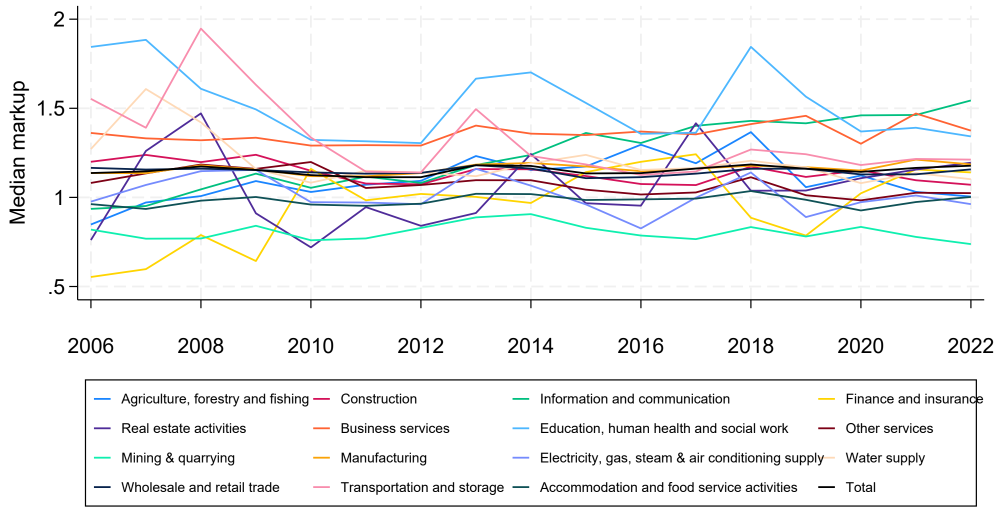
(b) **Materials**



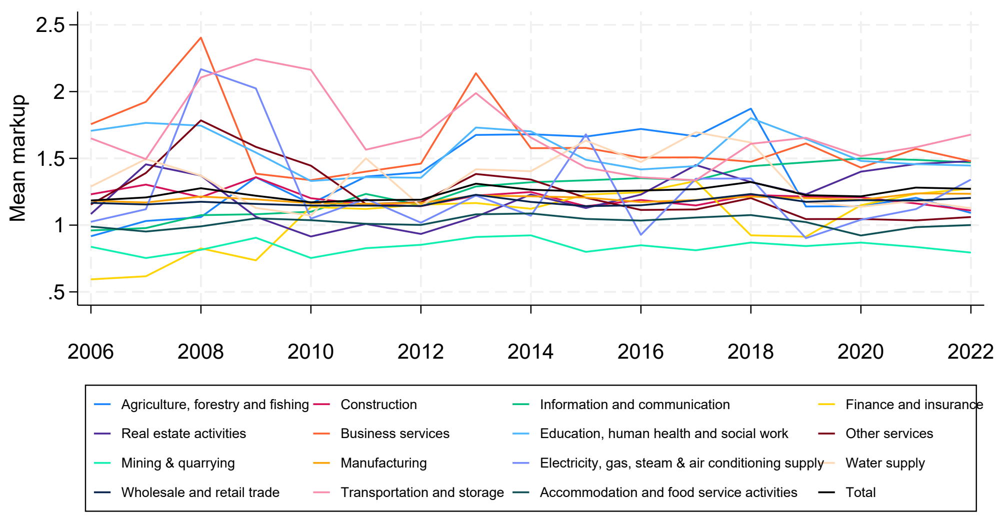
(c) **Energy**

Figure 8: **Distribution of Firm-level Markups, 2009–2019**

Note: This figure shows the evolution of firm-level markup distributions over time. Panel (a) shows the distribution of markups with labor selected as the variable input for calculation. Panel (b) reports the distribution of markups with material demand selected as the variable input. Last, panel (c) shows the distribution of markups with energy selected as the variable input for computation. All observations for computing key moments are revenue-weighted at the industry level.



(a) **Median Markup**



(b) **Average Markup**

Figure 9: **Evolution of Firm-level Markups by Industry, 2006 – 2022**

Note: This figure shows the evolution of firm-level markups by industry sector. Markups are estimated using materials as the variable input of choice. Panel (a) reports median firm-level markups and panel (b) shows average firm-level markups by industry. All observations for computing key moments are revenue-weighted at the industry level.

A primary consideration in this analysis is that heterogeneity in markup estimates is prevalent not only across time and production inputs but also across industries. Figure 9 presents a sectoral analysis that disaggregates firm-level markup dynamics by industry. This analysis indicates that, despite a general decline in median markups over the study period (as shown in Figure 7), there are quantitatively significant industry-specific deviations from this aggregate trend. This source of heterogeneity underscores the necessity of examining trade liberalization effects on markups by industry sector. This is because solely focusing either on the national markup distribution or a single industry would obscure this critical variation, thereby masking how the pro-competitive implications of trade reforms vary across different economic sectors.

To further contextualize the evolution of markups, we augment our analysis by examining the trajectory of HHI estimates over time in relation to changes in markups. Figures 10 and 11 display the economy-wide cumulative distribution functions (CDF) of HHI estimates from 2005 to 2022. Additionally, Figure 12 reports the time-averaged industry-specific HHI estimates for the entire economy, while Figure 13 presents a sectoral analysis, illustrating how industry concentration has evolved across all sectors of the economy.

As anticipated in Section 4.1, we provide results on concentration dynamics using three alternative revenue-weighted HHI measures: i) raw HHI, ii) adjusted HHI[7], and iii) net exports adjusted HHI[8]. Our analysis from Figure 10 and Figure 11 reveals modest increases in the dispersion of revenue-weighted and sector-specific HHI estimates in 2022 compared to 2005, with more industry sectors ranking either on the lower or upper ends of the support spectrum[9]. However, industry-specific HHI estimates remained, on average, unchanged over time—see Figure 12. Importantly, these findings remain qualitatively unchanged across alternative concentration measures.

Similarly to the analysis of markup dynamics, we also decompose these aggregate trends by conducting a sectoral analysis to understand which industry sectors constituted the central drivers of these changes. Figure 13 shows that real estate, alongside finance and insurance, consistently emerged as the most concentrated sectors, as evidenced by our revenue-weighted HHI estimates. In contrast, we find evidence that the agriculture sector experienced no significant change in concentration outcomes during the last two decades.

[7]Numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports.

[8]Numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

[9]We provide similar results in Section 7.2 under alternative market definitions within the 4-digit system of ISIC classifications to compare how these results vary based on market definition.

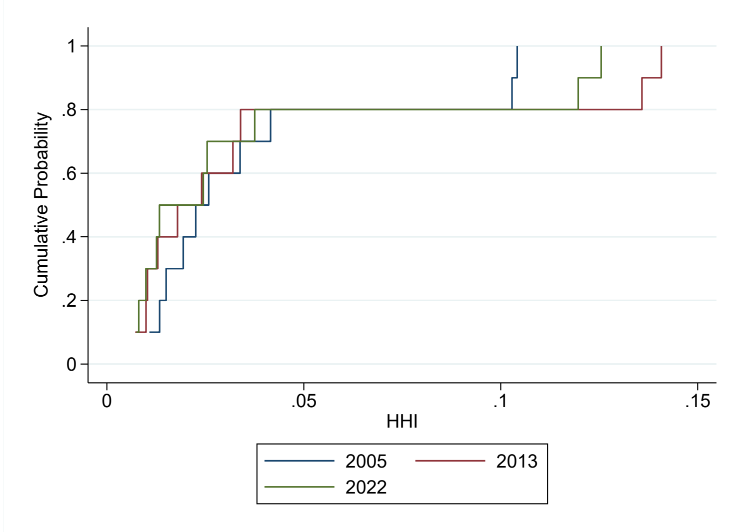
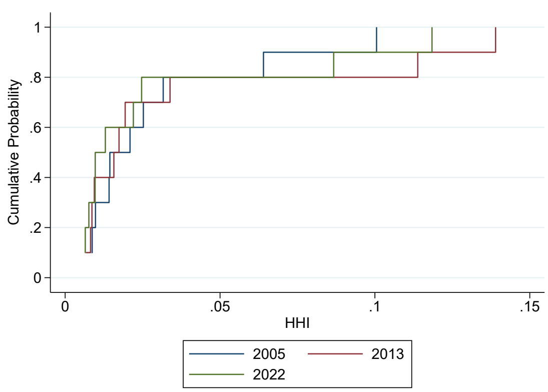
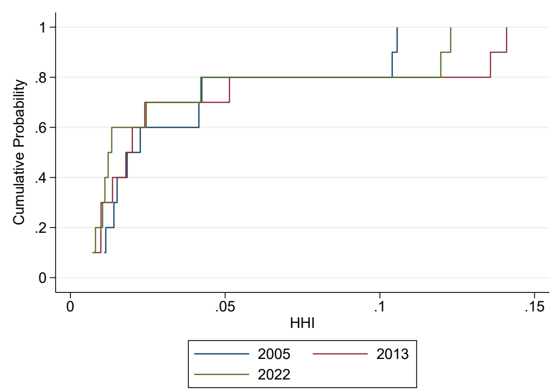


Figure 10: **CDF of HHI Estimates by Year, 2005–2022**

Note: This figure shows the economy-wide CDF of HHI estimates during 2005, 2015, and 2022. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts.



(a) **Adjusted HHI**



(b) **Net exports adjusted HHI**

Figure 11: **CDF of Adjusted HHI Estimates by Year, 2005–2022**

Note: This figure shows the economy-wide CDF of adjusted HHI estimates during 2005, 2015, and 2022. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports. Alternatively, for net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

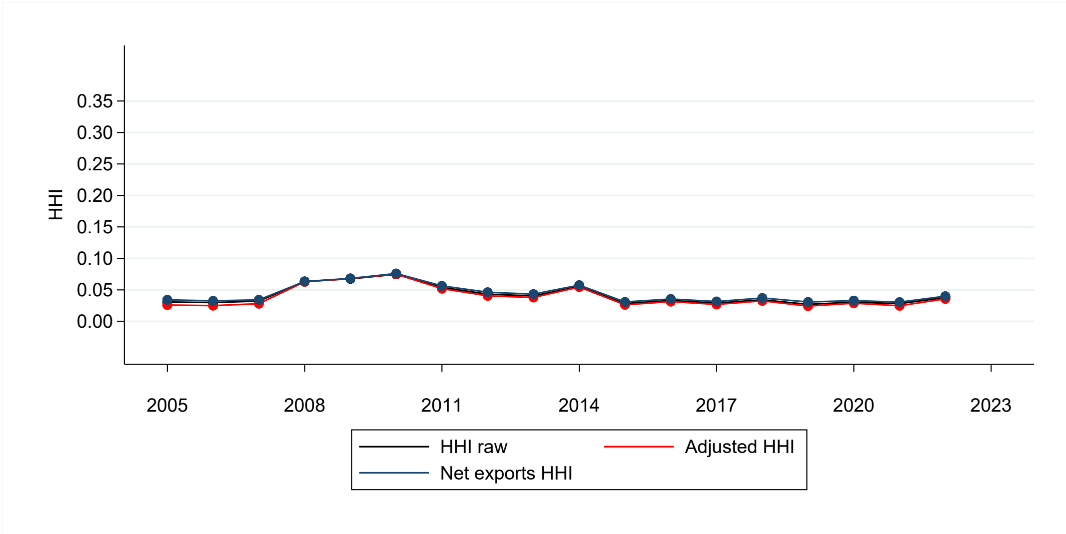
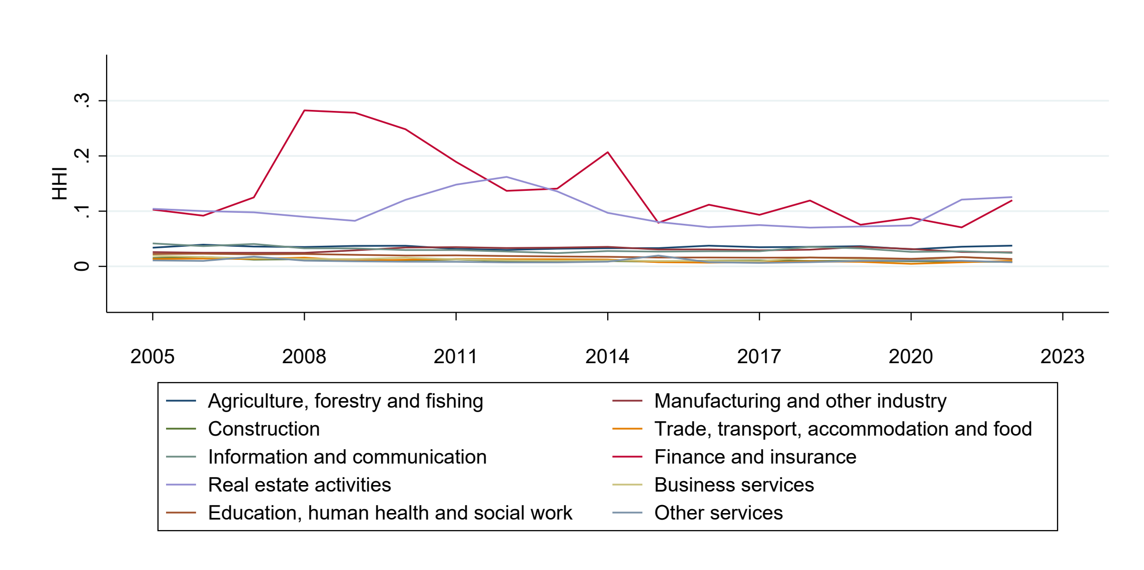
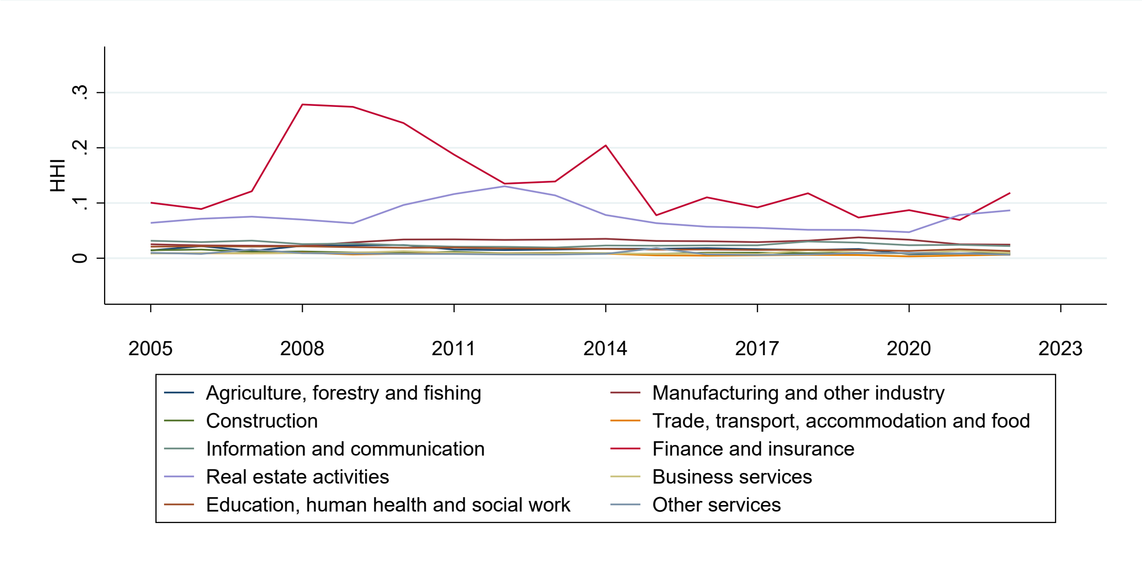


Figure 12: **Average Industry-specific HHI by Year, 2005–2022**

Note: This figure reports average industry-specific HHI estimates over time. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports. Alternatively, for net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.



(a) **Raw HHI Estimates**



(b) **Adjusted HHI Estimates**

Figure 13: **HHI Estimates by Year and Industry Classification, 2005 – 2022**

Note: This figure shows the evolution of HHI estimates by industry sector. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

5.3 Effects of Trade Liberalization

In this section, we examine the trade liberalization effects on markups obtained with the empirical strategy described in Section 4.3. As explained in Section 5.1, our analysis relies on materials-based markup estimates. Importantly, we rely on our index estimates—markups normalized by the 2006 markup level—to assess the industry-specific trade reform effects on markups. This allows us to focus on the *changes* in markups over time, mitigating any potential sources of econometric bias that may affect levels but not changes.

We initiate this analysis by examining the heterogeneity in industry composition across economic sectors between treated and non-treated firms. This is crucial as industries with a higher proportion of treated firms-—-defined as those engaged in export or import activities in 2010-—-will experience a greater degree of exposure to the trade reform effects. Specifically, industries with a higher share of treated firms will be impacted by the trade reform not only through the direct effects of tariff removal but also through general equilibrium price adjustments. Conversely, industries with a lower proportion of treated firms will be primarily influenced by the trade reform through general equilibrium effects stemming from price responses in input markets as well as markets of complements or substitutes.

Table 5: **Percentage of Treated Firms by Industry Sector**

	Total Firms	**% Treated**
All sectors	5794	59.30
Agriculture, forestry and fishing	368	44.56
Construction	198	48.48
Manufacturing	1274	73.00
Mining and quarrying	30	53.33
Electricity, gas, steam, and AC	18	55.56
Water supply	16	75.00
Wholesale and retail trade	2950	62.30
Transportation and storage	104	50.00
Accommodations and food services	336	22.02
Information and communication	54	77.78
Finance and insurance	12	33.33
Real estate activities	48	45.83
Business services	234	48.72
Education, human health and social work	66	36.36
Other services	86	44.19

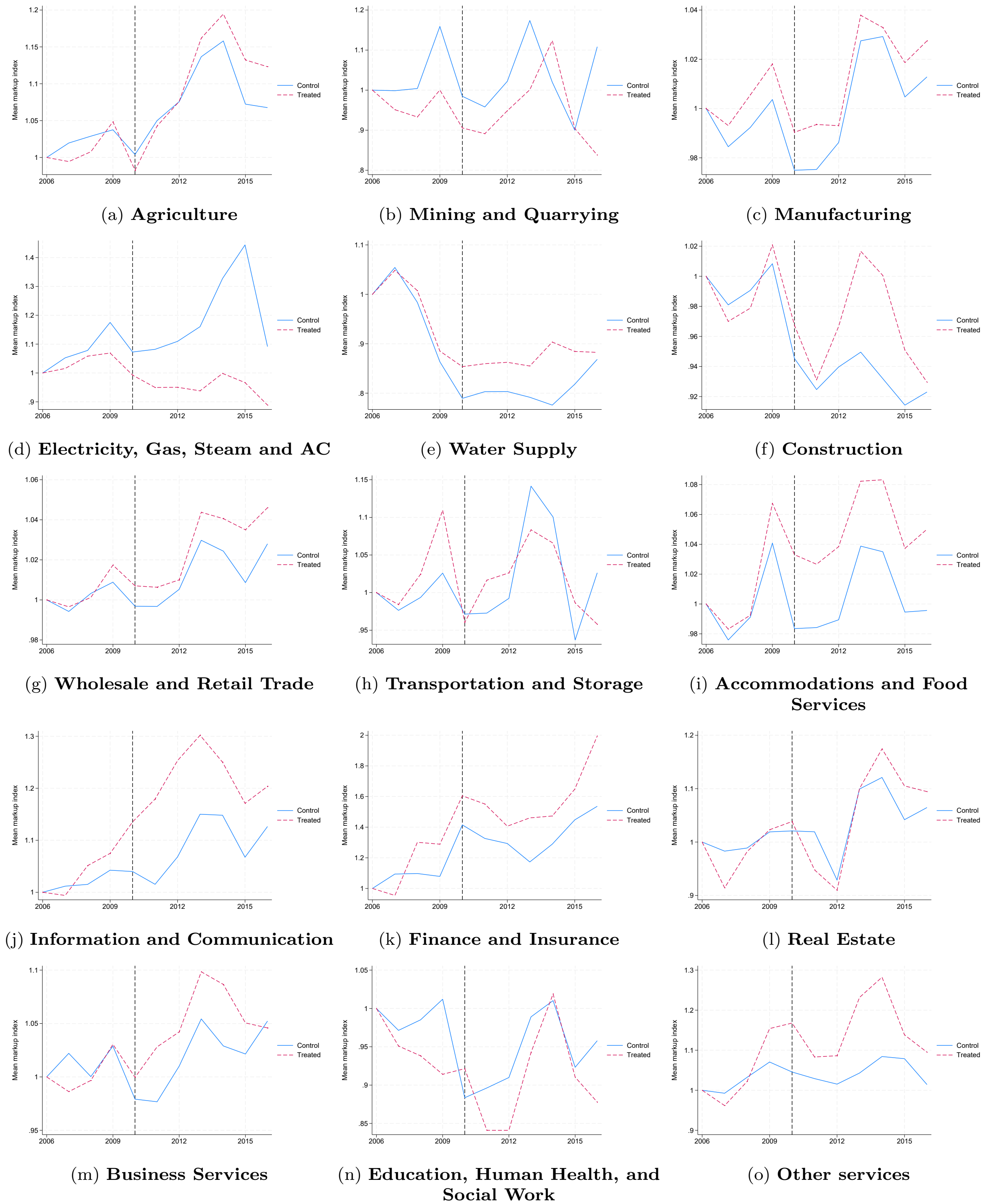
Note: This table provides numbers on the relative composition of industry sectors between treated and non-treated firms in 2010. From left to right, column 2 reports figures on the total number of firms by industry. Column 3 shows the percentage of firms in each industry that is considered "treated" under the trade reform.

Table 5 provides detail on the heterogeneity in industry composition between treated and non-treated firms across economic sectors during the treatment period. Our figures reveal substantial variation not only in industry composition but also in sector size, as measured by the number of firms. In line with existing economic theory (e.g., Melitz (2003) and Hopenhayn (1992)), this variation fundamentally matters because it suggests that the impact of firm entry on different industries will vary significantly depending on both industry size and exposure to international trade. For instance, the "Information and Communication" and "Manufacturing" sectors exhibit the highest percentages of treated firms, indicating the greatest exposure to the effects of trade liberalization. In contrast, the "Accommodations and Food Services" and "Finance and Insurance" sectors show the lowest levels of exposure to the trade reform effects.

A key identifying assumption from the empirical strategy described in Section 4.3 used to estimate the trade reform effects is the presumption of parallel trends in average firm-level markups between treated and non-treated firms. Otherwise, our estimates may risk conflating the true impact of the trade reform on markups with pre-existing differences in industry-specific markup dynamics between treated and non-treated firms that are unrelated to the removal of trade tariffs. In light of this, we conduct in Figure 14 a graphical inspection of our materials-based markup estimates over time to evaluate the extent to which the parallel trends assumption is supported by the data.

While the data provides empirical support for the parallel trends assumption in certain industries, there are also instances where this assumption appears less plausible. Figure 17 in Section 7.1 of the Appendix delivers a similar assessment by inspecting the trends in labor-based markups between treated and non-treated firms. To address this concern, we use the *partial identification* approach developed by Rambachan and Roth (2023) and estimate the 95% confidence intervals for the industry-specific trade reform effects λ_j while explicitly accounting for potential deviations from the parallel trends assumption. Figure 15 presents estimation results of these robust confidence intervals, segmented by industry sector j.

Intuitively, their approach involves assuming that pre-existing differences in trends continue unchanged over time and then extrapolating this assumption into the post-treatment periods for estimation purposes. However, imposing the strict assumption that pre-treatment trend differences extend linearly into the post-treatment period may be problematic when there are limited pre-treatment observations. To address this issue, Rambachan and Roth (2023) consider robustness to a specified degree of deviation M from the linear extrapolation of the difference in pre-treatment trends. Therefore, this partial identification framework allows us to estimate a confidence interval for the trade reform effect λ_j that explicitly accounts for non-linear violations over time of the parallel trends assumption. In addition, since M is arbitrarily determined by the analyst, the framework lends itself naturally to a sensitivity analysis that assesses the robustness of statistical significance from our λ_j estimates by determining the maximum permissible deviation from the linear extrapolation of pre-treatment trends before the null hypothesis $\mathrm{H}_0 : \lambda_j = 0$ can no longer be rejected.



(a) **Agriculture**

(b) **Mining and Quarrying**

(c) **Manufacturing**

(d) **Electricity, Gas, Steam and AC**

(e) **Water Supply**

(f) **Construction**

(g) **Wholesale and Retail Trade**

(h) **Transportation and Storage**

(i) **Accommodations and Food Services**

(j) **Information and Communication**

(k) **Finance and Insurance**

(l) **Real Estate**

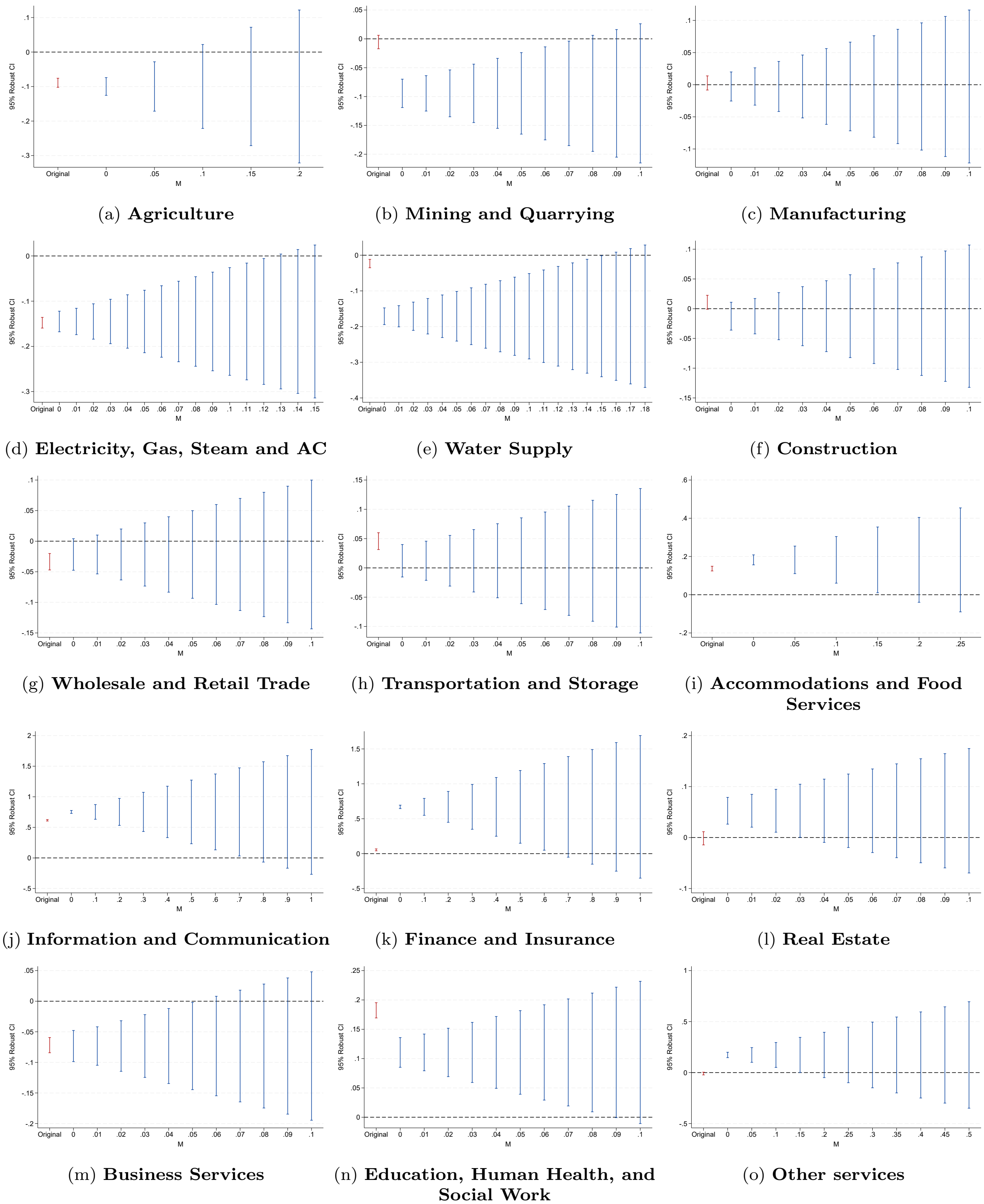
(m) **Business Services**

(n) **Education, Human Health, and Social Work**

(o) **Other services**

Figure 14: **Pre-reform vs. Post-reform Trends of Materials-based Markups by Industry**

Note: This figure shows the trends in average firm-level markup indexes—markups normalized by the 2006 markup level—before and after the post-treatment period (i.e., year 2010) for treated and non-treated firms, segmented by industry sector. The blue solid line represents firms in the control group, while the red dashed line corresponds to firms in the treatment group. Additionally, the thick black vertical line indicates the year 2010 (i.e., the post-treatment period in the baseline DiD framework). Findings are segmented by industry sector and estimated using materials demand as the variable input of choice.



(a) **Agriculture**
(b) **Mining and Quarrying**
(c) **Manufacturing**
(d) **Electricity, Gas, Steam and AC**
(e) **Water Supply**
(f) **Construction**
(g) **Wholesale and Retail Trade**
(h) **Transportation and Storage**
(i) **Accommodations and Food Services**
(j) **Information and Communication**
(k) **Finance and Insurance**
(l) **Real Estate**
(m) **Business Services**
(n) **Education, Human Health, and Social Work**
(o) **Other services**

Figure 15: **Trade Liberalization Effect on Materials-Based Average Markups by Industry**

Note: This figure shows trade liberalization effects on markups indexes—markups normalized by the 2006 markup level—after accounting for potential deviations from the baseline parallel trends assumption. The results show how much of a deviation from the pre-existing difference in trends would be needed before we can no longer reject the null hypothesis $H_0 : \lambda_j = 0$ (i.e., when the blue lines cross the dashed horizontal line at zero). The red line represents the 95% confidence interval for λ_j under the assumption of parallel trends. The blue lines represent 95% confidence intervals for λ_j at various degrees of deviation from the linear extrapolation of pre-treatment trend differences.

Figure 15 reveals four key findings. First, the trade liberalization episode had negative effects on average markups in five industry sectors: agriculture; mining; electricity, gas, steam, and air conditioning; water supply, and business services. In contrast, the trade reform increased average markups in five other sectors: accommodations and food services, information and communications, real estate; finance and insurance; and education, health, and social work. Most importantly, our results uncover a significant degree of heterogeneity in the trade reform effects across sectors, even among industries where average markups were affected in the same direction. These findings remain robust when accounting for potential non-linear deviations from the linear extrapolation of pre-reform trends between treated and untreated firms. Last, we do not find statistically significant effects on markups from the following four sectors: manufacturing, transportation and storage; construction, and wholesale and retail trade.

The previously described results contrast with our findings provided in Figure 18 from Section 7.1 of the Appendix, which rely on labor-based markups and show statistically insignificant trade reform effects across most industries. However, as explained in Section 5.1, we prefer our materials-based markups for examining the trade liberalization effects as labor-based markups are likely to be severely biased by existence of adjustment costs (e.g., legally mandated severance pay in Costa Rica), labor monopsony power due to unions, and labor-augmenting productivity (see Raval (2023)) for more details). These labor-specific biases are conflated with the "true" trade reform effect and, therefore, likely responsible for the statistically insignificant effects observed with labor-based markups—which stand in sharp contrast to the effects obtained using materials-based markups.

The findings described earlier have direct implications for understanding the relative significance of the opposing economic forces that influence markup changes in response to the trade liberalization reform. First, our findings indicate that in industries where average firm-level markups decline (i.e., agriculture; mining; electricity, gas, steam, and air conditioning; water supply, and business services), the reduction in markups attributable to decreased output prices (i.e., the output price effect resulting from entry of foreign firms into the domestic market and its recomposition towards more productive firms) and the increase in marginal production costs (i.e., the labor market effect due to more productive firms competing for labor) outweigh the impact of reduced import tariffs on markups (i.e., the direct tariff effect). Conversely, in industries where average markups increase (accommodations and food services, information and communications, real estate; finance and insurance; and education, health, and social work), the reduction of import tariffs predominantly drives the direction of the change in markups. Last, our findings show that these economic forces offset each other in industries where changes in markups are statistically insignificant (i.e., manufacturing, transportation and storage; construction, and wholesale and retail trade).

6 Concluding Remarks

This paper answers several policy questions that are at the heart of the economy-wide implications of a trade liberalization reform. How does trade liberalization affect firm-level markups? How do these effects vary by industry sector? Which industries become more and less competitive as trade barriers are eliminated? We addressed these questions by exploiting detailed firm-level microdata from administrative tax records spanning 2005—2022, covering the entire universe of formal-sector Costa Rican businesses. To estimate firm-level markups over time, we relied on the production function estimation approach developed by De Loecker and Warzynski (2012), which relaxes the need for assumptions regarding firms' demand curves, constant returns to scale, or the direct observation of the user cost of capital. Crucially, access to firm-level tax records across the full spectrum of Costa Rican firms enabled us to estimate markup dynamics across all industry sectors within the economy. We then leveraged these firm-level markup estimates in conjunction with Costa Rica's 2009 trade liberalization episode as a natural experiment to empirically assess the impact of trade liberalization on firm-level markups within a triple difference-in-differences (DiD) framework. The granularity of our data allowed us to uncover the entire distribution of average trade reform effects on firm-level markups, disaggregated by industry sector, thereby quantifying the full heterogeneity in the impacts of trade liberalization across the economy.

Our analysis revealed that the trade liberalization episode had statistically significant negative effects on average markups in five industry sectors: agriculture; mining; electricity, gas, steam, and air conditioning; water supply; and business services. In contrast, the reform led to increases in average markups in five other sectors: accommodations and food services; information and communications; real estate; finance and insurance; and education, health, and social work. Quantitatively, our results demonstrated considerable heterogeneity in the effects of the trade reform across these sectors (e.g., a ∼20% *increase* in average markups in accommodations and food services compared to a ∼10% *decrease* in agriculture), even within sectors where markups moved in the same direction. Last, we did not observe statistically significant effects of the trade reform on average markups in manufacturing; transportation and storage; construction; and wholesale and retail trade. Our findings constitute a critical step towards providing a more comprehensive evaluation of potential pro-competitive effects from trade liberalization than existing studies that focus exclusively on manufacturing firms.

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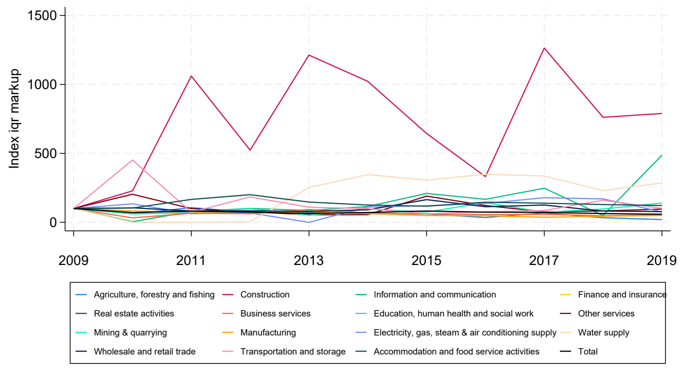
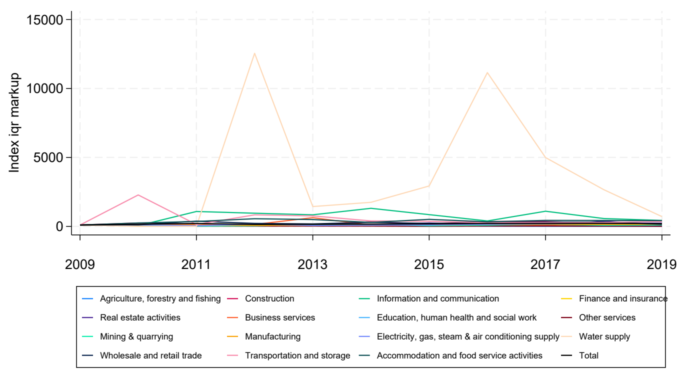
7 Appendix

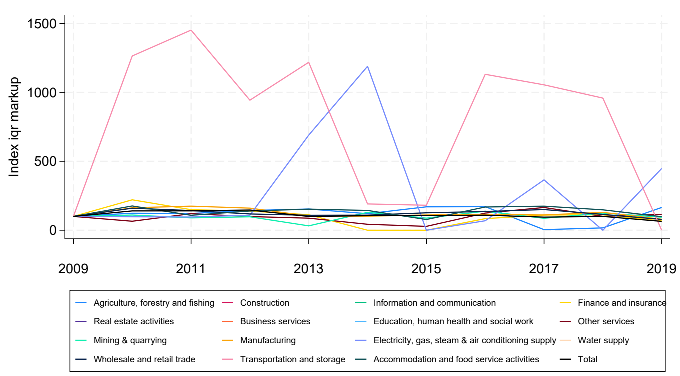
7.1 Sectoral Analysis: Markup Dynamics by Industry



(a) **Labor**



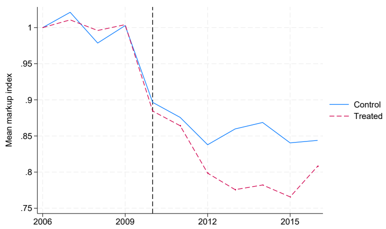
(b) **Materials**



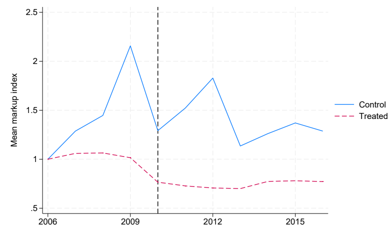
(c) **Energy**

Figure 16: **Interquartile Range of Avg. Markup Indexes by Industry, 2009–2019**

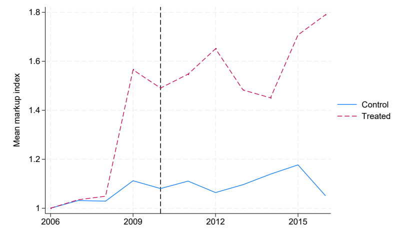
Note: This figure shows the evolution of the interquartile range from the distribution of firm-level markup indexes by industry sector. Panels (a), (b), and (c) reports findings using labor, materials demand, and energy as the variable input of choice, respectively. Indexes are computed by normalizing markups in year t with respect to markups in year 2009. All observations are revenue-weighted at the industry level.



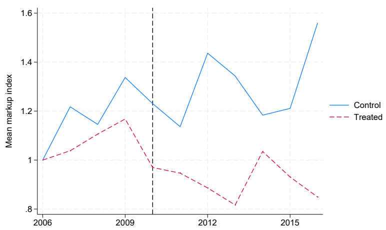
(a) **Agriculture**



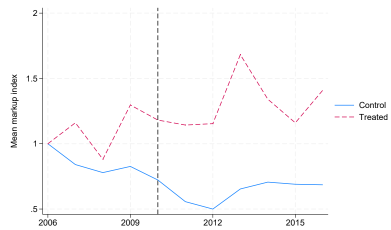
(b) **Mining and Quarrying**



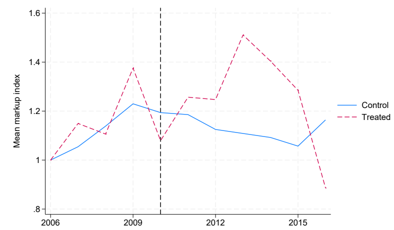
(c) **Manufacturing**



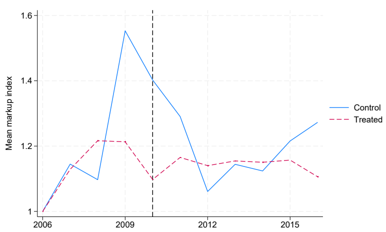
(d) **Electricity, Gas, Steam and AC**



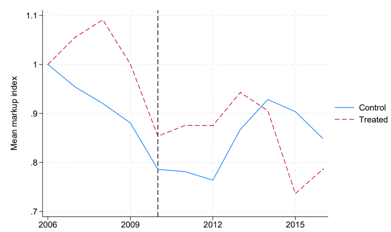
(e) **Water Supply**



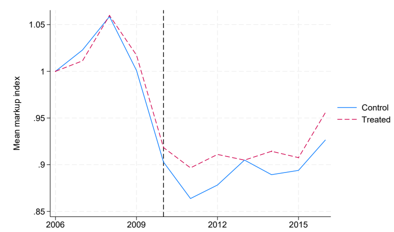
(f) **Construction**



(g) **Wholesale and Retail Trade**

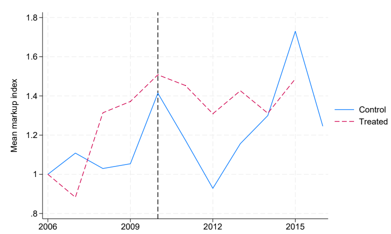


(h) **Transportation and Storage**

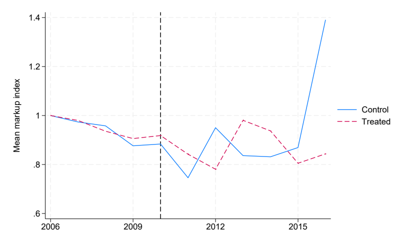


(i) **Accommodations and Food Services**

(j) **Information and Communication**

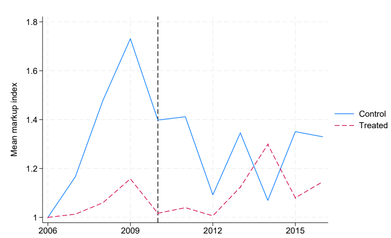


(k) **Finance and Insurance**

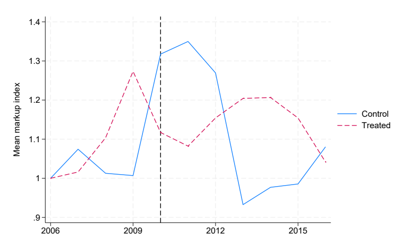


(l) **Real Estate**

(m) **Business Services**



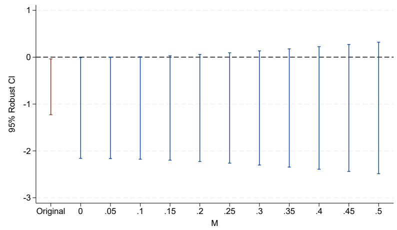
(n) **Education, Human Health, and Social Work**



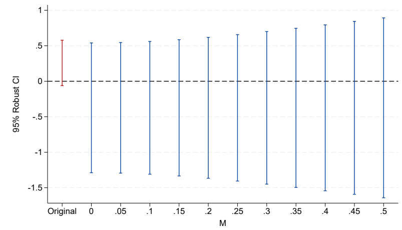
(o) **Other services**

Figure 17: **Pre-reform vs. Post-reform Trends of Labor-based Markups by Industry**

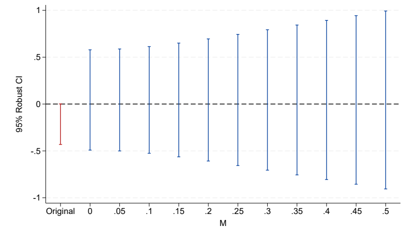
Note: This figure shows the trends in average firm-level markup indexes before and after the post-treatment period (i.e., year 2010) for treated and non-treated firms, segmented by industry sector. The blue solid line represents firms in the control group, while the red dashed line corresponds to firms in the treatment group. Additionally, the thick black vertical line indicates the year 2010 (i.e., the post-treatment period in the baseline DiD framework). Findings are segmented by industry sector and estimated using labor as the variable input of choice.



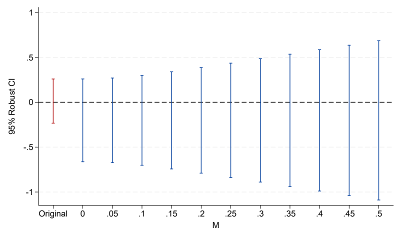
(a) **Agriculture**



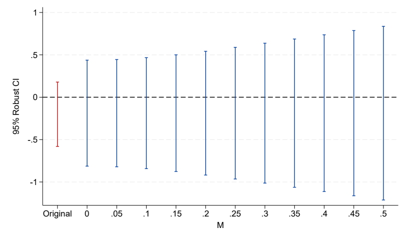
(b) **Mining and Quarrying**



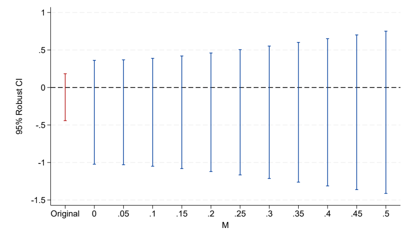
(c) **Manufacturing**



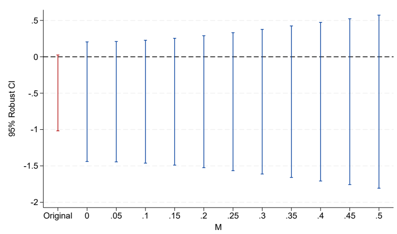
(d) **Electricity, Gas, Steam and AC**



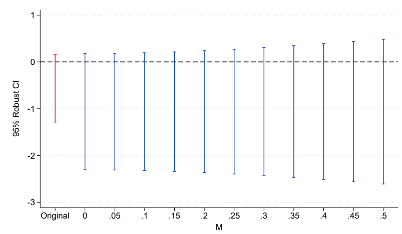
(e) **Water Supply**



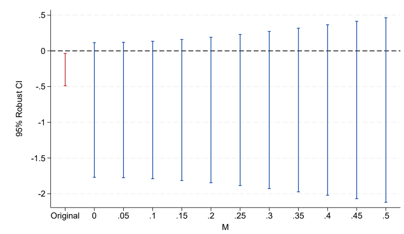
(f) **Construction**



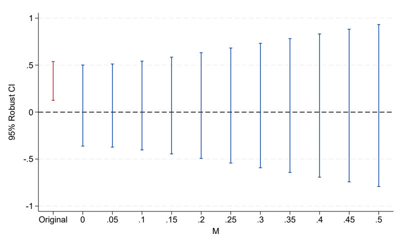
(g) **Wholesale and Retail Trade**



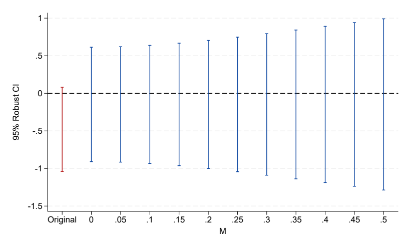
(h) **Transportation and Storage**



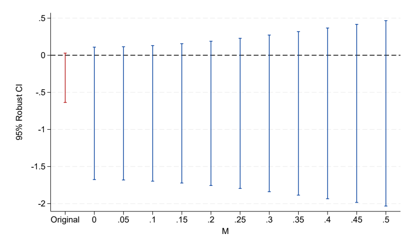
(i) **Accommodations and Food Services**



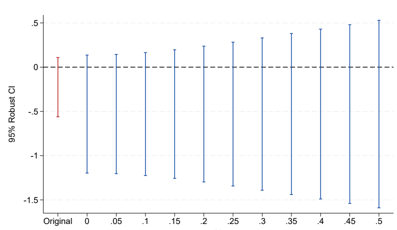
(j) **Information and Communication**



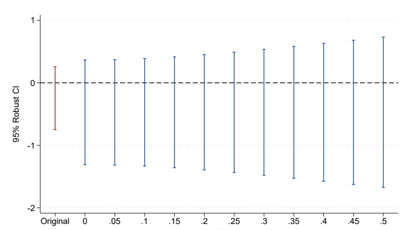
(k) **Finance and Insurance**



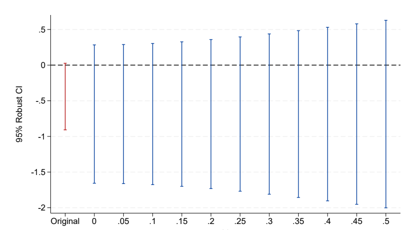
(l) **Real Estate**



(m) **Business Services**



(n) **Education, Human Health, and Social Work**



(o) **Other services**

Figure 18: **Trade Liberalization Effect on Labor-Based Average Markups by Industry**

Note: This figure shows trade liberalization effects on markups after accounting for potential deviations from the baseline parallel trends assumption. The results show how much of a deviation from the pre-existing difference in trends would be needed before we can no longer reject the null hypothesis $\mathrm{H}_0 : \lambda_j = 0$ (i.e., when the blue lines cross the dashed horizontal line at zero). The red line represents the 95% confidence interval for λ_j under the assumption of parallel trends. The blue lines represent 95% confidence intervals for λ_j at various degrees of deviation from the linear extrapolation of pre-treatment trend differences. Findings are segmented by industry sector and estimated using labor as the variable input of choice.

7.2 Industry Concentration Dynamics: Measuring the Changes in Market-level HHI Estimates Over Time

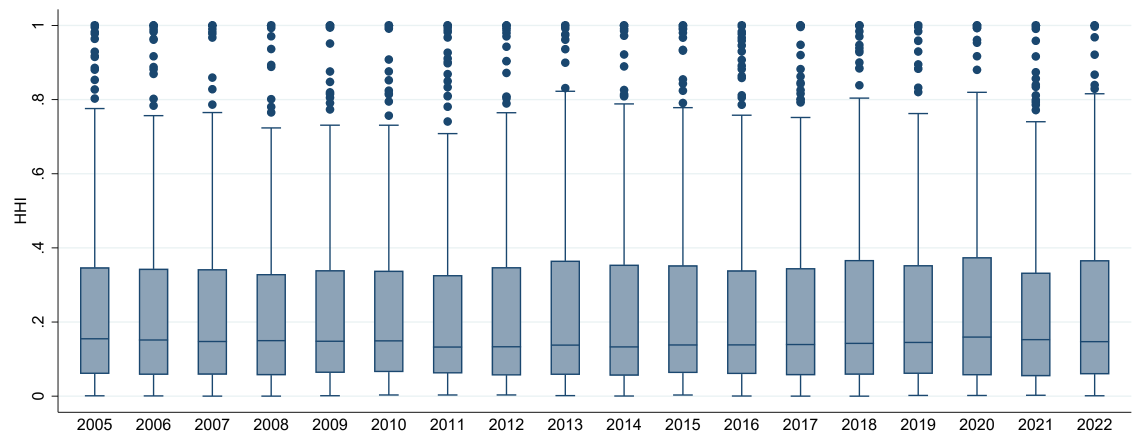


Figure 19: **Key Moments of Adjusted HHI Estimates at the 4-digit ISIC Class Level**

Note: This figure shows the evolution of key moments from the distribution of adjusted HHI estimates that have been calculated at the 4-digit ISIC class level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

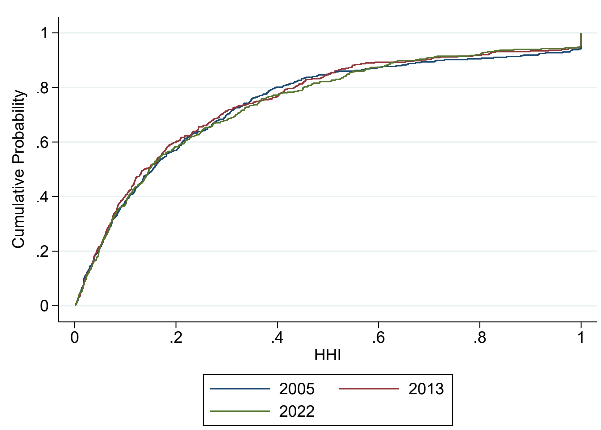


Figure 20: **CDF of Adjusted HHI Estimates at the 4-digit ISIC Class Level by Year**

Note: This figure shows the CDF of adjusted HHI estimates that have been calculated at the 4-digit ISIC class level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports.

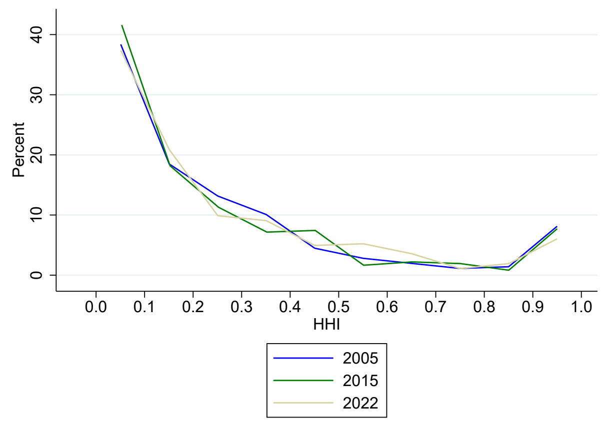


Figure 21: **Histogram of Adjusted HHI Estimates at the 4-digit ISIC Class Level by Year**

Note: This figure shows the histogram of adjusted HHI estimates that have been calculated at the 4-digit ISIC class level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports.

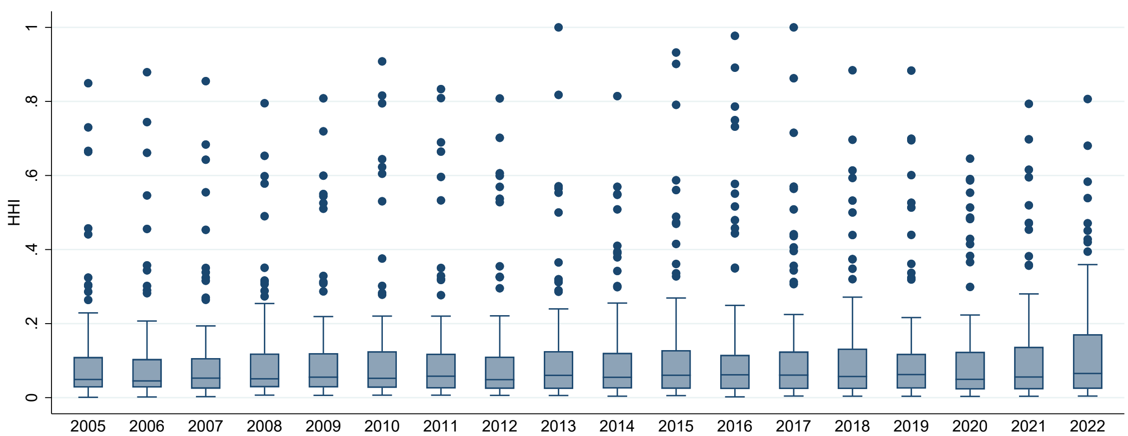


Figure 22: **Key Moments of Adjusted HHI Estimates at the 4-digit ISIC Division Level**

Note: This figure shows the evolution of key moments from the distribution of adjusted HHI estimates that have been calculated at the 4-digit ISIC division level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

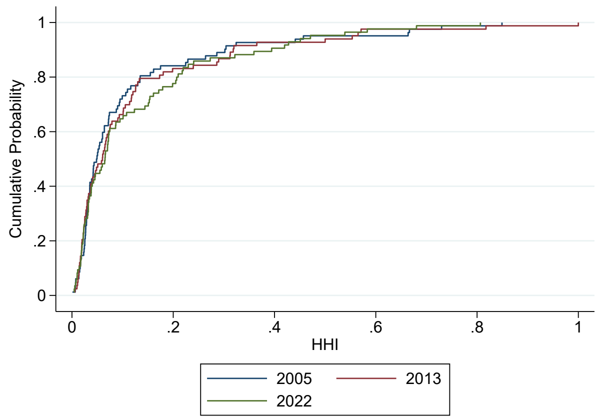


Figure 23: **CDF of Adjusted HHI Estimates at the 4-digit ISIC Division Level by Year**

Note: This figure shows the CDF of adjusted HHI estimates that have been calculated at the 4-digit ISIC division level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports.

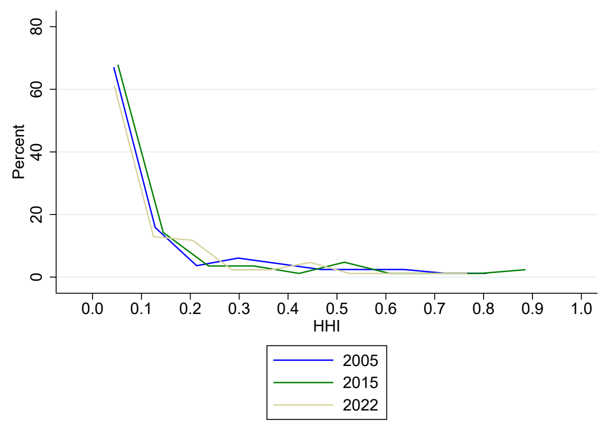


Figure 24: **Histogram of Adjusted HHI Estimates at the 4-digit ISIC Division Level by Year**

Note: This figure shows the histogram of adjusted HHI estimates that have been calculated at the 4-digit ISIC division level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports.

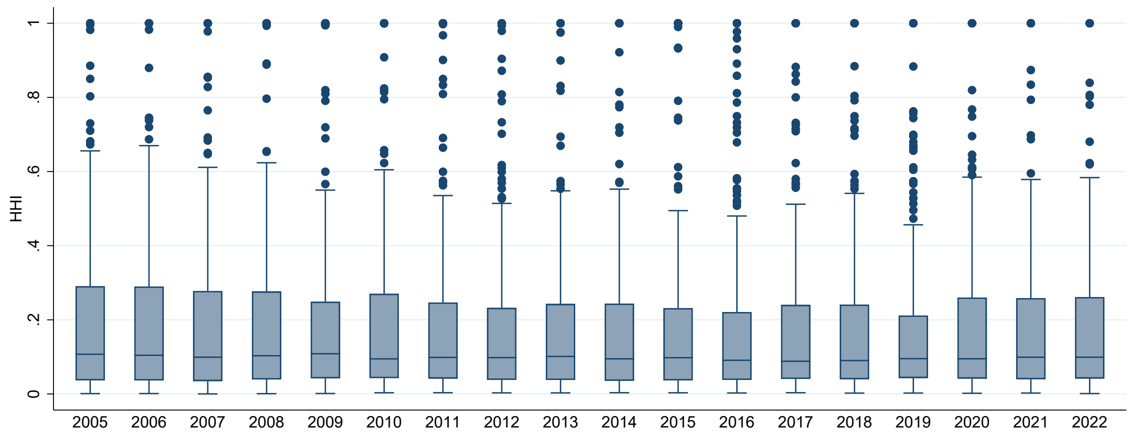


Figure 25: **Key Moments of Adjusted HHI Estimates at the 4-digit ISIC Group Level**

Note: This figure shows the evolution of key moments from the distribution of adjusted HHI estimates that have been calculated at the 4-digit ISIC group level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

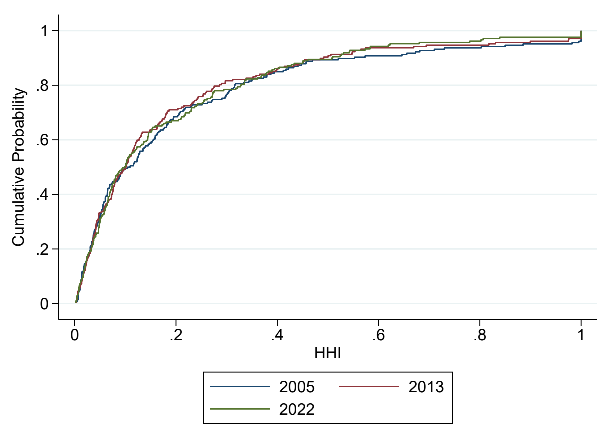


Figure 26: **CDF of Adjusted HHI Estimates at the 4-digit ISIC Group Level by Year**

Note: This figure shows the CDF of adjusted HHI estimates that have been calculated at the 4-digit ISIC group level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports.

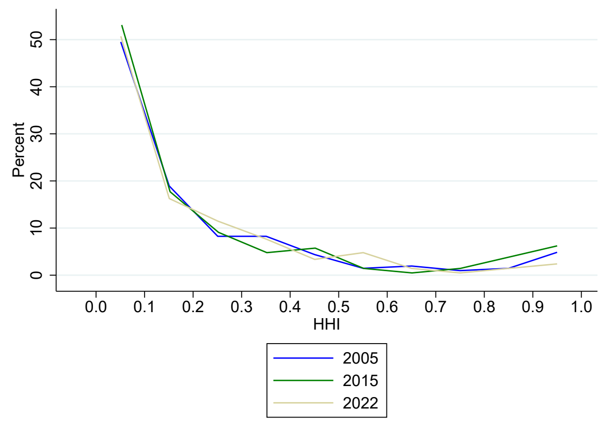


Figure 27: **Histogram of Adjusted HHI Estimates at the 4-digit ISIC Group Level by Year**

Note: This figure shows the histogram of adjusted HHI estimates that have been calculated at the 4-digit ISIC group level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports.

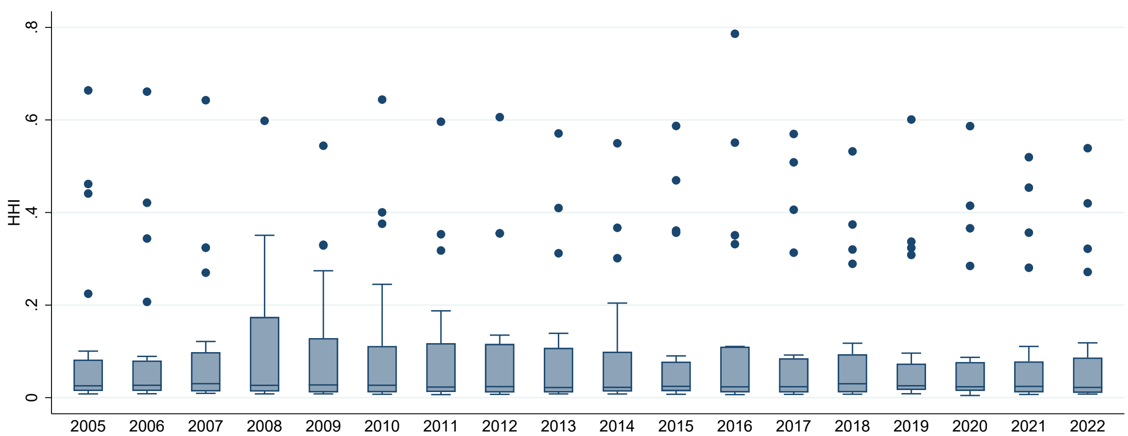


Figure 28: **Key Moments of Adjusted HHI Estimates at the 4-digit ISIC Section Level**

Note: This figure shows the evolution of key moments from the distribution of adjusted HHI estimates that have been calculated at the 4-digit ISIC section level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

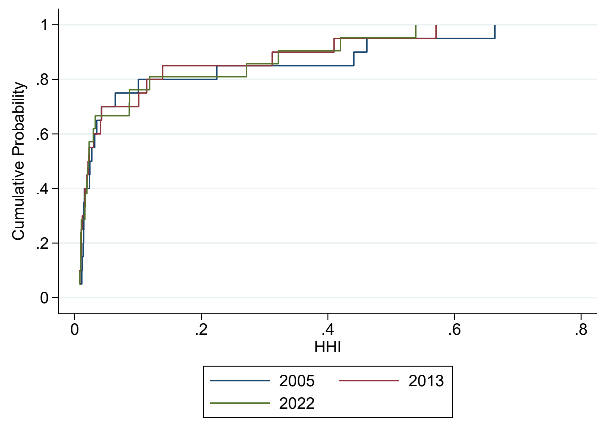


Figure 29: **CDF of Adjusted HHI Estimates at the 4-digit ISIC Section Level by Year**

Note: This figure shows the CDF of adjusted HHI estimates that have been calculated at the 4-digit ISIC section level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports.

Figure 30: **Histogram of Adjusted HHI Estimates at the 4-digit ISIC Section Level by Year**

Note: This figure shows the histogram of adjusted HHI estimates that have been calculated at the 4-digit ISIC section level. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports.

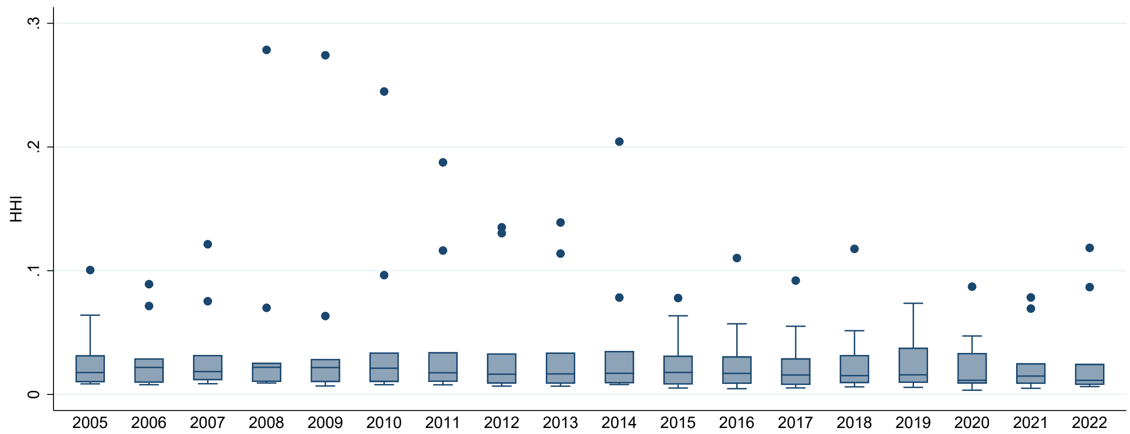


Figure 31: **Key Moments of Adjusted HHI Estimates at the Industry Level**

Note: This figure shows the evolution of key moments from the distribution of adjusted HHI estimates that have been calculated at the industry level. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

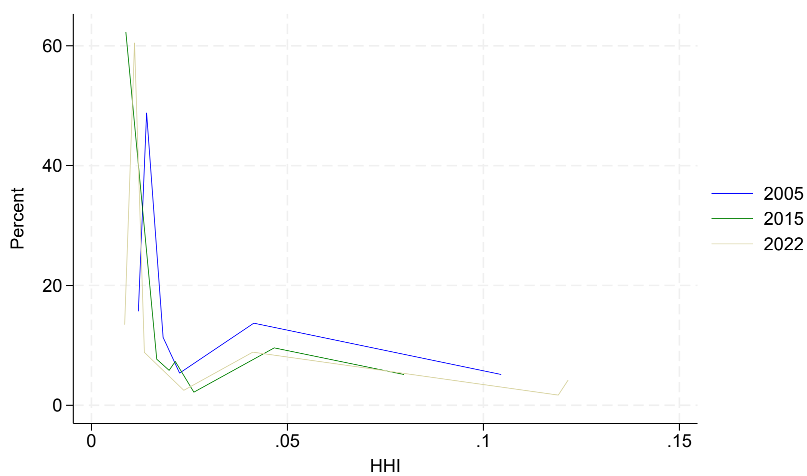


Figure 32: **Histogram of Adjusted HHI Estimates at the Industry Level by Year**

Note: This figure shows the histogram of adjusted HHI estimates that have been calculated at the industry level. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports.

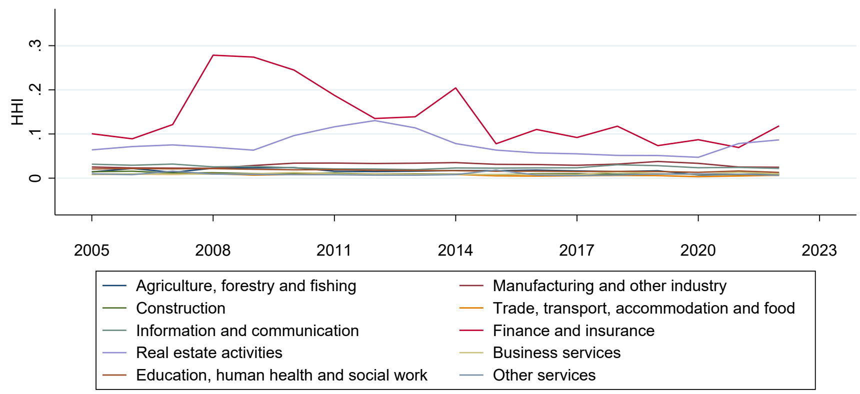


Figure 33: **Adjusted HHI Estimates by Year and Industry Classification**

Note: This figure shows the evolution of adjusted HHI estimates that have been calculated at the industry level. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts. For adjusted HHI, numerators of firm-level market shares exclude exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

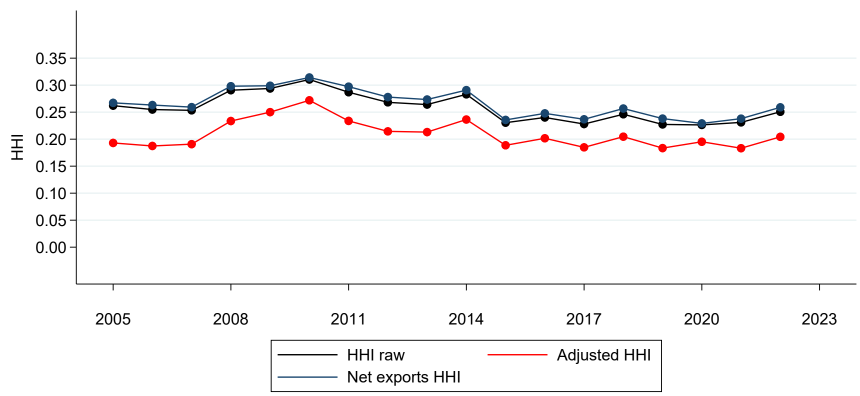


Figure 34: **Average of HHI Estimates at the 4-digit ISIC Class Level by Year**

Note: This figure shows the evolution of adjusted HHI estimates that have been calculated at the 4-digit ISIC class level. All sector-specific values are revenue-weighted.

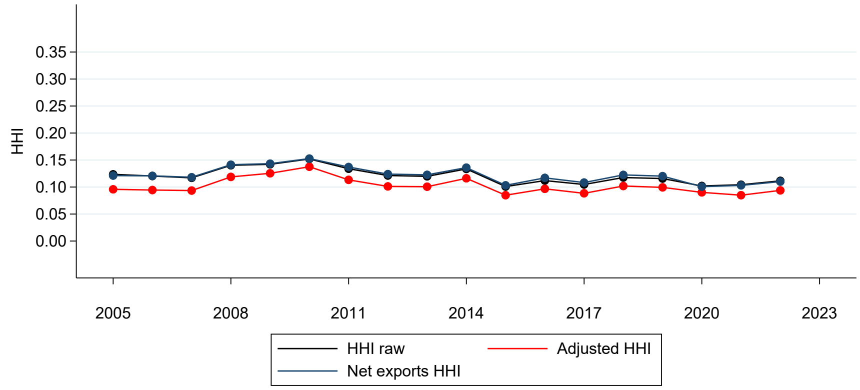


Figure 35: **Average of HHI Estimates at the 4-digit ISIC Division Level by Year**

Note: This figure shows the evolution of adjusted HHI estimates that have been calculated at the 4-digit ISIC division level. All sector-specific values are revenue-weighted.

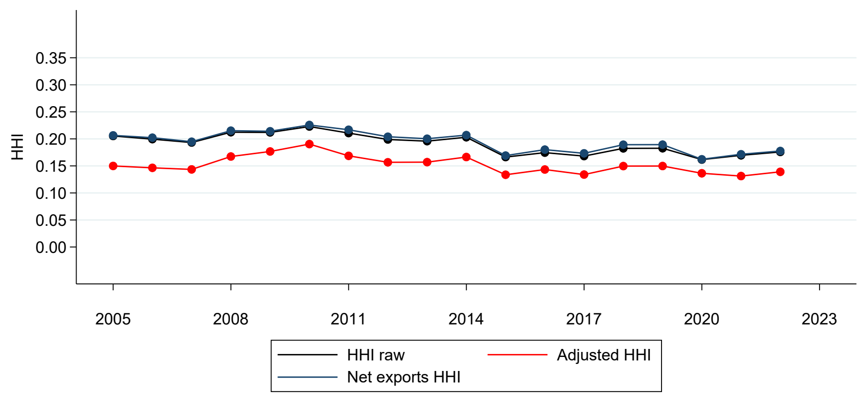


Figure 36: **Average of HHI Estimates at the 4-digit ISIC Group Level by Year**

Note: This figure shows the evolution of adjusted HHI estimates that have been calculated at the 4-digit ISIC group level. All sector-specific values are revenue-weighted.

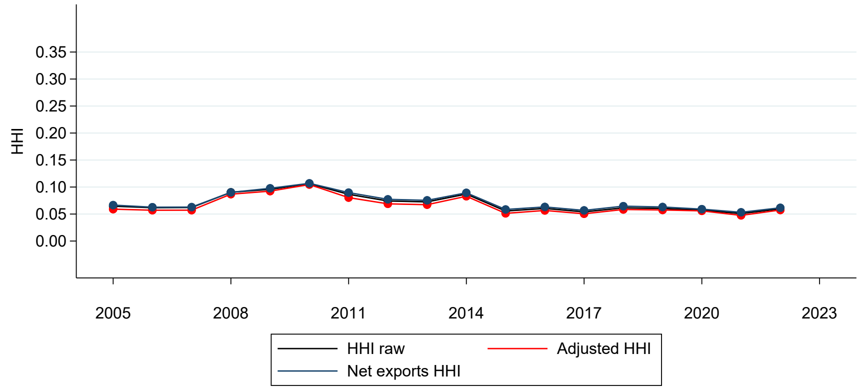


Figure 37: **Average of HHI Estimates at the 4-digit ISIC Section Level by Year**

Note: This figure shows the evolution of adjusted HHI estimates that have been calculated at the 4-digit ISIC section level. All sector-specific values are revenue-weighted.

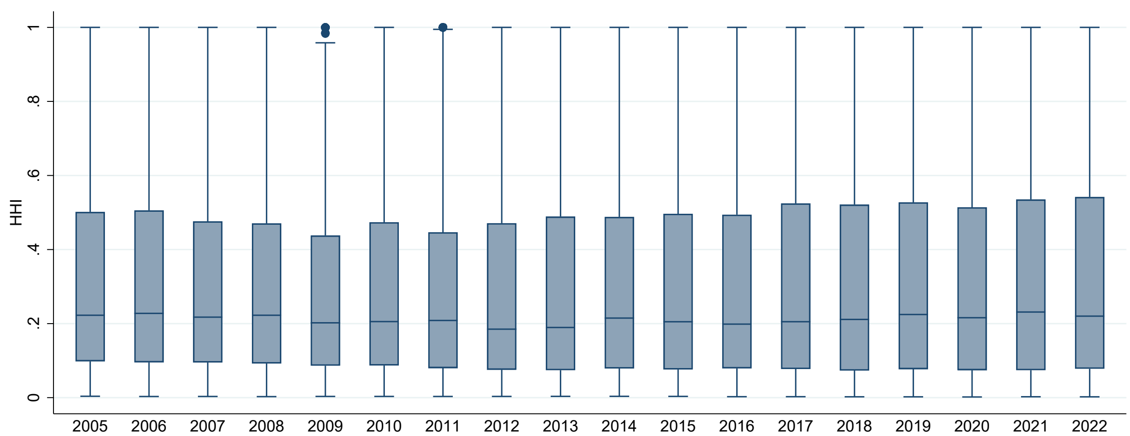


Figure 38: **Key Moments of Net Exports Adjusted HHI at the 4-digit ISIC Class Level**

Note: This figure shows the evolution of key moments from the distribution of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC class level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

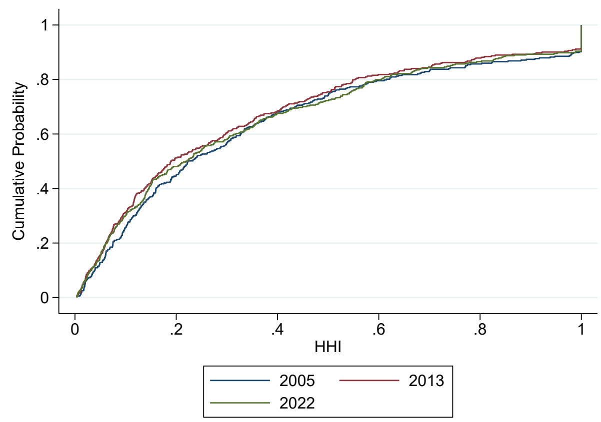


Figure 39: **CDF of Net Exports Adjusted HHI Estimates at 4-digit ISIC Class Level**

Note: This figure shows the CDF of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC class level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

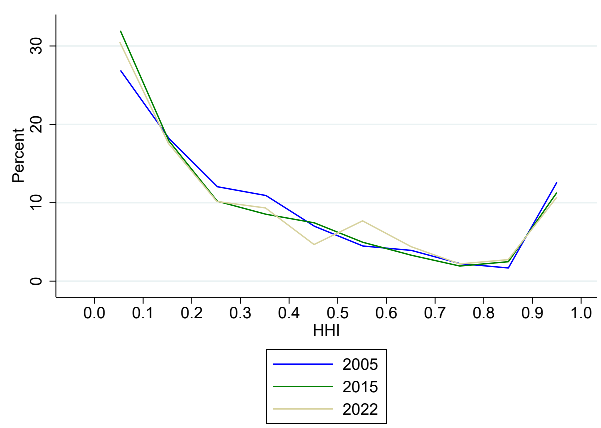


Figure 40: **Histogram of Net Exports Adjusted HHI Estimates at 4-digit ISIC Class Level**

Note: This figure shows the histogram of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC class level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

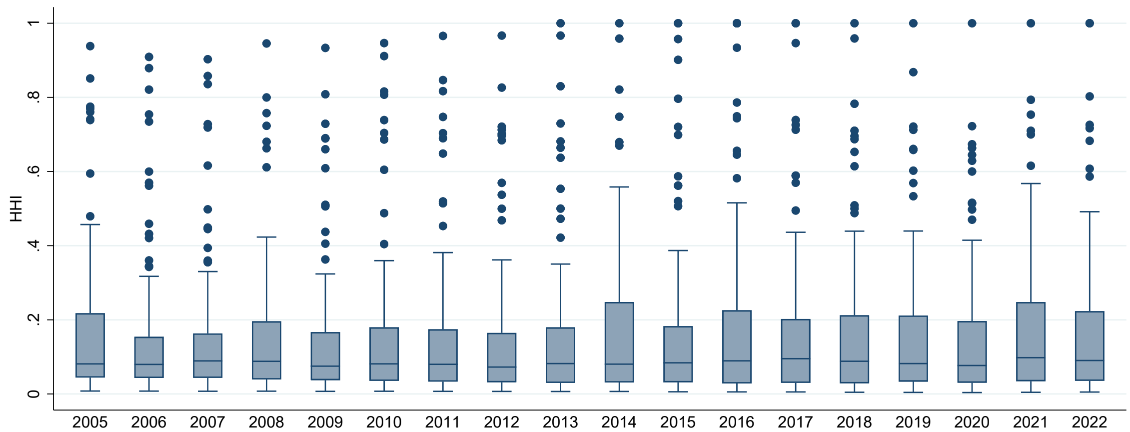


Figure 41: **Key Moments of Net Exports Adjusted HHI at the 4-digit ISIC Division Level**

Note: This figure shows the evolution of key moments from the distribution of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC division level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

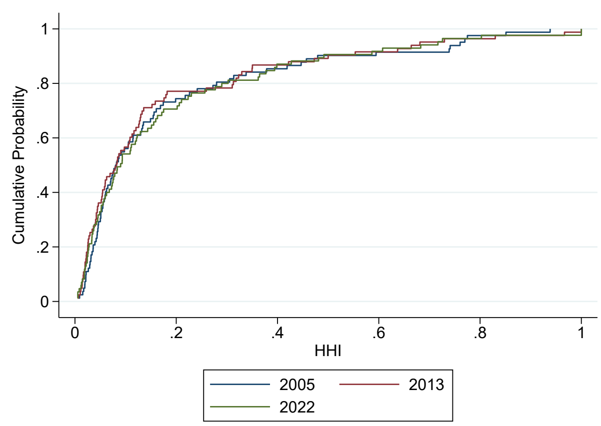


Figure 42: **CDF of Net Exports Adjusted HHI Estimates at 4-digit ISIC Division Level**

Note: This figure shows the CDF of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC division level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

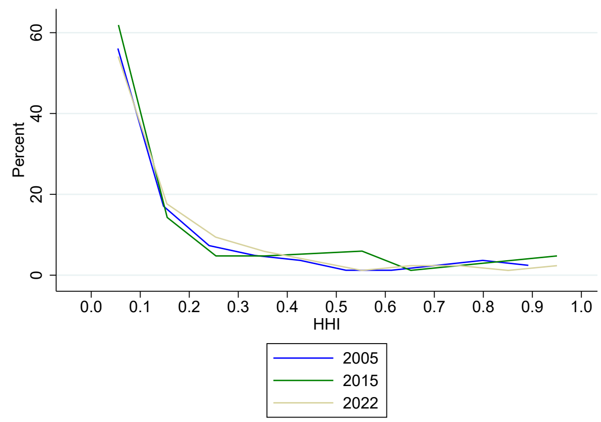


Figure 43: **Histogram of Net Exports Adjusted HHI Estimates at 4-digit ISIC Division Level**

Note: This figure shows the histogram of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC division level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

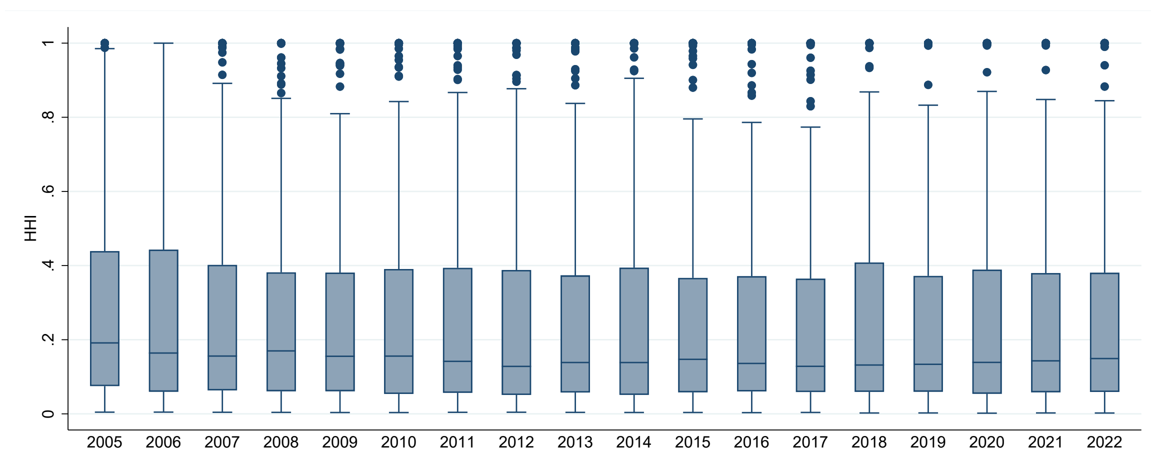


Figure 44: **Key Moments of Net Exports Adjusted HHI at the 4-digit ISIC Group Level**

Note: This figure shows the evolution of key moments from the distribution of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC group level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

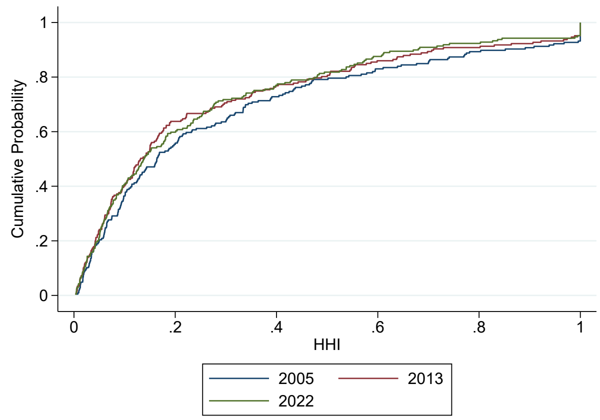


Figure 45: **CDF of Net Exports Adjusted HHI Estimates at 4-digit ISIC Group Level**

Note: This figure shows the CDF of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC group level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

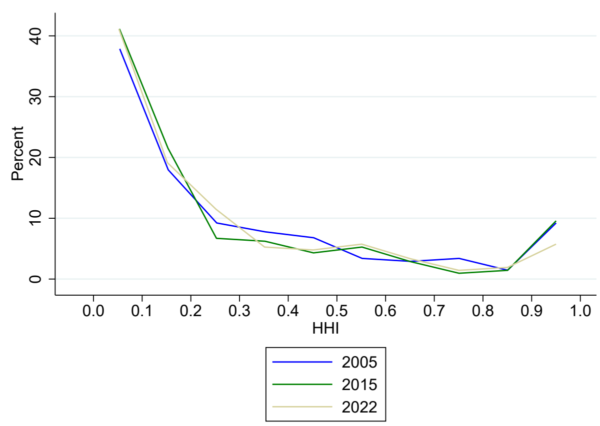


Figure 46: **Histogram of Net Exports Adjusted HHI Estimates at 4-digit ISIC Group Level**

Note: This figure shows the histogram of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC group level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

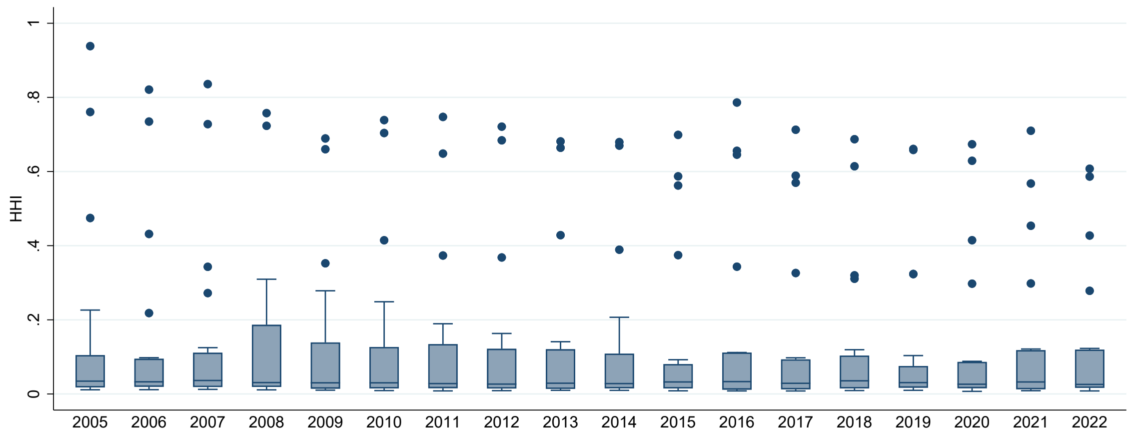


Figure 47: **Key Moments of Net Exports Adjusted HHI at the 4-digit ISIC Group Level**

Note: This figure shows the evolution of key moments from the distribution of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC section level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

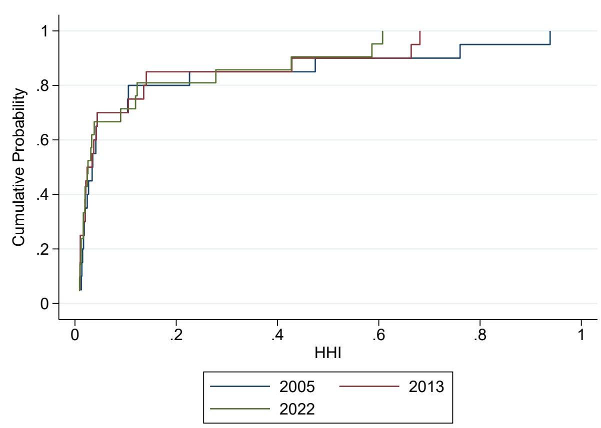


Figure 48: **CDF of Net Exports Adjusted HHI Estimates at 4-digit ISIC Section Level**

Note: This figure shows the CDF of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC section level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

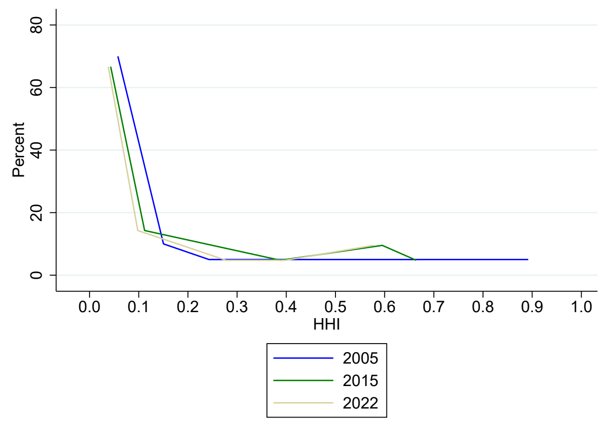


Figure 49: **Histogram of Net Exports Adjusted HHI Estimates at 4-digit ISIC Section Level**

Note: This figure shows the histogram of net exports adjusted HHI estimates that have been calculated at the 4-digit ISIC section level. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

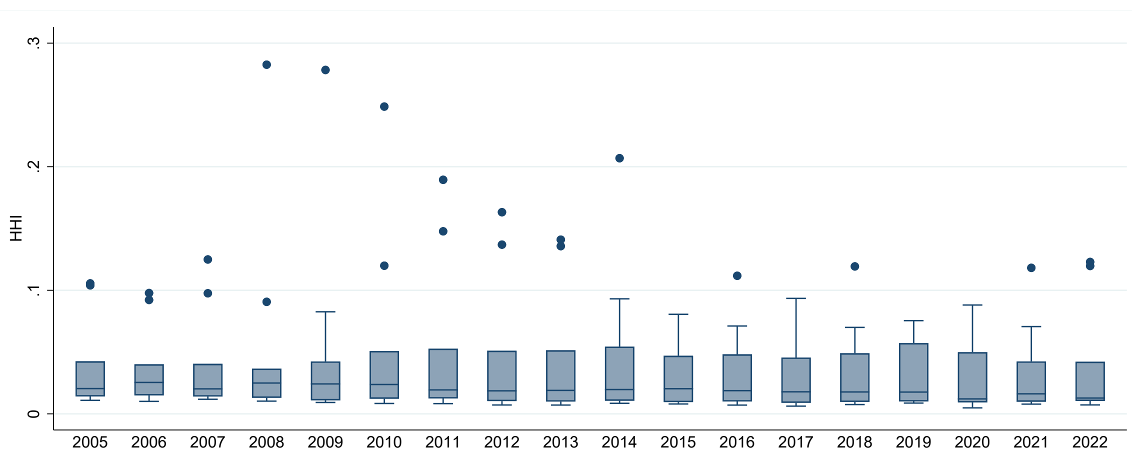


Figure 50: **Key Moments of Net Exports Adjusted HHI at the Industry Level**

Note: This figure shows the evolution of key moments from the distribution of net exports adjusted HHI estimates that have been calculated at the industry level. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports. All sector-specific values are revenue-weighted.

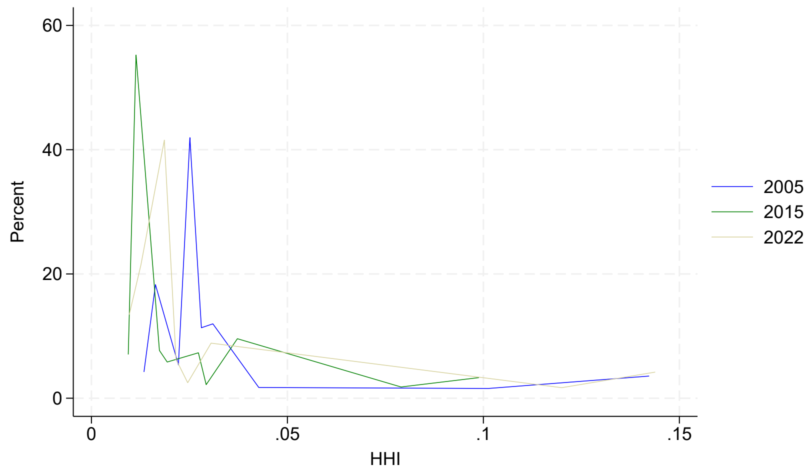


Figure 51: **Histogram of Net Exports Adjusted HHI at the Industry Level**

Note: This figure shows the histogram of net exports adjusted HHI estimates that have been calculated at the industry level. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts. For net exports adjusted HHI, numerators of firm-level market shares exclude net exports, and denominators exclude exports and include imports.

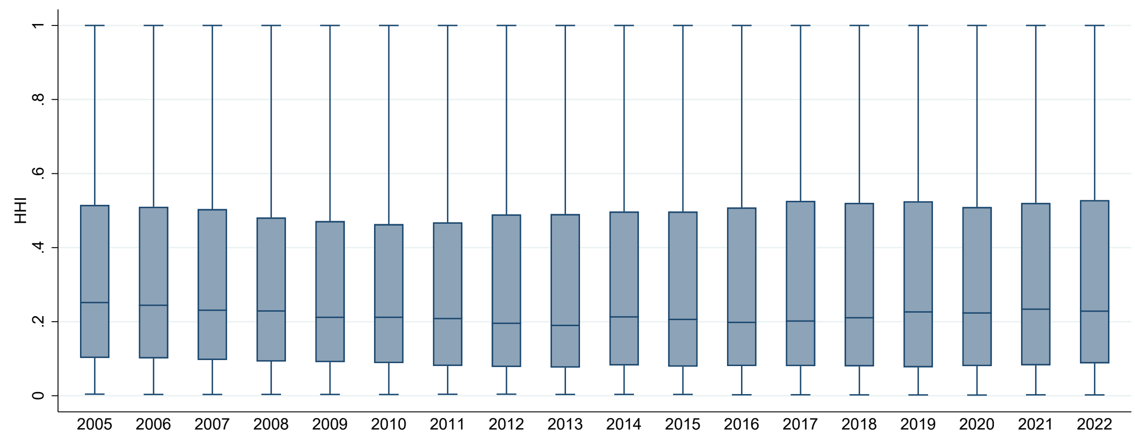


Figure 52: **Key Moments of HHI Estimates at 4-digit ISIC Class Level**

Note: This figure shows the evolution of key moments from the distribution of HHI estimates that have been calculated at the 4-digit ISIC class level. All sector-specific values are revenue-weighted.

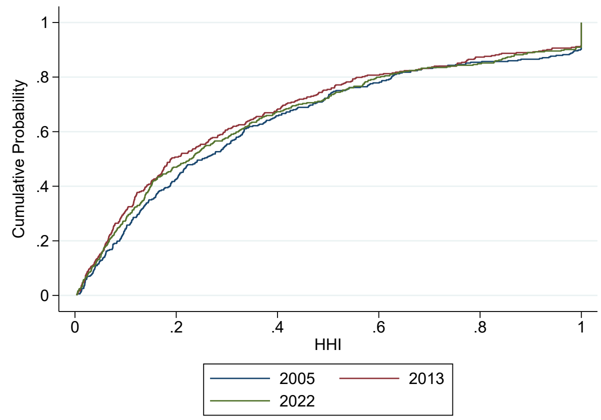


Figure 53: **CDF of HHI Estimates at 4-digit ISIC Class Level**

Note: This figure shows the CDF of HHI estimates that have been calculated at the 4-digit ISIC class level.

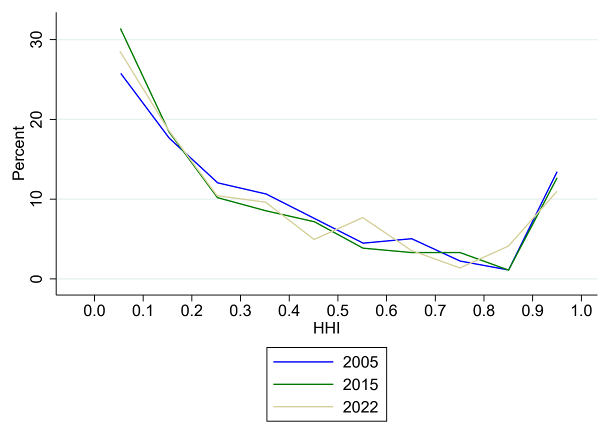


Figure 54: **Histogram of HHI Estimates at 4-digit ISIC Class Level**

Note: This figure shows the histogram of HHI estimates that have been calculated at the 4-digit ISIC class level.

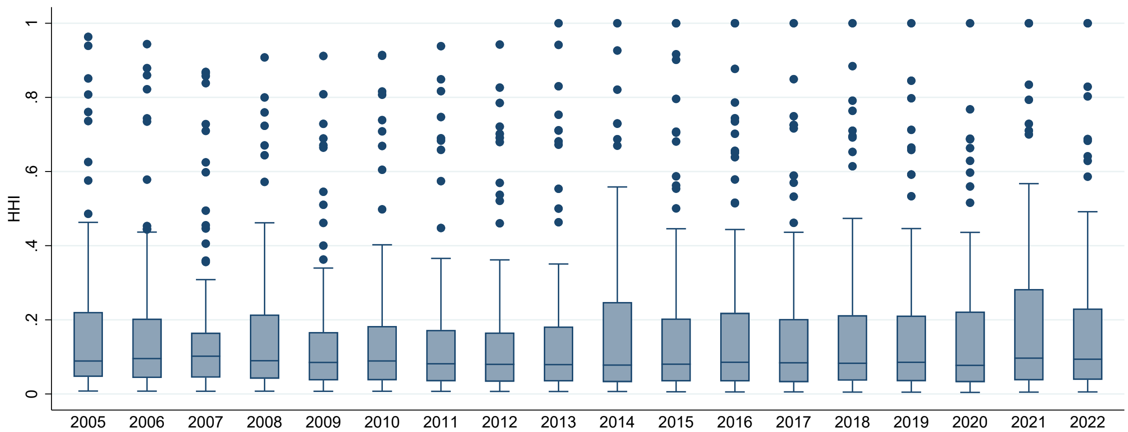


Figure 55: **Key Moments of HHI Estimates at 4-digit ISIC Division Level**

Note: This figure shows the evolution of key moments from the distribution of HHI estimates that have been calculated at the 4-digit ISIC division level. All sector-specific values are revenue-weighted.

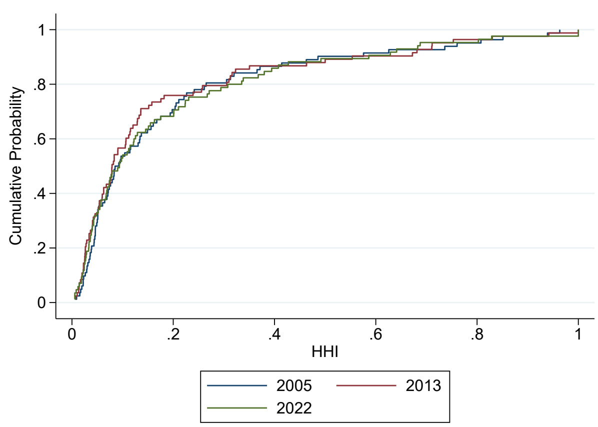


Figure 56: **CDF of HHI Estimates at 4-digit ISIC Division Level**

Note: This figure shows the CDF of HHI estimates that have been calculated at the 4-digit ISIC division level.

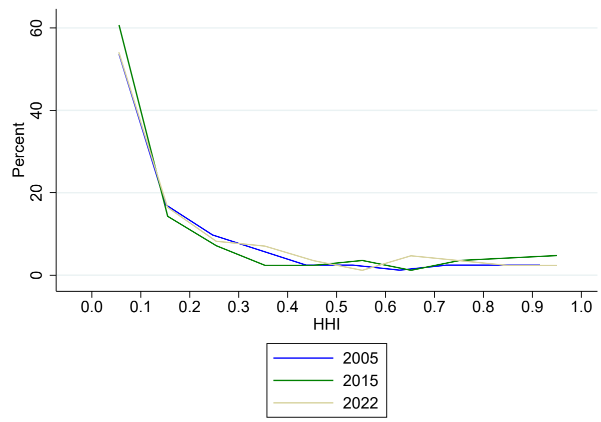


Figure 57: **Histogram of HHI Estimates at 4-digit ISIC Division Level**

Note: This figure shows the histogram of HHI estimates that have been calculated at the 4-digit ISIC division level.

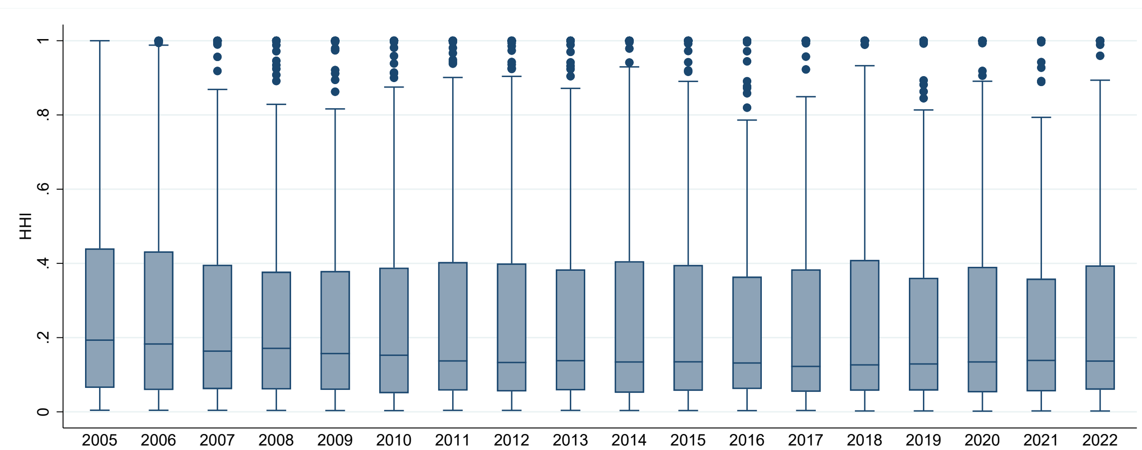


Figure 58: **Key Moments of HHI Estimates at 4-digit ISIC Group Level**

Note: This figure shows the evolution of key moments from the distribution of HHI estimates that have been calculated at the 4-digit ISIC group level. All sector-specific values are revenue-weighted.

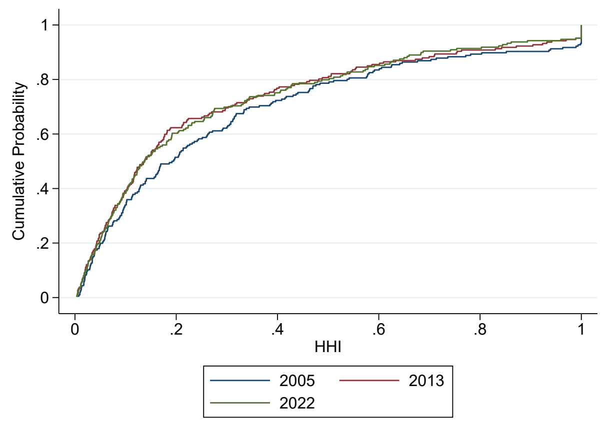


Figure 59: **CDF of HHI Estimates at 4-digit ISIC Group Level**

Note: This figure shows the CDF of HHI estimates that have been calculated at the 4-digit ISIC group level.

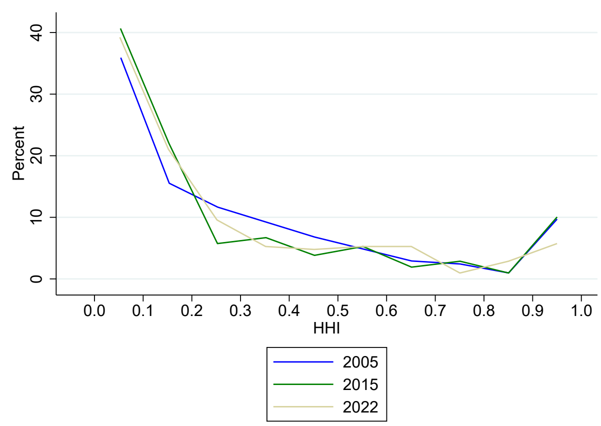


Figure 60: **Histogram of HHI Estimates at 4-digit ISIC Group Level**

Note: This figure shows the histogram of HHI estimates that have been calculated at the 4-digit ISIC group level.

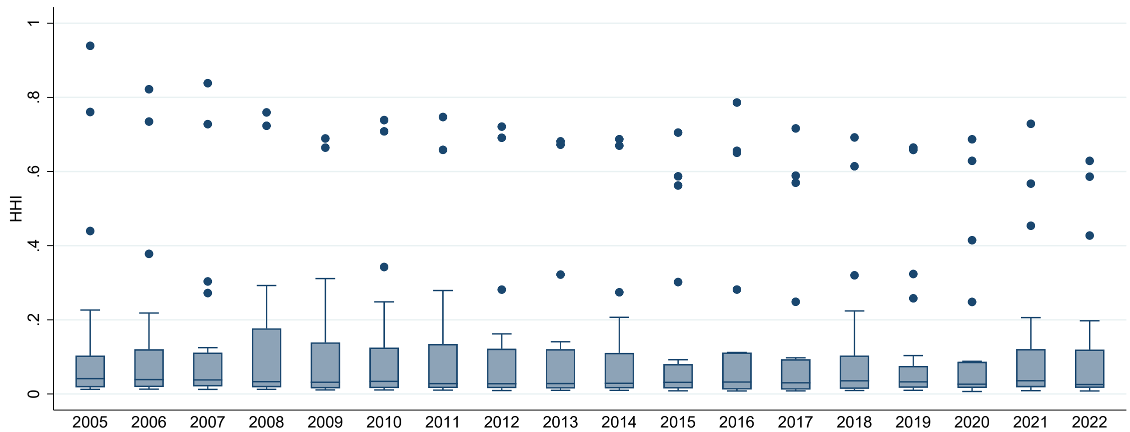


Figure 61: **Key Moments of HHI Estimates at 4-digit ISIC Section Level**

Note: This figure shows the evolution of key moments from the distribution of HHI estimates that have been calculated at the 4-digit ISIC section level. All sector-specific values are revenue-weighted.

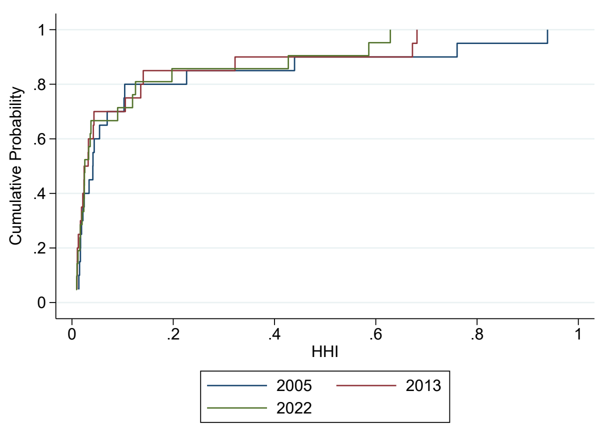


Figure 62: **CDF of HHI Estimates at 4-digit ISIC Section Level**

Note: This figure shows the CDF of HHI estimates that have been calculated at the 4-digit ISIC section level.

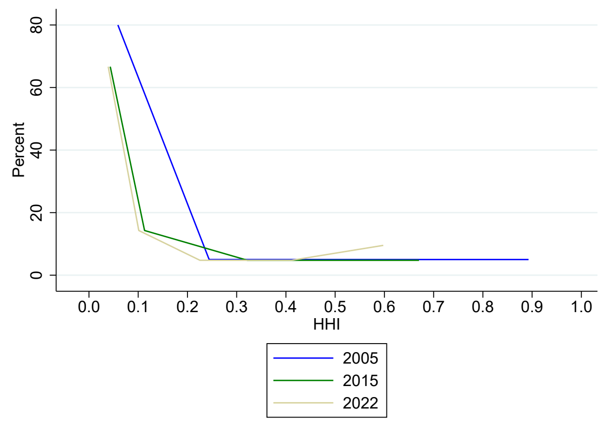


Figure 63: **Histogram of HHI Estimates at 4-digit ISIC Section Level**

Note: This figure shows the histogram of HHI estimates that have been calculated at the 4-digit ISIC section level.

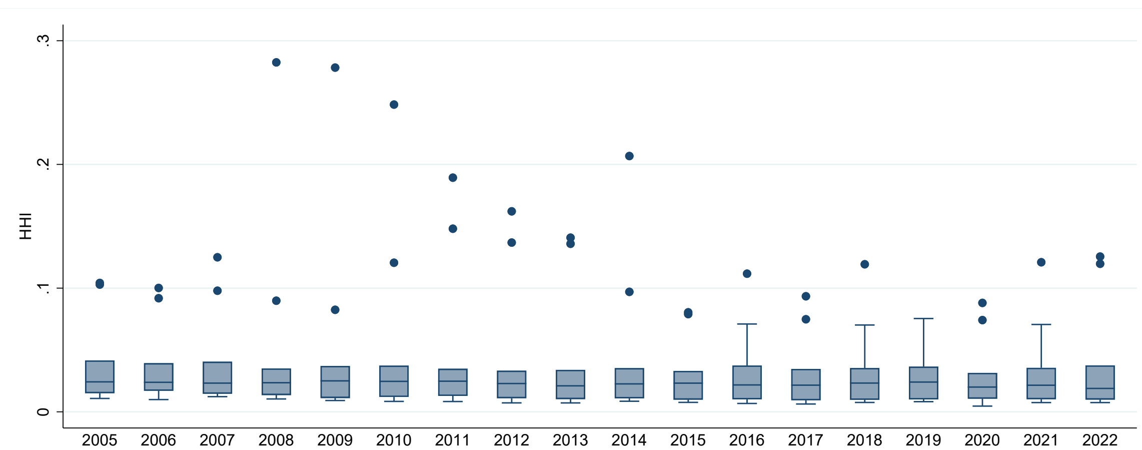


Figure 64: **Key Moments of HHI Estimates at the Industry Level**

Note: This figure shows the evolution of key moments from the distribution of HHI estimates that have been calculated at the industry level. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts. All sector-specific values are revenue-weighted.

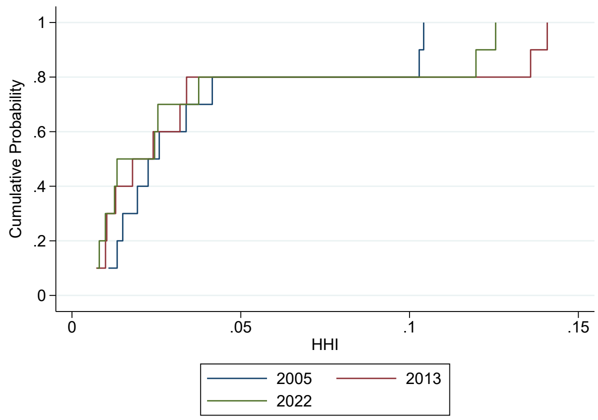


Figure 65: **CDF of HHI Estimates at the Industry Level**

Note: This figure shows the CDF of HHI estimates that have been calculated at the industry level. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts.

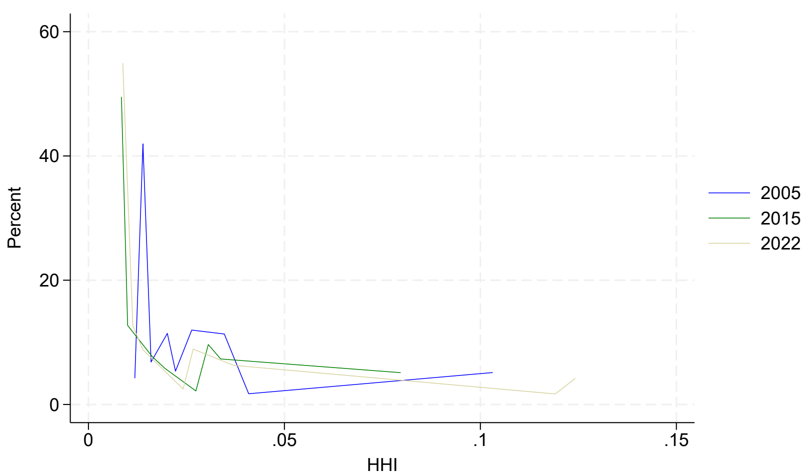


Figure 66: **Histogram of HHI Estimates at the Industry Level**

Note: This figure shows the histogram of HHI estimates that have been calculated at the industry level. In our calculations, we align our treatment of markets with industry sectors in accordance with definitions outlined in the framework of national accounts.