U.S. Market Concentration and Import Competition*

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Abstract

Many studies have documented that market concentration has risen among U.S. firms in recent decades. In this paper, we show that this rise in concentration was accompanied by tougher product market competition due to the entry of foreign competitors. Using confidential census data covering the universe of all firm sales in the U.S. manufacturing sector, we find that rising import competition increased concentration among U.S. firms by reallocating sales from smaller to larger U.S. firms and by causing firm exit. However, this increase in concentration was counteracted by the expansion of foreign firms, which reduced domestic firms' share of the U.S. market inclusive of foreign firms' sales. We find that once the sales of foreign exporters are taken into account, U.S. market concentration in manufacturing was stable between 1992 and 2012.

Key Words: market concentration, markups, import competition, international trade

JEL Classifications: F14, F60, L11

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1 Introduction

A salient feature of the U.S. economy is the increasing dominance of large firms. Many studies have documented that market concentration has risen among U.S. firms across all sectors in recent decades (e.g., Gutiérrez and Philippon (2017), Van Reenen (2018), Grullon, Larkin, and Michaely (2019), Covarrubias, Gutiérrez, and Philippon (2019), Autor et al. (2020), and Barkai (2020)). One reason for the close attention to market concentration is that it is often interpreted as a proxy for market power. However, to make that connection, it is necessary to account for all firms that compete in the market. The number of foreign firms competing in the U.S. market has significantly increased as import penetration has nearly doubled in recent decades. Standard international trade models, such as Melitz (2003), predict that trade liberalization increases market concentration among domestic firms due to reallocation from small inefficient firms to large firms, while simultaneously exposing domestic firms to tougher product market competition. In this paper, we provide new evidence for this channel and show that while import penetration contributed to the rise in the dominance of large U.S. firms in the manufacturing sector, it has reduced their sales as a share of the U.S. market inclusive of foreign firms' sales. We find that once the sales of foreign exporters are accounted for, market concentration in manufacturing was stable between 1992 and 2012.

Rising market concentration is often associated with an increase in market power, since a firm's market share is a sufficient statistic for markups in a large class of models (e.g. Mrázová and Neary (2017), Amiti, Itskhoki, and Konings (2019)). However, this result rests on an appropriate definition of a market. The conventional approach to measuring concentration computes market shares based on where the sales originate (i.e. in the U.S.), and includes all sales irrespective of where they are destined, i.e. they also include sales to foreign markets. We refer to this conventional concentration measure as *production concentration*, since it is based on where shipments are produced. This approach contrasts with the theory-consistent measure of a market, which focuses on the destination of the sales. For example, a firm selling a car in the U.S. is unlikely to be competing with a car destined for Japan. Instead U.S. firms compete with other U.S. firms and foreign firms selling to the U.S. The theory-consistent measure, which we refer to as *market concentration*, would require knowledge of the universe of all firms' sales to the U.S. market, which is rarely available.

In this paper, we overcome these measurement issues by using confidential data from the U.S. Census Bureau covering the universe of all firm sales in the manufacturing sector in the U.S. for the census years (every 5 years) from 1992 to 2012. We define the market at the 5-digit NAICS industry level, where firms can operate in more than one industry. Critically, the data include the sales of all foreign firms selling in the U.S. market. Having firm-level data for all foreign firms is important because it is not only the share of imports by industry that matters for market concentration but the distribution of these firm sales. For example, an increase in imports of 10 percentage points would have very different implications for market concentration if the increase were due to 100 firms than if it were due to one or two firms. Our study is the first to include all of the foreign firms' sales to measure market concentration in the U.S.

Our analysis uncovers several new stylized facts. First, once the market shares of foreign firms are taken into account, we find that market concentration did not rise but instead remained flat between 1992 and 2012. This result is consistent with trade theory such as Melitz (2003), which predicts that trade liberalization reduces domestic firms' sales while foreign competitors gain. Under the added assumption that firms' productivity is Pareto distributed as in Chaney (2008), these two effects completely offset each other, resulting in no change in market concentration. Furthermore, our results are not driven by just a handful of industries. We find that the inclusion of foreign firms attenuates the rise in concentration in a broad range of manufacturing industries.

Second, we show that the growth of foreign firms' market shares was mostly at the bottom of the sales distribution. In theory, an increase in imports could be consistent with either rising or falling concentration if the Pareto distribution assumption does not hold or if foreign and domestic firms face different fixed costs. Our comprehensive firm-level data allows us to pinpoint which part of the market share distribution foreign firms enter. We find that the entry of foreign firms with small market shares counteracted the increase in concentration among U.S.-based firms, generating the flat trend in market concentration.

Our third stylized fact shows a negative relationship between the change in import competition and the change in concentration. Market concentration fell in industries that experienced strong growth in import competition between 1992 and 2012, which are also the industries that already had high import penetration at the beginning of the sample. In contrast, market concentration rose in most industries with low import penetration. Effectively, the production concentration measure commonly used in the literature and our market concentration measure differ the most in industries where foreign firms play a significant role. In import-competing industries, such as electronics, the two measures differ significantly – these are the industries that were further liberalized and became less concentrated. By contrast, industries like concrete remain fairly closed to trade and thus do not face increased competition from foreign firms.

Did tougher import competition affect U.S. market concentration? In order to establish a causal relationship between import competition and concentration, we need exogenous shocks that shift the world supply of goods to the U.S. To this end, we construct time-varying industry Bartik-type instruments for U.S. imports, using a novel methodology developed by Amiti and Weinstein (2018). We then estimate industry-level regressions of the five-year change in concentration on the change in import penetration, using two-stage least squares. First, we compute production concentration, measured as total sales of the top-20 U.S. firms as a share of only U.S. firms' sales. As predicted by the trade theory, we find that higher import penetration increased concentration among domestic U.S. firms. Moreover, consistent with the Melitz (2003) model, which predicts the exit of inefficient domestic firms, we find that the number of U.S. firms fell with import competition. In contrast, the regression reveals that higher import penetration reduced the market shares of the top-20 U.S. firms as a share of all firms' sales, inclusive of foreign exporters to the U.S. Our results show that a one standard deviation increase in import penetration reduced the overall market shares of the top-20 U.S. firms by 3 percentage points. A back-of-the-envelope calculation which aggregates the predicted effects from this regression across industries and years suggests that import competition accounts for half of the decline in the market share of the top-20 U.S. firms. These contrasting results highlight the importance of the definition of a market in understanding the relationship between import competition and concentration. When we only consider the sales of the top U.S. firms relative to total sales of U.S. firms, we find that larger firms gained market share in industries with tougher import competition, and hence concentration appears to have risen. However, when we consider the market share of the top U.S. firms as a share of all sales in the U.S. market, inclusive of foreign firms' sales, we find that the market share of large U.S. firms actually shrank.

Our paper relates to a growing literature on market concentration. A number of studies have shown a rise in concentration by constructing production concentration measures with the confidential census data, e.g, Autor et al. (2020). However, none of the earlier studies have included the sales of all foreign exporters in the U.S. using firm-level foreign exporter data. While Autor et al. (2020) make an aggregate adjustment for imports using 6-digit Harmonized System (HS6) level import data from Comtrade, they do not have firm-level imports and exports, which are necessary to get an accurate picture of the trend in market concentration.[1] A number of recent studies that have used alternative definitions of markets have found that concentration has declined over the last few decades: Rossi-Hansberg, Sarte, and Trachter (2021) define the market at the local level; Freund and Sidhu (2017) at the global level; and Benkard, Yurukoglu, and Zhang (2021) at a more narrow product level. Defining the relevant market is an open question. In general, whether one focuses on the U.S. national market or more local markets should depend on how tradeable the sector is.[2] Since our data only comprise the manufacturing sector, we define the market at the national level and use the most disaggregated industry level our data allows.[3] Focusing only on exporters, Bonfiglioli, Crinò, and Gancia (2021) also find falling concentration; however, these data only include seaborne trade, which accounts for half of total trade, and exclude domestic sales of U.S. firms. The advantage of our data is that they comprise the entire distribution of domestic and foreign firms selling to the U.S.

We also contribute to the literature studying the consequences of rising concentration for markups. Autor et al. (2020) and Baqaee and Farhi (2020) find that conventional production concentration measures have increased due to a reallocation of sales towards larger firms that have higher markups. A number of papers have shown that globalization reduces market power. For example, Feenstra and Weinstein (2017) find that Herfindahl indexes in the U.S. fell between 1992 and 2005 once they take account of U.S. imports, and show that their model implies falling markups. De Loecker et al. (2016) and Edmond, Midrigan, and Xu (2015) find that lower import tariffs reduced markups in India and Taiwan, respectively, and Amiti, Itskhoki, and Konings (2014, 2019) provide evidence that large firms

1. Autor et al. (2020) treat six blocks of source countries as firms to adjust the numerator and denominator of their market share measures and find that this adjustment makes little difference to their concentration measures.

2. For example, for services such as hair cuts a more local market measure would be more appropriate.

3. We provide robustness at a more aggregated industry level.

reduced their markups in response to lower competitor prices in Belgium. Although markups are generally not observed and their estimation is beyond the scope of this paper, our results have important implications for market power.[4] Our work suggests that once foreign firms exporting to the U.S. are taken into account, domestic firms' market power in the U.S. may have actually declined.

The rest of the paper is organized as follows. Section 2 presents the empirical framework, and Section 3 describes the data. Section 4 describes the stylized facts, Section 5 presents the regression results, and Section 6 concludes.

2 Empirical Framework

A commonly used measure of market concentration is the sum of the market shares of the top 4 or 20 firms. An alternative measure is the Herfindahl-Hirschman Index (HHI), defined as the sum of squares of all market shares within an industry. Earlier studies (e.g., Grullon, Larkin, and Michaely (2019), Autor et al. (2020)) find increasing concentration for all of these measures. What is critical in these measures is the definition of the market over which market shares are computed. Let f index firms, and denote by F^{US} the set of firms located in the U.S. (U.S. firms) and by F^{*} the set of firms located in the rest of the world selling to the U.S. market (foreign exporters). The standard approach is to define market shares only for domestic firms using shipment data, as follows:

$$S^P_{ift} = \frac{shipments_{ift}}{\sum_{f \in F^{US}} shipments_{ift}}, \tag{1}$$

where $shipments_{ift}$ denotes a U.S. firm f's total sales, both domestic sales and exports, in industry i in year t.[5] This equation defines market shares over all firms within industry i located in the U.S. We refer to concentration measures based on this definition of market shares as *production concentration*, since the measure uses only shipments produced in the U.S.

However, if we are interested in concentration as an indicator of market power, we need to construct market concentration using all sales in the U.S market. Specifically, for U.S. firms we need to subtract exports from their total shipments and compute the size of the overall market including foreign firms' exports to the U.S. Similarly, for foreign firms, we need to take their exports to the U.S. market and divide by the total market size. Thus, market shares are computed as:

$$S_{ift} = \begin{cases} \dfrac{shipments_{ift} - exports_{ift}}{\sum_{f \in F^{US}} \left(shipments_{ift} - exports_{ift}\right) + \sum_{f \in F^{*}} exports^{*}_{ift}} & \text{if} \quad f \in F^{US} \\[2ex] \dfrac{exports^{*}_{ift}}{\sum_{f \in F^{US}} \left(shipments_{ift} - exports_{ift}\right) + \sum_{f \in F^{*}} exports^{*}_{ift}} & \text{if} \quad f \in F^{*} \end{cases}, \tag{2}$$

4. Empirical evidence on the evolution of markups in the U.S. is mixed: while De Loecker, Eeckhout, and Unger (2020) find that markups in the U.S. have increased significantly over the last decades, Traina (2018) and Karabarbounis and Neiman (2018) find relatively unchanged markups, and Gutiérrez and Philippon (2017) and Hall (2018) show a moderate increase in markups in most industries.

5. Publicly available U.S. Census data only report concentration measures for U.S. firms, using their total shipments. Note that U.S. firms include establishments of foreign-owned firms that are located in the U.S.

where the top row computes the market share of domestic firms and the bottom one computes the market share of foreign firms, and $exports^*_{ift}$ are foreign firms' exports to the U.S. Summing over all exports by foreign firms to the U.S. yields total U.S. imports. Critically, in both expressions the denominator sums the sales of all firms selling to the U.S. market, by both domestic firms and foreign firms. We refer to concentration measures based on this definition of market shares as *market concentration*.

Standard trade theory generates predictions for how a fall in trade costs affects market shares. The simplest model to gain intuition for the mechanisms is the Melitz (2003) model, although a drawback of this framework is that it features a continuum of firms and constant markups, and hence cannot directly address market power. In contrast, models with variable markups that feature a discrete number of firms do not have analytical expressions for the distribution of sales, making it difficult to illustrate the forces at play (see, e.g., Eaton, Kortum, and Sotelo (2013)). Therefore, we rely on the Melitz (2003) model to provide intuition for the effects of trade liberalization on concentration in the clearest possible way, and refer to variable markup models below to discuss the link between market concentration and market power. We provide more details on our analysis in Appendix A.

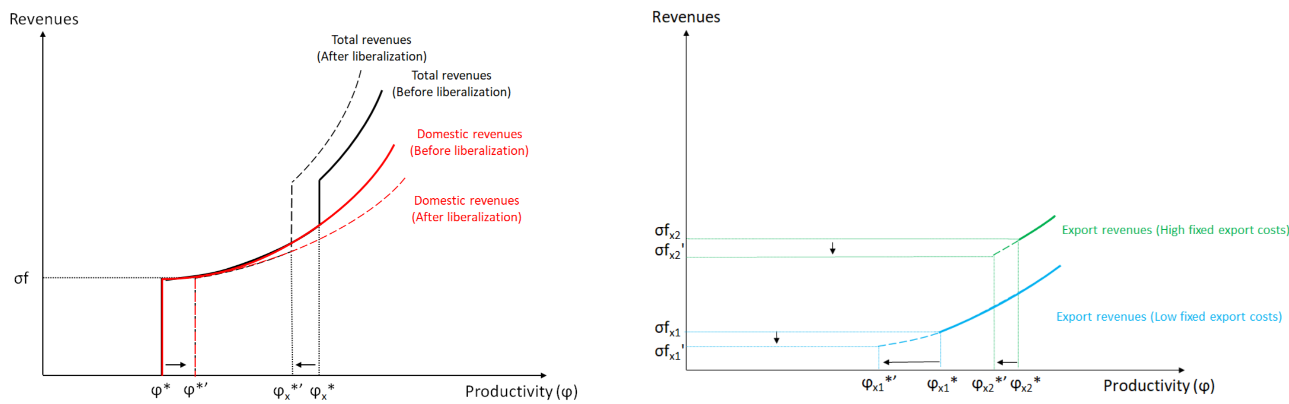
To illustrate the model's predictions, Figure 1a plots the effect of a fall in variable trade costs on firms' revenues as a function of firms' productivity level φ. The black lines show total revenues inclusive of exports, while the red lines present the revenues in the domestic market. As shown in Melitz (2003), with a continuum of firms in monopolistic competition, a fall in variable trade costs has two effects: (i) it increases the productivity cutoff for domestic firms from φ^* to the right to $\varphi^{*'}$, causing exit of the more inefficient firms and lowering the remaining firms' domestic sales due to increased foreign competition; and (ii) it lowers the productivity cutoff of exporting from φ^*_x to $\varphi^{*'}_x$, allowing additional firms to export and increasing the total sales of existing exporters. Consequently, for U.S. firms, the theory predicts a rise in production concentration using the market shares in equation (1). By contrast, the theory predicts a fall in U.S. firms' overall market share, using equation (2) and summing across only the U.S. firms. The question is what happens to the market concentration computed using the market shares in equation (2) summed across both U.S. and foreign firms. If we assume firms' productivity is Pareto distributed as in Chaney (2008) and the fixed cost of market entry is the same for domestic and foreign firms, the model predicts that market concentration remains unchanged in response to a fall in trade costs. Intuitively, a reduction in variable trade costs decreases domestic firms' sales in the domestic market (and the least productive firms exit); however, the growth of foreign competitors' sales (and the entry of additional competitors) exactly offsets this decline. The two effects exactly offset each other because of the property that a Pareto distribution always remains Pareto with the same shape regardless of where it is cut.

When the distribution is not Pareto or the fixed costs of market entry are asymmetric, the impact of a trade liberalization on market concentration cannot be unambiguously signed. The change in market concentration depends on the market share of the cutoff exporter relative to the market share of the domestic cutoff firm, which in turn are determined by the relative size of fixed costs and

Figure 1: Effect of a Trade Liberalization on Revenues

(a) Total Revenues and Domestic Sales Revenues

(b) Sales Revenues of Foreign Exporters



Notes: The figures show the effect of a trade liberalization on revenues according to the Melitz model, and are based on Figure 2 in Melitz (2003). The variable σ is the elasticity of substitution, f is the fixed cost of entry, and σf are the cutoff revenues needed by a firm to make nonnegative profits. φ^* is the cutoff productivity level before the trade liberalization, $\varphi^{*'}$ is the analogous level after liberalization, f_x is the fixed cost of exporting, φ_x^* is the cutoff productivity level for exporters before liberalization and $\varphi_x^{*'}$ is the analogous level after liberalization. The left panel shows firms' total revenues inclusive of exports and their domestic revenues before a trade liberalization (solid) and after a liberalization (dashed lines). The right panel shows the revenues of foreign exporters in the domestic market before (solid) and after liberalization (dashed lines) in two cases. In Case 1, depicted in blue, the fixed costs of exporting are relatively low and variable trade costs are relatively high. In Case 2, depicted in green, the fixed costs of exporting are high and the variable trade costs are low.

variable trade costs. For our purposes, we want to note that one can construct cases where market concentration need not rise with trade liberalization. To gain intuition, we consider the case when the cutoff exporter's market share is small relative to the share of the domestic cutoff firm. This case arises, for example, when exporters' fixed costs of entering the domestic market, f_x, are small relative to the fixed costs of domestic firms, f, but variable trade costs are high so that exporters obtain only small revenues. We illustrate the revenues of exporters in this case by the blue line in Figure 1b. A further fall in the fixed costs of exporting extends the blue line to the left, from φ_{x1}^* to $\varphi_{x1}^{*'}$, allowing more small exporters to enter. At the same time, as shown in the left panel, domestic firms lose market share and domestic firms with productivity between φ^* and $\varphi^{*'}$ exit. Since the exiters have larger revenues than the entering exporters, there is a reallocation of market share from larger domestic sellers towards smaller foreign sellers and market concentration falls. The opposite case arises when the cutoff exporter's market share is large relative to the share of the domestic cutoff firm, illustrated by the green lines in Figure 1b. This case arises for example when exporters' fixed cost of entering the domestic market are large relative to the fixed costs of domestic firms, but variable trade costs are small. Here, domestic exiters are replaced by relatively large foreign sellers, and concentration rises.

Importantly, a large class of models provides a link between market concentration and market power. In Arkolakis et al. (2019), lower trade costs cause the least productive domestic firms that charge near-zero markups to exit, which tends to increase the average markup, but all other domestic firms shrink their markups because of more foreign competition, which lowers the average markup. With a Pareto distributed productivity, the two effects exactly offset each other. The logic is flipped among foreign firms operating in the domestic market. Thus, the markup distribution is always invariant to a decline in trade costs when productivity is Pareto distributed. In contrast, in Eaton, Kortum, and Sotelo (2013) aggregate markups can go in either direction depending on the assumptions made, but importantly there is always a one-to-one mapping to the market share distribution.[6] Thus, if market concentration is unchanged aggregate markups stay constant.

Overall, these theories highlight that more concentration among domestic firms, i.e., higher production concentration, is entirely consistent with less market power because of the increased competition from foreign firms. While the effect on market concentration is generally ambiguous, under the assumption that productivity is Pareto distributed, as in Chaney (2008) and Arkolakis et al. (2019), trade theory also predicts that a trade liberalization has no effect on market concentration. We next examine the relationship between market concentration and trade liberalization empirically.

3 Data

Our analysis relies on three highly disaggregated datasets from the U.S. Census Bureau. We briefly discuss these data here and provide more details in Appendix B.1. The first dataset is the Census of Manufactures for 1992-2012, which reports the total sales for each manufacturing establishment in the U.S. every five years. We merge into this dataset time-consistent North American Industrial Classification (NAICS) 2007 industry codes for each establishment constructed by Fort and Klimek (2018) to make industry activity comparable over time. These time-consistent codes are constructed from information in the economic censuses on an establishment's industry under several classifications, as well as from official concordances.

The new data we bring to the analysis of U.S. market concentration is transaction-level import data from the Longitudinal Firm Trade Transactions Database (LFTTD) of the Census Bureau. This dataset contains transaction-level data from U.S. customs forms, covering the universe of U.S. imports since 1992. Critically, these data contain an identifier for the foreign exporter in the form of a Manufacturer ID (MID), which enables us to construct the market shares of the foreign sellers in the U.S. The MID is an alphanumeric code that combines information on the seller's country, name, street address, and city.[7] Because of our interest in identifying foreign exporters at the firm-level, rather than plant-level, we consider MIDs with the same name and country component but with a different street address or city component to belong to the same exporter, since plants of the same firm located in different locations have a different MID. Our methodology builds on earlier work by Kamal, Krizan, and Monarch (2015), which used the foreign firm identifiers in a different context.

6. See alsoGaubert and Itskhoki (2021), which also allow for variable markups via oligopolistic competition.

7. Specifically, the MID consists of the two-digit ISO country code of origin of the good, the first three characters of the first word of the exporter's name, the first three characters of the second word of the exporter's name, the first four numbers of the street address of the foreign exporter, and the first three letters of the foreign exporter's city.

They provide an external validation exercise by comparing the number of MIDs in the Census data to the number of foreign exporters for 43 countries from the World Bank's Exporter Dynamics Database (EDD), which is based on foreign national government statistics and private company data. Kamal, Krizan, and Monarch (2015) show that the number of MIDs in the Census data matches well with the number of sellers in the EDD when the street address or the city component are omitted.

Related work by Kamal and Monarch (2018) provides further support that the MID is a good identifier of foreign exporters. First, errors due to manual data entry are likely low because most firms use customs brokers for their official customs invoice and nearly all entries are filed electronically using specialized customs software. Second, the MID is used for regulatory purposes, such as enforcing anti-dumping measures or tracking compliance with U.S. restrictions for textile shipments, which provide an incentive for the U.S. government to ensure that the MIDs are correct. Third, as an external validation, Kamal and Monarch (2018) assess whether the MID can distinguish between distinct exporters using Chinese data: they construct artificial MIDs from exporter names and addresses in the Chinese Annual Survey of Industrial Firms, and show that they tend to be unique firm identifiers within sectors.

Each transaction in the import data contains a 10-digit Harmonized Tariff System (HTS10) code for the product traded (comprising around 21,000 product codes), which we map to a time-consistent 5-digit NAICS industry in which the product is most likely sold using a concordance we develop based on the mappings by Pierce and Schott (2012a, 2012b) We manually adjust this concordance to take account of revisions over time in the HTS10 and inconsistent mappings from HTS10 to NAICS. Appendix B.2 contains more information on the concordances and contains some illustrative examples.[8] Our choice of the 5-digit NAICS level is dictated by the fact that a time-consistent mapping of HTS10 to 6-digit NAICS is not possible without making many arbitrary assignments or combining some industries into large groups.[9]

An important feature of the LFTTD is that it contains an indicator for whether a transaction is conducted between related parties, as documented in Bernard, Jensen, and Schott (2009). For each U.S. firm, we use this information to omit related-party imports that fall within an industry in which the firm is active. This approach aims to avoid double counting the imports of final goods obtained from a U.S. firm's plants abroad and sold in the U.S. market, since these will already be counted in the firm's domestic sales. However, we do keep the related-party imports that fall into an industry in which the U.S. firm is not selling. These imports are counted as the foreign firm's sales in that industry.

8. The new concordances are available from https://www.sebastianheise.com.

9. In particular, some of the original HTS10 codes need to be combined to accommodate splits or unions of HTS10 over time, and the constituents of these grouped HTS10 codes may sometimes map to multiple 6-digit NAICS codes. For example, if HTS10 code A and B are replaced by the new code C in some year, then we create a time-consistent group code HTS10g which combines these three codes. However, the original HTS10 code A may map to NAICS 1 while code B maps to NAICS 2. In such cases, we need to either assign all trade of the HTS10 group to one of the NAICS, apportion the grouped HTS10 code across the different NAICS codes, or combine the NAICS into one group. At the 6-digit NAICS level we face a large number of such choices. Since the accurate classification of industries is central to our analysis of industry concentration, we go to the 5-digit NAICS level where the issue arises for far fewer industries.

To match the import data, we collapse the sales data from the Census of Manufactures across establishments within the same firm to the time-consistent 5-digit NAICS-firm level used for the trade data. Each of a firm's major outputs is counted in its corresponding industry. Our analysis covers 169 time-consistent NAICS industries for the manufacturing sector, where we define a market at the national level, spanning across all of the U.S. We show the robustness of our results to more aggregate 4-digit industry definitions in Appendix C.

The final dataset we use is U.S. firm-level export data, also recorded in the LFTTD. As in the import data, we map the HTS10 code of the product traded to its corresponding 5-digit NAICS industry code, based on our own concordance building on Pierce and Schott (2012a). We construct the domestic sales of U.S. firms in each industry by subtracting the firms' exports from their total sales. We net out both related-party and arm's-length exports, since both are likely to be counted in a firm's total sales.

4 Stylized Facts

In this section, we present a number of new stylized facts about the evolution of market concentration in the U.S. and how it relates to import competition. Since all of the measures of concentration described earlier point to similar trends in the conventional production concentration measures (see, e.g., Autor et al. (2020)), we will use the top-20 market concentration as our baseline and report the robustness of our findings to other measures in Appendix C.

Fact 1. *Market concentration in U.S. manufacturing, adjusted for foreign firms, remained stable between 1992 and 2012.*

We begin by considering how concentration evolved in the U.S. manufacturing sector. In Figure 2a, we plot the top-20 concentration measures, averaged across all 5-digit NAICS industries in manufacturing, from 1992 and 2012. The solid red line depicts the production concentration measure, showing an upward trend in concentration over the last two decades. This upward trend is consistent with a large empirical literature (e.g., Van Reenen (2018)) that constructs concentration measures as in equation (1). It is also consistent with the theory predictions: a fall in trade costs increases the domestic productivity cutoff, which increases concentration among U.S. firms.

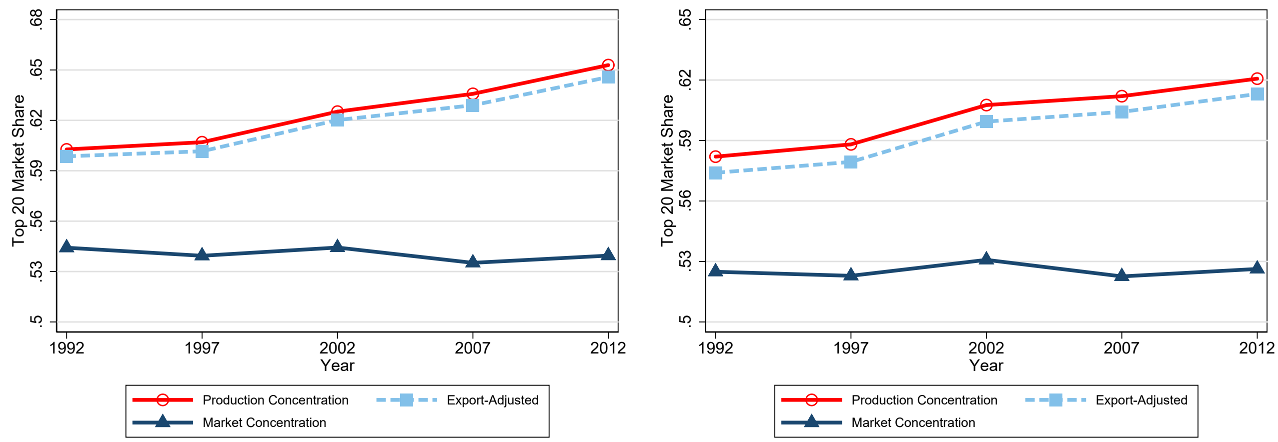
However, the market concentration measures, using market shares based on all sales to the U.S. market as in equation (2) and summing across both foreign and U.S. firms, remained flat between 1992 and 2012, depicted by the solid blue line in Figure 2a. This finding is consistent with a large class of trade models if productivity is Pareto distributed, as in Chaney (2008). Interestingly, it turns out that subtracting U.S. firms' exports from their total shipments makes little difference to the trend in concentration, as shown by the dashed blue line, and so it is the inclusion of the foreign firms' sales that is responsible for this new finding.

Figure 2b shows an analogous figure where instead of a simple average we take a weighted average across industries, using sales weights. For the production concentration measure we weight

Figure 2: Top-20 Market Concentration

(a) Unweighted Concentration

(b) Weighted Concentration



Notes: The figures show the evolution of top-20 concentration over time. Data are for census years: 1992, 1997, 2002, 2007, and 2012. The production concentration line measures concentration of the top-20 U.S. firms using market shares defined in equation (1). The export-adjusted line subtracts U.S. firms' exports from their total sales and sums the market shares over domestic firms. The market concentration line constructs market shares as in equation (2) for all firms selling in the U.S. irrespective of where the firm is located. Panel a presents the top-20 concentration measures computed as a simple average across all NAICS 5-digit manufacturing industries. Panel b shows weighted averages across all NAICS 5-digit manufacturing industries. For the production concentration measure we weight each industry by its U.S. firms' total shipments in 1992; for the export-adjusted measure we use shipments minus exports in 1992; and for the market concentration measure we use total absorption in 1992, i.e., shipments minus exports plus imports.

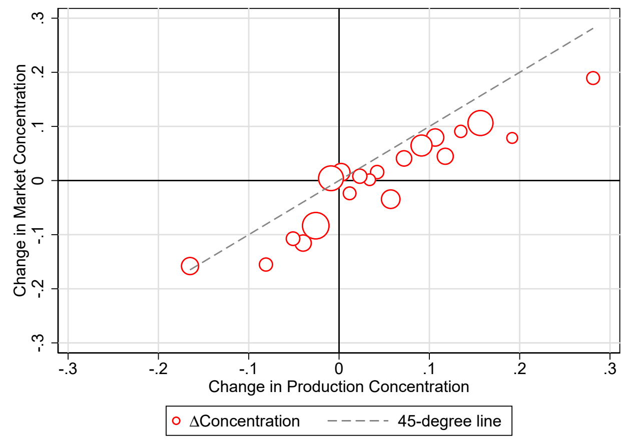
each industry by its U.S. firms' total shipments in 1992; for the export-adjusted measure we use shipments minus exports in 1992; and for the market concentration measure we weight by total *absorption* in 1992, defined as total shipments by U.S. firms minus exports plus total imports. We find results similar to those obtained before.[10]

Is the stable trend in market concentration driven by a few large industries or does foreign competition reduce concentration more broadly? To explore this question, Figure 3 plots the change between 1992 and 2012 in the top-20 production concentration measure on the x-axis against the change in the top-20 market concentration measure on the y-axis as a bin scatter. We bin the industries by ranking them by the change in their production concentration measure, and then combine them into 20 groups of 8-9 industries each.[11] Each bubble depicts one of these groups of industries, with the size of the bubble proportional to the industry group's total absorption, i.e., shipments minus exports plus imports. The figure shows that nearly all of the bubbles are below the 45-degree line, indicating that accounting for foreign firms' sales results in a smaller increase in market concentration in almost all industry groups than the production concentration measures would suggest. However, there is a wide range in the size and direction of changes in market concentration, and market concentration

10. We show in Appendix C that these patterns are robust to using alternative concentration measures. Importantly, market concentration does not increase under any of the alternatives.

11. Census disclosure rules prevent us from disclosing top-20 market shares for individual industries.

Figure 3: Change in Concentration across Industries, 1992-2012



Notes: The figure shows the change in the top-20 production concentration measure between 1992 and 2012 (x-axis) against the change in the top-20 market concentration measure from equation (2) using all firms selling to the U.S. market (y-axis). Each bubble is a group of 8 or 9 industries, where industries are grouped by their change in the top-20 production concentration between 1992 and 2012. The size of each bubble is proportional to the total absorption of the industry in 1992, defined as total shipments less exports plus imports.

rose in a number of industries, as shown by the bubbles in the top right quadrant.

The reason why the growth of foreign firms's sales did not increase market concentration is because their entry and growth was mostly in the bottom part of the market share distribution, with the loss in U.S. firm market shares completely offset by the gain in foreign shares as predicted by models with a Pareto distribution.[12]

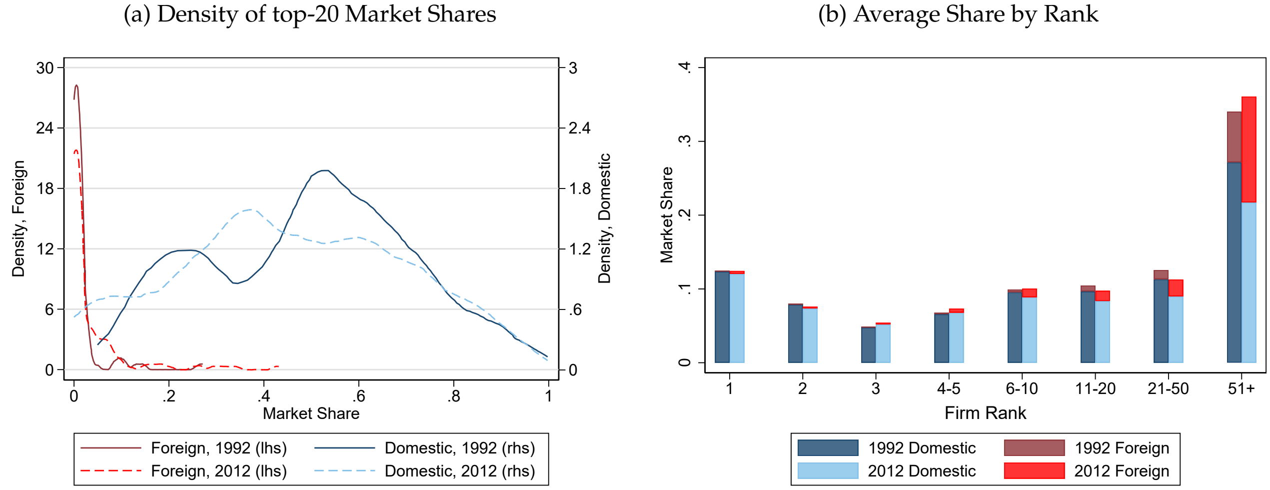
Fact 2. *Foreign firms have increased their presence among the top-20 firms, but their share in the top-20 remains low. Foreign firms' largest growth has been in the bottom part of the sales distribution.*

We show how foreign firms affect the overall market share distribution in the U.S. in Figure 4, by slicing the data in two ways.

First, in Figure 4a we plot the kernel density of the top-20 market share in each industry accounted for by U.S. firms in blue, and by foreign firms in red. This figure illustrates the distribution of the market shares of the top-20 firms across industries. To construct the figure, we first identify the top-20 firms in each industry according to equation (2). We then compute separately the market share of the domestic firms that are in the top-20 (using the top part of equation (2)) and the market share of the foreign firms in the top-20 (bottom part of (2)), and construct the density of these two objects across industries. Note that the density on the left axis for foreign firms is 10 times that of the right axis for domestic firms, reflecting that in most industries the market share of foreign firms in the top-20 is close to zero. The foreign densities are conditional on industries in which at least one foreign firm is in the top-20. We find that the number of industries with zero foreign market shares in the top-20 fell from 108 in 1992 to 76 in 2012, but do not show it in the figure in order to zoom in on the positive

12. This conclusion does not need to hold in every single industry, but it is true on average.

Figure 4: Market Share Heterogeneity



Notes: Panel a plots the kernel densities of the summed market shares of U.S. firms in the top-20, computed using the top part of equation (2) (blue lines) and of foreign firms in the top-20, computed using the bottom part of equation (2) (red lines) across industries. For foreign firms, we omit from the density industries in which no foreign firms are in the top-20, and hence the density includes only non-zero values. In panel b each set of bars plots the weighted average market share across industries of the firms with the rank noted on the x-axis, where we weight the market shares by each industry's absorption in 1992. The blue bars represent the market share of domestic firms with a given rank and the red bars are the market share of foreign firms with that rank.

market share distribution. The figure shows a rightward shift in the foreign firm density between 1992 and 2012 (dashed red line). This shift indicates that foreign firms have increased their presence in the top-20, but in the vast majority of industries the market share of foreign firms in the top-20 remains well below 10 percent. In contrast, the kernel density of domestic firms in the top-20 has shifted to the left (blue lines), indicating that in the average industry the market share of domestic firms in the top-20 has fallen. However, the market share of U.S. firms in the top-20 in the average industry is still large, falling from around 60 percent to around 50 percent between 1992 and 2012.

Second, we plot the market shares accounted for by firms of a given ranking within each industry summed across all industries in Figure 4b. Thus, the height of the first bar shows that the market share according to equation (2) of all of the number 1 ranked firms amounts to 12 percent of all manufacturing sales in 1992.[13] We split each bar into the market share accounted for by domestic firms (computed using the top part of equation (2)) in blue and into the market share accounted for by foreign firms (computed using the bottom part of equation (2)) in red. It turns out that foreign firms with rank 1 account for a market share of virtually zero in the aggregate. This is mostly due to the fact that there are very few industries where foreign firms are the top firm . To see how these patterns evolved over the sample period, we plot the analogous information for 2012 with lighter colors. A clear pattern emerges, showing that the largest growth in foreign sales is in the bottom part of the distribution. Foreign firms with a rank higher than 50 more than doubled their market share

13. We aggregate the market share of each X ranked firm across industries using each industry's absorption in 1992 as weight. Summing over the bars of firms with rank 1 to 20 gives the solid blue line in Figure 2b in 1992 and 2012.

from 6.9 percent to 14.4 percent. By contrast, the foreign shares of the top ranked firms remained low on average, below 3 percent for each of the top seven bins.

This analysis helps reconcile the increased production concentration (computed using equation (1)) with the flat market concentration (using equation (2) and summed across U.S. and foreign firms). From Figure 4b, we see that the market share of domestic firms declined in all the bins with ranks above 5, while their market share at the top ranks remained approximately unchanged. As a result, concentration rose among domestic firms themselves, consistent with trade theory, which predicts the exit of lower productivity firms. However, the market share gains of foreign firms, mostly in the lower tail of the distribution, have offset the rise in domestic concentration. As Figure 4b shows, the overall market shares of the top-20 firms barely changed between 1992 and 2012, as illustrated by the flat market concentration trend in Figure 2b.

Fact 3. *Market concentration fell the most in industries with high import penetration.*

To examine the relationship between market concentration and import competition, we first need a measure for import competition, which we proxy with import penetration for each industry i in year t, as follows:

$$IP_{it} = \frac{Imports_{it}}{Absorption_{it}}. \tag{3}$$

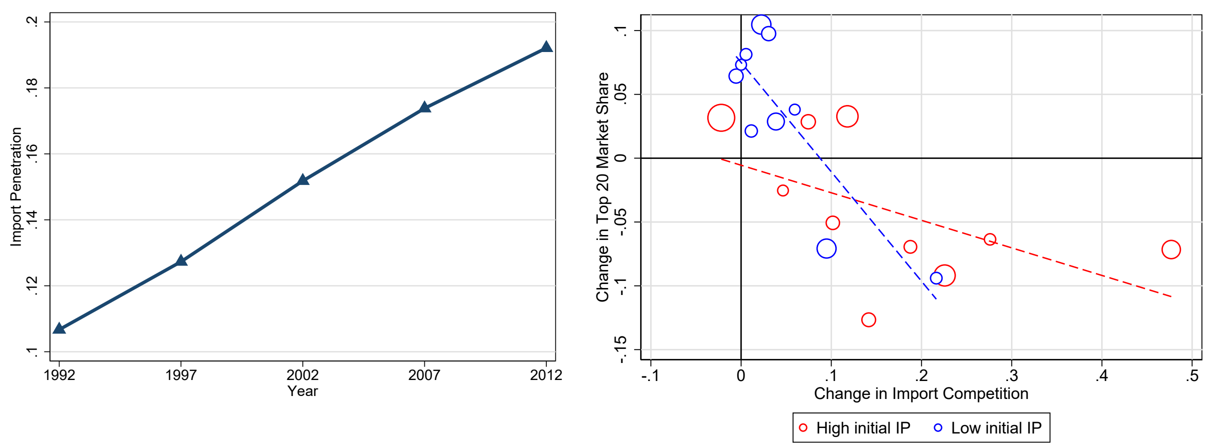
We compute absorption as total sales less exports plus imports, as in the denominator of equation (2). Based on our import measure, which excludes some related-party trade, aggregate import penetration has increased from 10.7 percent to 19.2 percent over our sample period, as shown in Figure 5a. Figure 5b plots an industry's change in import penetration between 1992 and 2012 against the change in concentration over the same period as a bin scatter. We distinguish industries with a below-median level of import competition in 1992 (blue bubbles) from those with above-median import competition (red bubbles), and sort industries within each of these two groups into 10 deciles based on their change in import competition between 1992 and 2012. We combine the industries in each decile into industry groups by taking a weighted average of the change in import penetration and the change in the top-20 market share across the industries in each decile, using the absorption of each industry in 1992 as weight.[14] Each bubble represents one of these groups of industries, with the size of the bubble proportional to total absorption in 1992. The figure shows a negative relationship between the change in import penetration and the change in market concentration. Moreover, seven out of ten industry groups with above-median import penetration in 1992 experienced further increases in foreign competition in subsequent years together with a decline in concentration. Examples include audio and video equipment manufacturing, semi-conductor and electronic components, and curtain and linen mills.[15] In contrast, eight out of ten industry groups with low initial import penetration continued to have a low share of foreign firms, and showed an increase in market concentration, for example, concrete industries. Thus, the industries with the largest increase in import competition showed the slowest growth in market concentration.

14. As before, Census regulations prevent us from disclosing results for individual industries.
15. These examples are based on publicly available census data for 1997 to 2012.

Figure 5: Market Concentration and Import Penetration

(a) Import Penetration

(b) Changes in Market Concentration vs. Import Penetration



Notes: Panel a plots the time series of import penetration, where imports exclude related party imports in industries in which a firm is active, as described in Section 3. Panel b presents a bin scatter plot of the change in the top-20 market concentration between 1992 and 2012 on the y-axis against the change in import penetration, defined as the change in imports between 1992 and 2012 divided by initial absorption in each industry. The size of each dot is proportional to industry absorption in 1992. The "High Initial IP" dots are for industries with an above-median level of import penetration in 1992. The "Low Initial IP" dots are for industries with a below-median level of import penetration in 1992. We sort industries within each of these two groups into 10 deciles based on their change in import competition between 1992 and 2012, and construct each bubble by taking a weighted average of the change in import penetration and the change in the top-20 market share across the industries in each decile.

5 Market Concentration and Import Competition

In this section, we turn to analyzing how import competition affected production concentration and market concentration of the top-20 U.S. firms. Since changes in imports are partially due to changes in U.S. demand, we need exogenous shocks that shift the world supply of goods to the U.S. to isolate the causal effect of import competition on U.S. firms. To this end, we construct time-varying instruments for U.S. imports using a methodology developed in Amiti and Weinstein (2018). Our approach is related to the methodology developed by Autor, Dorn, and Hanson (2013), with refinements to further address the possibility that rest-of-the-world supply shocks are correlated with the demand shocks in the U.S. Our instrument has the desirable property that it strips out any U.S.-specific factors.

To provide intuition for this methodology, we start with a standard fixed effects regression model, with

$$\triangle M_{ijkt} = \alpha_{ikt} + \beta_{ijt} + \epsilon_{ijkt}, \tag{4}$$

where $\triangle M_{ijkt}$ is the percentage change in imports from country j to country k in a 5-digit NAICS industry i over the five-year period up to time t. The dependent variable is regressed on importer country-industry-time fixed effects, α_{ikt}, and exporter country-industry-time fixed effects, β_{ijt}. The coefficients on these fixed effects isolate the change in imports due to conditions in the importer country and the exporter country, respectively, holding fixed the other component.

These coefficients could, in principle, be recovered using fixed effects estimation. However, the dependent variable is in percentage changes and is therefore not defined for any new importer-exporter country-industry trading relationship, which leads to biased estimates in cases where the share of new trading relationships is high. We overcome this problem by using the Amiti and Weinstein (2018) approach, which enables us to include these new trading relationships in the estimation of the coefficients in equation (4).[16]

We estimate α_{ikt} and β_{ijt} with bilateral HS 6-digit import data from UN COMTRADE, collapsed to the bilateral 5-digit time-consistent NAICS level, for the countries making up the top 50 U.S. trading partners, which cover more than 90 percent of U.S. trade.[17] Importantly, we also include the U.S. as an exporter j and an importer k in the estimation. By including the U.S. trade flows, we can strip out any U.S. specific effects that might be correlated with the exporter and importer shocks in other countries, and hence obtain export supply shocks that are cleaned of U.S. demand effects.

To construct export supply shocks at the industry level, we aggregate across all countries j within each NAICS industry i:

$$Instrument\triangle IP_{it} = \sum_{j \neq US} w_{ij,t-5} \hat{\beta}_{ijt} \tag{5}$$

where the weights are the five-year lagged total imports of industry i from country j as a share of total absorption of that industry i, and $\hat{\beta}_{ijt}$ are the estimated coefficients from equation (4), relative to their industry-year median.[18] This variable will serve as an instrument for import competition, which we proxy with the percentage change in import penetration[19]:

$$\triangle IP_{it} = \frac{Imports_{it} - Imports_{i,t-5}}{Absorption_{i,t-5}}.$$

We estimate the effect of import competition on top-20 market concentration measures using two-stage least squares:

$$\triangle C^{20}_{it} = \gamma \triangle IP_{it} + \delta_t + \epsilon_{it}, \tag{6}$$

where ΔC^{20}_{it} is the five-year change in top-20 U.S. firm concentration in industry i in year t. All regressions include time fixed effects and are weighted by industry shipments or absorption in 1992.

16. Amiti and Weinstein (2018) show that this methodology is equivalent to a weighted least squares estimation with lagged values as weights when there are no new trade relationships. See Appendix D for more details.

17. https://comtrade.un.org/db/default.aspx. We include the periods 1997-2002, 2002-2007, and 2007-2012; and omit the earlier period 1992-1997 because few countries had adopted the Harmonized System of reporting in 1992.

18. See Borusyak, Hull, and Jaravel (forthcoming) for a discussion of shift-share instruments, and see Borusyak and Hull (2020) on the importance of substracting the average industry-year value. Moreover, the fixed effects coefficients are generally estimated relative to an arbitrary numeraire so it is more meaningful to construct them relative to their average value.

19. We proxy for import competition with the percentage change rather than the percentage point change following Autor, Dorn, and Hanson (2013). Moreover, this approach is in parallel with our instruments, which need to be estimated using the percentage change in imports for the adding up constraints to hold. See Amiti and Weinstein (2018).

Table 1: Change in Concentration and Import Competition Regressions

Dependent variable	ΔC_{it}^{P20} (1)	ΔC_{it}^{P20} (2)	ΔC_{it}^{20} (3)	ΔC_{it}^{20} (4)	ΔC_{it}^{P20} (5)	ΔC_{it}^{20} (6)
Regression weights	1992 weights				Lagged weights	
	shipments$_{i,1992}$		absorption$_{i,1992}$		shipments$_{i,t-5}$	absorption$_{i,t-5}$
	OLS	IV	OLS	IV	IV	IV
ΔIP_{it}	-0.025	0.209**	-0.238***	-0.289***	0.247**	-0.321***
	(0.027)	(0.089)	(0.028)	(0.083)	(0.029)	(0.089)
First stage		ΔIP_{it}		ΔIP_{it}	ΔIP_{it}	ΔIP_{it}
instrument$_{\Delta IP_{it}}$		0.383***		0.390***	0.347***	0.375***
		(0.050)		(0.049)	(0.048)	(0.048)
Predicted effects		0.005		-0.008	0.004	-0.008
Actual		0.033		-0.016	0.030	-0.015
N	500	500	500	500	500	500

Notes: Decimals have been rounded to four significant digits per Census Bureau disclosure guidelines. Number of observations has been rounded to hundreds. ΔC_{it}^{P20} is the change in the top-20 production concentration measure and ΔC_{it}^{20} is the change in the top-20 market concentration measure using the top 20 U.S. firms. Mean of ΔIP_{it} is 0.052; standard deviation is 0.098. The predicted effects are calculated by first predicting the change in import penetration as the first-stage coefficient times the instrument, and then multiplying this by the second-stage coefficient and aggregating across all industries using 1992 absorption weights for the market concentration measure and 1992 U.S. shipment weights for the production concentration measure. Year fixed effects are included.

First, we consider the effect of import competition on the top-20 production concentration measure, $\triangle C_{it}^{P20}$, with the market shares from equation (1). Given the upward sloping red line in Figure 2a, and the predictions of trade theory, we would expect tougher competition to increase production concentration among U.S. firms, as some domestic firms exit and some of the surviving U.S. firms expand their exports to foreign markets. However, using OLS estimation in column 1 of Table 1, we find a negative, albeit insignificant, coefficient. This result may be due to the endogeneity of import penetration, as changes in U.S. demand could affect the demand for imports and the demand for domestically produced goods simultaneously. Once we instrument for import competition in column 2, we find a positive and significant coefficient of import penetration on production concentration, as hypothesized, equal to 0.21. This result implies that a one standard deviation increase in import penetration causes a 2 percentage point increase in production concentration. To get a sense of the aggregate effect on manufacturing, we calculate the implied change in import penetration using the first stage coefficient times the import penetration shock, $Instrument\triangle IP_{it}$, multiplied by the second stage coefficient in column 2. Summing across all industries and time periods, using 1992 shipment weights, we find that the predicted effect is equal to 0.005, which accounts for about one-seventh of the actual rise in production concentration between 1997 and 2012.[20]

20. The predicted effect is calculated as 0.383x$Instrument\triangle IP_{it}$x0.209, summed across all industries and all time periods using 1992 shipment weights. We construct the actual rise in production concentration using the same weights. This should be viewed as a back-of-the-envelope calculation as with regressions of this type we cannot say how import competition affected the constant.

We next consider the effect of import competition on the overall market shares of the top-20 U.S. firms, $\triangle C_{it}^{20}$. According to trade theory, increased competition from foreign firms lowers the domestic sales of U.S. firms. We would therefore expect import competition to lower the domestic sales as a share of absorption of the top ranked U.S. firms. To test this, in columns 3 and 4, we replace the dependent variable with the market concentration measure using the top-20 U.S. firms, calculated by summing the market shares in the top row of equation 2 across the 20 U.S. firms with the highest market shares in each industry.[21] Consistent with theory, we find negative and significant coefficients on import competition in column 3 using OLS and in column 4 using IV. The IV estimate is of larger magnitude than the estimate under OLS, equal to -0.29. Our estimate implies that a one standard deviation increase in import penetration results in a 3 percentage point fall in the market share of the top-20 U.S firms. Using the estimates from the first stage and second stage coefficients in column 4, and aggregating across industries and time, we predict a decline of 0.8 percentage point in the market concentration of the top-20 U.S. firms due to import competition between 1997 and 2012. Import competition therefore accounts for half of the 1.6 percentage points decline in the actual weighted average concentration of the top-20 U.S. firms over this period.

Columns 5 and 6 re-run the IV regressions using five-year lagged regression weights instead of fixed 1992 sales weights. We find that using these weights makes very little difference to the regression results.[22]

In Table 2, we next turn to estimating the effect of import compeition on the extensive margin by replacing the dependent variable with the ratio of the number of domestic firms in t and in $t-5$. The OLS specification in Column 1 shows a small but insignificant increase in the number of firms due to import competition. However, once we instrument for import penetration in Column 2, we find that the number of U.S. firms fell in industries with increased import competition.[23] Our estimate implies that a one standard deviation increase in import penetration generates a 23 percent fall in the number of U.S. firms. This finding is consistent with trade theory where the domestic exit cutoff rises with lower trade costs. Column 3 shows that the results are very similar when we use lagged weights instead of 1992 weights. How can we reconcile the positive effect of import competition on production concentration in column 2 of Table 1 with the negative effect on market concentration in column 4 and the increased firm exit in Table 2? The key to understanding these results is to consider how to define the market in which a firm competes. If we ignore the sales of foreign firms in the U.S. market, we find that large firms are taking a larger share of U.S. firms' total sales in industries with more import competition. It is likely that the large firms are less hurt by foreign competition than small firms if, for example, they adjust their markups. Moreover, these firms gain from the exit

21. Note that here we sum only the top row of equation 2, as opposed to using both rows and summing across both U.S. and foreign firms. As shown above, the market share of the top-20 firms irrespective of origin remained approximately constant as foreign firms' market share gains offset domestic firms' losses.

22. We show results for unweighted regressions in Appendix C.3.

23. Gutiérrez and Philippon (2017) also find that the number of U.S. firms fell in response to Chinese import penetration, using Compustat data.

Table 2: Change in Number of Firms and Import Competition Regressions

Dependent variable	ΔNfirms$_{it}$ (1)	ΔNfirms$_{it}$ (2)	ΔNfirms$_{it}$ (3)
Regression weights	1992 weights absorption$_{i,1992}$		Lagged weights absorption$_{i,t-5}$
	OLS	IV	IV
ΔIP_{it}	0.219	-2.298***	-2.243***
	(0.140)	(0.539)	(0.567)
First stage		ΔIP_{it}	ΔIP_{it}
instrument$_{\Delta IP_{it}}$		0.390***	0.375***
		(0.049)	(0.048)
N	500	500	500

Notes: Decimals have been rounded to four significant digits per Census Bureau disclosure guidelines. Number of observations has been rounded to hundreds. Mean of ΔIP_{it} is 0.052; standard deviation is 0.098. Year fixed effects are included.

of domestic competitors.[24] However, once we consider the total sales in the U.S. market, inclusive of imports, we find that the share of the top-20 U.S. firms actually fell, as foreign firms gained some of their market share and replaced some of the exiting domestic firms. Taken together, these results help explain the stable trend in market concentration shown in Figure 2.

6 Conclusion

A large literature has documented an increase in the concentration among domestic U.S. firms over the last three decades. This trend has raised concerns of increasing market power. Using confidential Census data, we find that once foreign firms' sales in the U.S. are taken into account, market concentration did not rise but instead remained flat between 1992 and 2012 in the manufacturing sector. We reconcile the flat trend in market concentration with the previously documented rise in conventional production concentration measures by showing that the growth of foreign firms' market shares was mostly at the bottom of the sales distribution, counteracting the increase in concentration among U.S.-based firms. Consistent with trade theory, we show that import competition caused an increase in market concentration among U.S. firms as well as exit. In contrast, import competition caused the largest U.S. firms to lose sales as a share of total sales in the U.S. market.

Our findings have important implications for market power. Standard models (such as Atkeson and Burstein (2008)) link markups directly to market shares. Interpreting our findings through the lens of these models suggests that markups of domestic firms have fallen and those of foreign firms have risen, offsetting each other resulting in stable aggregate markups.

24. In many models, large firms reduce markups in response to increased competition; see, for example, Atkeson and Burstein (2008).

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Appendix

A Melitz model

We briefly outline how import competition affects market concentration in the standard Melitz (2003) model. The details are exactly as in Melitz (2003).

A continuum of monopolistically competitive firms with productivity φ produces differentiated consumption goods. The firms can export to a symmetric set of n foreign countries, subject to a fixed cost of exporting $f_x > 0$ and a standard iceberg trade cost $\tau > 1$. Each firm's revenues are

$$r(\varphi) = r_d(\varphi) + \mathbb{I}_x n r_x(\varphi), \tag{A.1}$$

where $r_d(\varphi)$ are revenues from the domestic market, $r_x(\varphi) = \tau^{1-\sigma} r_d(\varphi)$ are revenues from exporting to a foreign country, and $\mathbb{I}_x$ is an indicator that is equal to one if firm φ is an exporter. Firms face a marginal cost of production of φ^{-1} and sell to a representative household in each country with CES demand with elasticity σ. Since more productive firms have lower marginal costs, they set lower prices, obtain larger revenues, and have a higher market share. Each firm has to pay a fixed overhead cost f to stay in the market. Since profits are increasing in productivity, the presence of this fixed cost implies that there is a cutoff productivity level φ^*, determined by $r(\varphi) = \sigma f$ as shown in in Melitz (2003), such that profits are zero. Firms with $\varphi < \varphi^*$ exit the market and are replaced by new entrants. Similar to the domestic cutoff, there exists an export productivity cutoff level φ_x^* such that only firms with $\varphi \geq \varphi_x^*$ become exporters. If $\tau^{\sigma-1} f_x > f$, then $\varphi_x^* > \varphi^*$, and some domestic firms do not export.

We show that a trade liberalization increases production concentration as defined by equation (1), i.e., domestic sales plus exports. We define production concentration in the model as $C_{\bar{\varphi}} = \frac{1}{R}\int_{\bar{\varphi}}^{\infty} r(\varphi)\mu(\varphi)d\varphi$, where R are aggregate revenues, $\mu(\varphi)$ is the mass of firms with productivity φ and $\int_{\bar{\varphi}}^{\infty} \mu(\varphi)d\varphi = X$. Here, X is some exogenously chosen constant. This measure is a model analogue to the market share of the top X firms.

Consider a reduction in the iceberg trade cost τ. The black lines in Figure 1a plot the effect of this trade liberalization on firms' total revenues, $r(\varphi)$, as a function of firms' productivity level φ. As shown in Melitz (2003), the reduction in τ leads additional competitors to enter the market, which bids up wages and shifts the domestic productivity cutoff φ^* to the right to $\varphi^{*'}$. As a result, firms with productivity between φ^* and $\varphi^{*'}$ exit the market. At the same time, the lower trade costs enable some firms that did not export before to become exporters, shifting the export cutoff φ_x^* to the left to $\varphi_x^{*'}$. Revenues from the domestic market, $r_d(\varphi)$, decline, as illustrated by the downward shift of the black revenue curve to the left of the exporting cutoff. However, exporters more than compensate for this decline by an increase in export revenues, causing their overall revenues $r(\varphi)$ to increase and shifting the portion of the revenue curve to the right of the exporting cutoff upward. Overall, the more productive exporting firms increase their revenues while smaller non-exporters exit or lose revenues. Thus, the Melitz model predicts that a trade liberalization increases production concentration $C_{\bar{\varphi}}$. The results are similar if the trade liberalization is associated with a fall in the fixed cost f_x.

We next show that domestic firms lose domestic market share as a result of trade liberalization. The red lines in Figure 1a plot firms' domestic revenues, $r_d(\varphi)$. All domestic firms lose revenues at home due to the additional competition resulting from the liberalization, shifting the domestic revenue curve downward. Since a trade liberalization expands the total market size (since the aggregate price level P must decline), domestic firms' share of the overall market falls. The Melitz model thus predicts that all domestic firms lose market share when we define it according to equation (2).

We now analyze the effect of a liberalization on market concentration from equation (2), summing across both foreign and domestic firms. The behavior of domestic firms' revenues is still given by the red lines in Figure 1a. For the effect of foreign exporters' revenues, we consider two scenarios. First, in Case 1 we consider the scenario in which the fixed cost of exporting, f_{x1}, is small, but the iceberg trade cost, τ_1, is large. In this case, relatively many foreign firms obtain exporting revenues of at least σf_{x1} and export to the domestic market, but their revenues are small compared to domestic firms' revenues since $\tau_1 \gg 1$. This scenario is illustrated by the blue line in Figure 1b. Consider the effect of a decline in the fixed cost of exporting from f_{x1} to f'_{x1}. This reduction shifts the exporting cutoff to the left from φ^*_{x1} to $\varphi^{*'}_{x1}$, allowing more foreign firms to enter and extending out the blue line to the left. The entering firms have smaller revenues than the exiting domestic firms due to the large iceberg trade costs. The revenues of existing exporters are unchanged, and hence the revenue curve does not shift. Since domestic firms' revenues fall, there is a reallocation of market share from larger domestic sellers towards smaller foreign sellers. Therefore, market concentration falls.

Second, in Case 2 we consider an alternative scenario in which the fixed cost of exporting, f_{x2}, is large, but the iceberg trade cost, τ_2, is relatively close to one. In this case, only the most productive foreign firms, which obtain exporting revenues of at least σf_{x2}, are profitable enough to export. However, these exporters generate revenues that are similar to those of the largest domestic firms, since $r_x(\varphi) = \tau_2^{1-\sigma} r_d(\varphi)$ and $\tau_2 \approx 1$. This case is illustrated by the green line in Figure 1b. A reduction in f_{x2} to f'_{x2} shifts the exporting cutoff to the left from φ^*_{x2} to $\varphi^{*'}_{x2}$, allowing more foreign firms into the domestic market. Since large foreign exporters gain market share while small domestic non-exporters exit (to the left of $\varphi^{*'}$ in Figure 1a), market share is reallocated from small to large sellers. Therefore, market concentration rises.

If firms' productivity is Pareto distributed and the fixed cost of entry into the market is the same for domestic and foreign firms, then the loss of domestic firms' market share and the gains by foreign firms exactly cancel each other out, and market concentration is unchanged. The two effects exactly offset each other because of the property that a Pareto distribution always remains Pareto with the same shape regardless of where it is cut.

B Data

B.1 Data Construction

We combine three datasets of the U.S. Census Bureau.

Census of Manufactures This dataset contains the universe of U.S. manufacturing establishments from the Census Bureau. We obtain from this dataset the total sales (also referred to as shipments) for each manufacturing establishment in the U.S. every five years over the period 1992-2012. We merge into this dataset each establishment's time-consistent North American Industrial Classification (NAICS) 2007 industry codes constructed by Fort and Klimek (2018).

To address measurement errors in reporting, we clean the data by dropping establishments with more than 100 possible NAICS codes according to Fort and Klimek (2018). We also drop establishments with missing NAICS codes and inactive establishments with zero employees.

To facilitate the merge with the trade data, we aggregate across establishments to the time-consistent 5-digit NAICS-firm level, where the 5-digit NAICS codes are constructed to map consistently to HTS10 trade codes, as we describe in Section B.2. Thus, a firm with establishments active in multiple industries would be recorded in each of these industries with the corresponding sales in each year. Our time-consistent industry aggregation consists of 169 NAICS industries at the 5-digit level for the manufacturing sector. We drop outlier firms whose increase in the sales/employees ratio between year $t-5$ and year t is above the 99.5th percentile and whose sales/employee ratio in year t is above the 99.5th percentile of that industry-year. This removes firms that report implausibly large sales relative to their number of employees when the sales are extremely different from the firms' previous reporting.

Longitudinal Firm Trade Transactions Database (LFTTD) - Imports The LFTTD dataset provides transaction-level data for the universe of all U.S. imports. Critically, it contains an identifier for the foreign exporter in the form of a Manufacturer ID (MID) in addition to the identifier for the U.S. importer for each transaction. As described in Kamal and Monarch (2018), the MID is an alphanumeric code that consists of the two-digit ISO country code of origin of the good, the first three characters of the first word of the exporter's name, the first three characters of the second word of the exporter's name, the first four numbers of the street address of the foreign exporter, and the first three letters of the foreign exporter's city. For example, the exporter "Quan Kao Company", at 1234 Beijing Lane in Beijing, China would have the MID "CNQUAKAO1234BEI". Since the MID differs across establishments of the same firm in different locations and since we are interested in firm-level exports to the U.S., we replace the MID with a shortened identifier that contains only the country ISO code and the name portion of the ID, as described in the main text. Transactions with a missing foreign firm identifier account for 1.1 percent of total imports and 0.2 percent of total sales (imports plus domestic sales) in the U.S. We keep imports with missing identifiers for the denominator of the market shares.

We drop all transactions with a negative value and imports flagged as warehouse entries.

The LFTTD also contains an indicator for whether a transaction is conducted between related parties. Based on Section 402(e) of the Tariff Act of 1930, a related-party trade is an import transaction between parties with "any person directly or indirectly, owning, controlling, or holding power to vote, [at least] 6 percent of the outstanding voting stock or shares of any organization." To correct for missing or incorrect related-party flags, we classify an importer-exporter pair as related if it had a related-party flag for any transaction in the given year. We drop related-party imports when the industry code of the imports falls within the same 5-digit NAICS code as the U.S. firm's shipments, since these products are unlikely to have any additional value added, and keep related-party imports that are not within the firm's output industry. This step removes about 34 percent of U.S. imports.

Each import transaction also contains a 10-digit Harmonized Tariff System (HTS10) code for the product traded, which we map to time-consistent 5-digit NAICS codes, as we describe in Section B.2. We finally aggregate across transactions to the foreign exporter-year-5-digit NAICS level.

Longitudinal Firm Trade Transactions Database (LFTTD) - Exports In addition to U.S. imports, the LFTTD also provides transaction-level data on U.S. firms' exports. We clean the export data by keeping only domestic exports, and map the HTS10 product codes to time-consistent 5-digit NAICS codes using a concordance which we construct analogously to the import data, as described in Section B.2. We then compute the domestic sales of U.S. firms in each industry by subtracting exports from total shipments. We net out both related-party and arms'-length exports from total shipments, since both are likely to be counted in a firm's total shipments. We drop all export transactions that are not by a manufacturing firm in the Census of Manufactures.

B.2 Concordances

We describe how we construct our concordance from HTS10 codes to time-consistent 5-digit NAICS industries.[25]

The starting point of our mapping are the concordances of HTS10 import and export codes constructed by Pierce and Schott (2012b) for 1992-2009.[26] These concordances assign HTS10 codes that disappear at a given point in time to new HTS10 codes. The data provide the year and month in which an HTS10 code became obsolete and give a new code that replaces it. We extend this concordance to the years 2010 and 2011. For this purpose, we first identify obsolete codes in the Census trade data up to 2011 by finding HTS10 codes that appear for the last time in 2009 or 2010. Similarly, we identify new codes as those that appear for the first time in 2010 or 2011. We then match obsolete and new codes if their HTS10 description in the data is exactly identical. The first row of Table A.1 provides an example of such an exact match. Next, we match the remaining obsolete codes to all

25. The concordance is available at https://www.sebastianheise.com.

26. We use version 2010.5.22. The concordance is available from Peter Schott's website: https://sompks4.github.io/sub_data.html. The data were subsequently updated with a version extending the import concordance to 2019 but the export concordance ends in 2009.

new codes that have matching first eight digits, provided that the new codes first appear in the same year or in the year after the last observation of the obsolete code. We manually go through these matches to remove linkages that appear incorrect based on the item descriptions, correcting 55 of these mappings. Rows 2-4 of the table contain some examples of matches (note that this is not the complete list of matches for these codes). Finally, we map 148 remaining HTS10 codes manually by finding codes with similar descriptions. Rows 5-6 of the table contain examples.

In the next step, we combine obsolete and new codes that belong together into "grouped" HTS10 codes, which exist continuously throughout the period 1992-2011. We then check whether the constituent HTS10 of these groups map to different 5-digit NAICS codes, based on the concordance between HTS10 and NAICS by Pierce and Schott (2012a). Such mappings are problematic because in such cases we need to either manually assign one of the 5-digit NAICS industries to the overall HTS10 group, distribute the trade across all industries based on some assignment, or combine the different 5-digit NAICS into one grouped industry code. In total, the Pierce-Schott concordance generates 327 such problematic mappings at the 5-digit NAICS level. The problem becomes significantly more severe at the 6-digit level, making a mapping impossible without making many arbitrary assignments or grouping industries into large groups. At the 5-digit level, we can manually inspect all cases and make adjustments.

We assign grouped HTS10 codes to only one 5-digit NAICS whenever possible. An example of such an assignment is provided in the first five rows of Table A.2. Here, the grouped HTS10 code 2106906075gg contains an original code for coffee whiteners, which only exists in 1992 and is mapped in 1993 by the Pierce-Schott concordance to a number of new codes, including orange juice and herbal teas. From the HTS10-NAICS concordance, coffee whiteners belong to NAICS 31151 (Dairy Product Manufacturing), while orange juice belongs to NAICS 31141 (Frozen Food Manufacturing) and herbal teas belong to NAICS 31192 (Coffee and Tea Manufacturing). As a result, the grouped HTS10 code maps during the period 1992-1994 to three different NAICS. We manually remove the code for orange juice from the grouped code and assign it to a different group which contains juice, and similarly move the code for herbal tea to a group that contains teas. Thus, our final HTS10 group 2106906075gg only contains constituent codes which map to NAICS 31151.

In some cases unique assignments are not possible. In other instances, there are many HTS10 groups mapping to the same set of multiple 5-digit NAICS codes. In such cases, we combine multiple NAICS codes into a single grouped 5-digit NAICS code. An example of such a case is provided by rows 6-8 of Table A.2. In this case, the grouped HTS10 code 6112192010gg consists of codes for track suit jackets. In 1993-1994, the HTS10 code combines both genders. The successor HTS10 codes in later years split out male and female track suit jackets. This is problematic because according to the HTS10-NAICS concordance by Pierce and Schott (2012a) male track suits belong to NAICS 31522 (Men's and Boys' Cut and Sew Apparel Manufacturing) while female track suits map to NAICS 31523 (Women's and Girls' Cut and Sew Apparel Manufacturing). Since there are a number of such cases, we choose not to assign the HTS10 codes to one or the other NAICS, but instead combine industries 31522 and 31523 into a grouped 5-digit NAICS code 31522g.

Finally, there are two problematic HTS10 codes which are more difficult to assign. These are 8517700000, “PARTS OR APPS FOR TRASMISIT/RECP OF VOICE/IMG/DATA” and 8517620050, “MACH FOR RECP/CONV/REGEN VOICE/IMAGE/DATA. NESOI”. Constituents of the groups formed by these HTS10 map to NAICS 33421, “Telephone Apparatus Manufacturing”, NAICS 33422, “Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing”, and NAICS 33441, “Printed Circuit Assembly (Electronic Assembly) Manufacturing”. If we map these groups to only one of the NAICS, we get a large trend break in industry-level import penetration in 2007 for these industries. At the same time, combining the NAICS is not possible without forming a very large group. We therefore decide to keep the NAICS separate and apportion the HTS10 groups to each code based on their trade share in 2006.

In the next step, we verify that the mappings for imports and exports are consistent. We check that whenever the same product appears in both the import and the export data it maps to the same 5-digit NAICS code in both datasets. Moreover, we manually go through the code descriptions for all codes to ensure that similar descriptions map to the same NAICS.

In the last step, we extend the concordance to 2012. Extending the concordance to 2012 is more difficult than the extension to 2010-2011 because 2012 is a Census year, which leads to many changes in HTS10 codes. We use the concordances for 2012 provided by the Census Bureau, and add any new HTS10 codes that appear to our existing groups. We then map the new HTS10 to our time-consistent 5-digit NAICS codes as before, using the concordance by Pierce and Schott (2012a). In some cases, the grouped HTS10 codes now map to multiple NAICS codes, and we manually correct these cases. Our final concordance maps each HTS10 import and export code in 1992-2012 to one of 169 time-consistent 5-digit NAICS codes, which we use for our analysis. Given our interest in the trend in concentration over time, it is essential that the industry codes can be meaningfully compared over time.

Table A.1: Examples of the Concordance for 2010-2011

	Old HTS10	Obsolete Description	New HTS10	New Description	Year	Method
(1)	2009806035	BERRY JUICE, NOT FORTIFIED ETC., NESOI	2009806065	BERRY JUICE, NOT FORTIFIED ETC., NESOI	2010	Exact match
(2)	0901210030	COFFEE, ROASTED, NOT DECAF, RETAIL WEIGHING LT=2KG	0901210035	COFFEE ORGANIC RETAIL CNTNR LT=2KG ROAST NOT DECAF	2010	8-digit match
(3)	0901210030	COFFEE, ROASTED, NOT DECAF, RETAIL WEIGHING LT=2KG	0901210045	COFFEE RETL CNTNR LT=2KG ROAST NT ORGANIC NT DECAF	2010	8-digit match
(4)	4909004020	GREETING CARDS, PRINTED	4909004000	CARDS, PRINTED, EXCEPT POSTCARDS	2010	8-digit match
(5)	6404193515	FOOTWEAR RUBPLAS SOL 10%OROV RUBPLAST HOUSE SLIPPR	6404193715	FTWR RUBPLAS SOL 10%OROV TEX MAT UPPR HOUSE SLIPPR	2011	Manual
(6)	6404198030	FOOTWEAR RUBPLAS SOL NESOI OV$6.50NOV$12 MEN	6404198930	FOOTWEAR RUBPLAS SOL NESOI OV$6.50NOV$12 MEN,NES	2011	Manual

Table A.2: Examples of Manually Adjusted HTS10-NAICS Mappings

	HTS10 group	Obsolete HTS10	New HTS10	Description	Years	NAICS code	New HTS10 group	New NAICS code
(1)		2106906075		COFFEE WHITENERS, NON-DAIRY	1992	31151	2106906075gg	31151
(2)			2106901600	ORANGE JUICE, FORTIFIED W/VITAMINS OR MINERALS	1993-1994	31141	2106901600gg	31141
(3)	2106906075gg		2106906575	COFFEE WHITENERS, NON-DAIRY	1993	31151	2106906075gg	31151
(4)			2106906587	HERBAL TEAS & HERBAL INFUSIONS OF MIXED HERBS	1993	31192	2106906087gg	31192
(5)			2106906975	COFFEE WHITENERS, NON-DAIRY, NESOI	1994	31151	2106906075gg	31151
(6)		6112192010		JACKET FOR TRACK STS OT TEX MAT CON 70% SILK, KNIT	1993-1994	31522	6112192010gg	31522g
(7)	6112192010gg		6112194010	MEN/BOYS KNIT TRACK SUTS OT TEX MAT CONT 70% SILK	1995-2012	31522	6112192010gg	31522g
(8)			6112194020	W/G KNIT TRACK SUTS OTH TEX MAT CONT 70% SILK	1995-2012	31523	6112192010gg	31522g

C Additional Results

C.1 Alternative Measures of Concentration

We show that market concentration remained virtually unchanged between 1992 and 2012 using alternative measures of concentration.

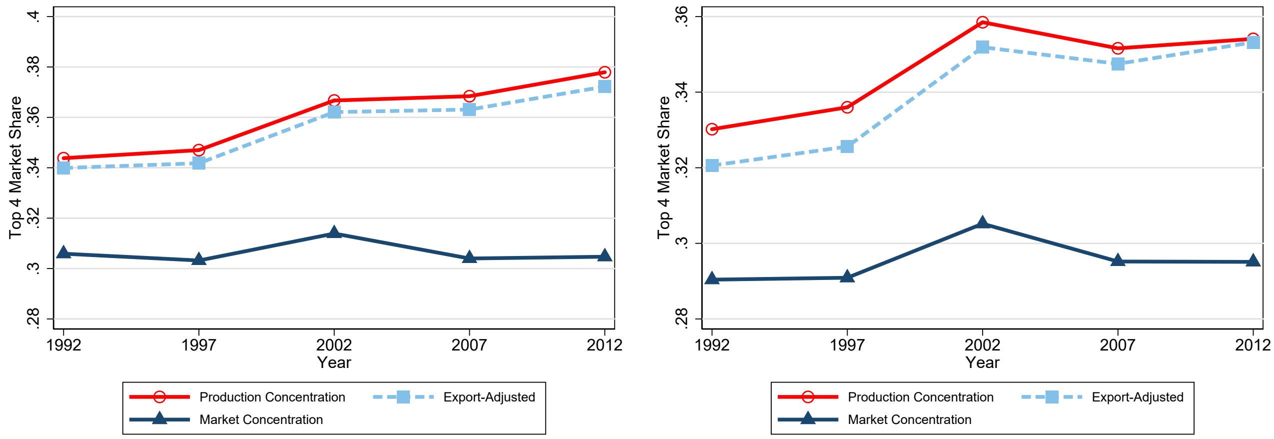
Figure C.1a shows the evolution of the top-4 concentration measure when we take a simple average across 5-digit NAICS industries. Figure C.1b takes a weighted average across industries using sales weights. As in the main text, for the production concentration measure we weight each industry by its U.S. firms' total shipments in 1992; for the export-adjusted measure we use shipments minus exports in 1992; and for the market concentration measure we use total absorption in 1992, i.e., shipments minus exports plus imports. We find similar results as before: while production concentration increases between 1992 and 2012, market concentration remains relatively unchanged.

Figures C.2a and C.2b show analogous results for the Herfindahl-Hirschman Index (HHI), using all firms. The left panel, using a simple average across industries, shows a similar result as the other measures. However, the right panel, which weighs industries using sales weights in 1992, shows both declining production concentration and market concentration. This result is driven by the relatively large weight on some commodity-related industries in 1992. Importantly, we still find declining market concentration. For comparison, Figures C.3a-C.3c show weighted concentration when we use sales weights in 2012 rather than in 1992. We find that under this weighting scheme production concentration increases significantly under all measures, while market concentration is relatively unchanged, as before.

Figure C.1: Top-4 Concentration

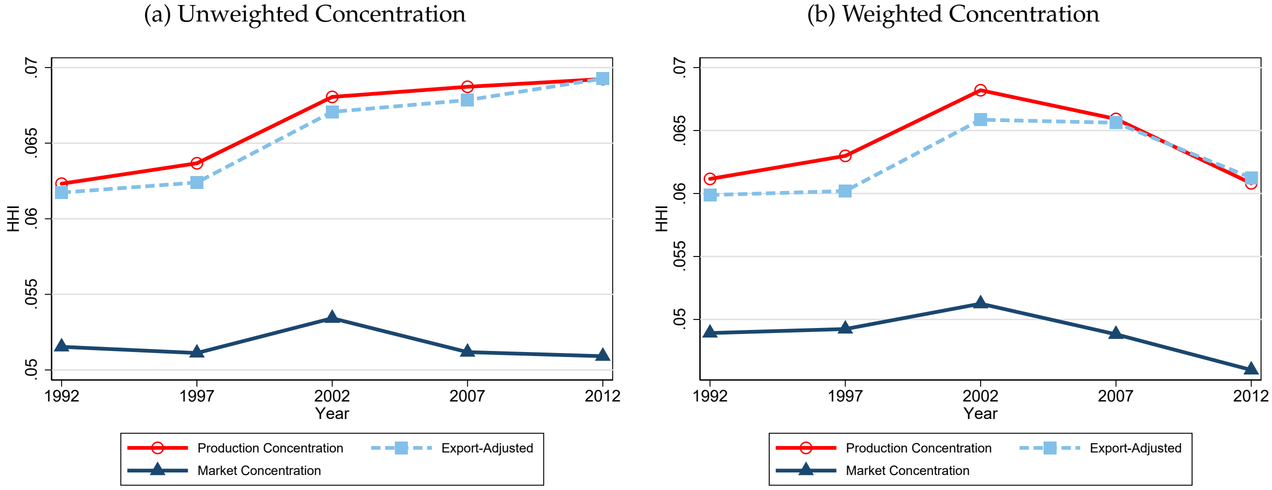
(a) Unweighted Concentration

(b) Weighted Concentration



Notes: The figures show the evolution of top-4 concentration over time. Data are for census years: 1992, 1997, 2002, 2007, and 2012. The production concentration line measures concentration of the top-4 U.S. firms using market shares defined in equation (1). The export-adjusted line subtracts U.S. firms' exports from their total sales and sums the market shares over domestic firms. The market concentration line constructs market shares as in equation (2) for all firms selling in the U.S. irrespective of where the firm is located. Panel a presents the top-4 concentration measures computed as a simple average across all NAICS 5-digit manufacturing industries. Panel b shows weighted averages across all NAICS 5-digit manufacturing industries. For the production concentration measure we weight each industry by its U.S. firms' total shipments in 1992; for the export-adjusted measure we use shipments minus exports in 1992; and for the market concentration measure we use total absorption in 1992, i.e., shipments minus exports plus imports.

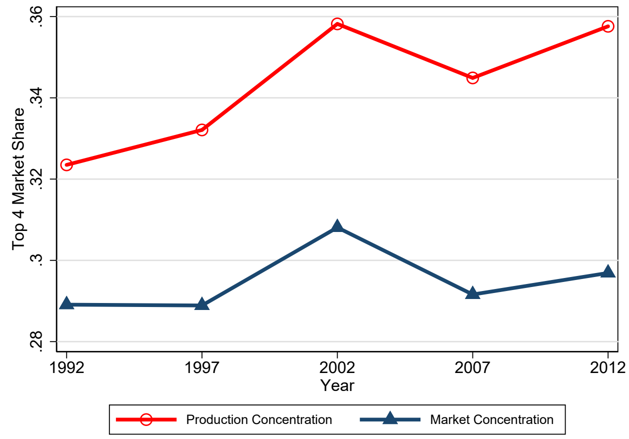
Figure C.2: Herfindahl-Hirschman Index (HHI)



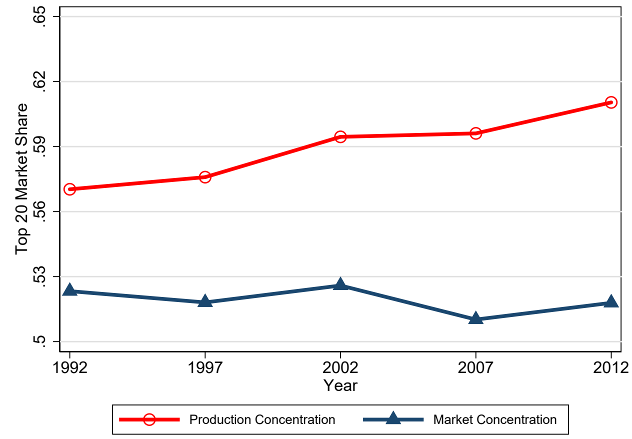
Notes: The figures show the evolution of the HHI over time. Data are for census years: 1992, 1997, 2002, 2007, and 2012. The production concentration line measures concentration according to the HHI over all U.S. firms using market shares defined in equation (1). The export-adjusted line subtracts U.S. firms' exports from their total sales and sums the market shares over domestic firms. The market concentration line constructs market shares as in equation (2) for all firms selling in the U.S. irrespective of where the firm is located. Panel a computes the HHI concentration measure in each industry and takes a simple average across all NAICS 5-digit manufacturing industries. Panel b shows weighted averages across all NAICS 5-digit manufacturing industries. For the production concentration measure we weight each industry by its U.S. firms' total shipments in 1992; for the export-adjusted measure we use shipments minus exports in 1992; and for the market concentration measure we use total absorption in 1992, i.e., shipments minus exports plus imports.

Figure C.3: Weighted Average Concentration Using Weights in 2012

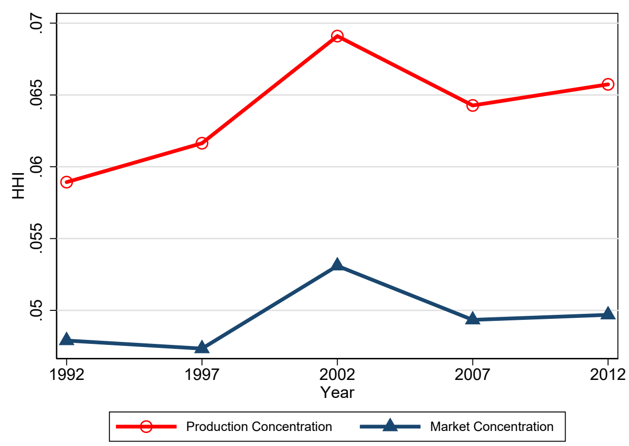
(a) Top-4 Concentration



(b) Top-20 Concentration



(c) Herfindahl-Hirschman Index (HHI)

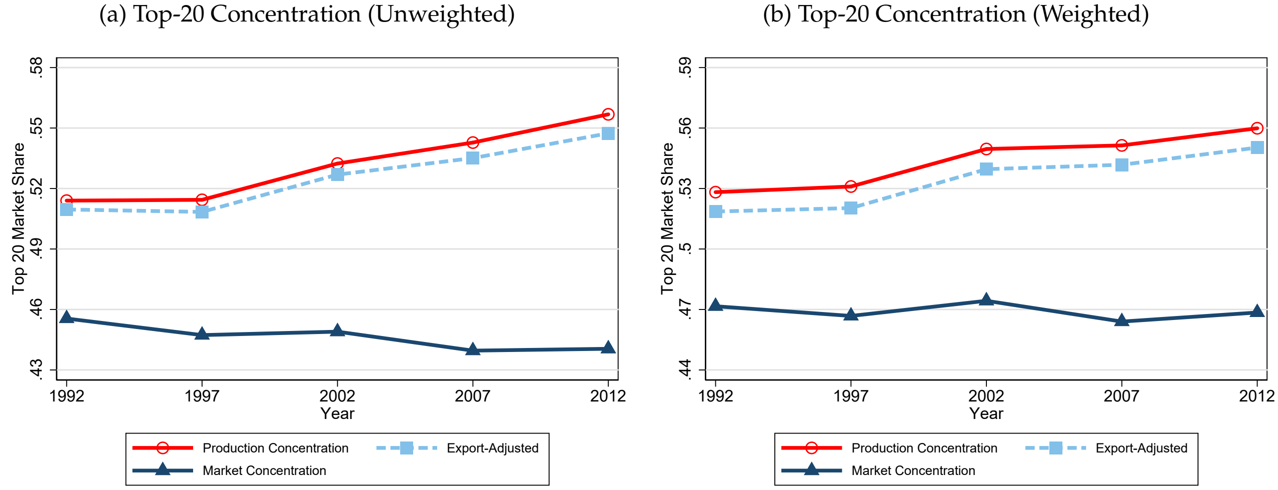


Notes: The figures show the evolution of concentration over time. Data are for census years: 1992, 1997, 2002, 2007, and 2012. The production concentration line measures concentration over all U.S. firms using market shares defined in equation (1). The market concentration line constructs market shares as in equation (2) for all firms selling in the U.S. irrespective of where the firm is located. Panel a computes the top-4 concentration, panel b computes the top-20 concentration, and panel c the HHI. All panels show weighted averages across all NAICS 5-digit manufacturing industries. For the production concentration measure we weight each industry by its U.S. firms' total shipments in 2012; for the market concentration measure we use total absorption in 2012, i.e., shipments minus exports plus imports.

C.2 Aggregation at the 4-Digit NAICS Level

We present the top-20 concentration measure computed at the 4-digit NAICS level. Figure C.4a presents an unweighted average across industries and Figure C.4b presents a weighted average. The results are similar to those for the 5-digit aggregation.

Figure C.4: Concentration, NAICS 4-Digit Aggregation



Notes: Panel a plots a simple average of the top-20 concentration across all NAICS 4-digit manufacturing industries. Data are for census years: 1992, 1997, 2002, 2007, and 2012. The production concentration line is a production market concentration measure using only total sales data of firms located in the U.S. The export-adjusted line subtracts U.S. firms' exports from their total sales. The market concentration line uses all firms' sales in the U.S. irrespective of where the firm is located. Panel b plots a weighted average of the top-20 concentration across all NAICS 4-digit manufacturing industries. For the production concentration measure we weight each industry by its U.S. firms' total shipments in 1992; for the export-adjusted measure we use shipments minus exports in 1992; and for the market concentration measure we use total absorption in 1992, i.e., shipments minus exports plus imports.

C.3 Alternative Regression Weightings

We present the regression results using specification (6) for unweighted regressions in Table C.1. The results are broadly similar to those in the main text.

Table C.1: Unweighted Regression Results

Dependent variable	ΔC_{it}^{P20} (1)	ΔC_{it}^{P20} (2)	ΔC_{it}^{20} (3)	ΔC_{it}^{20} (4)	ΔNfirms$_{it}$ (5)	ΔNfirms$_{it}$ (6)
	OLS	IV	OLS	IV	OLS	IV
ΔIP_{it}	-0.007	0.122*	-0.184***	-0.339***	0.106*	-0.959***
	(0.023)	(0.072)	(0.026)	(0.081)	(0.098)	(0.325)
First stage		ΔIP_{it}		ΔIP_{it}		ΔIP_{it}
instrument$_{\Delta IP_{it}}$		0.446***		0.446***		0.446***
		(0.056)		(0.056)		(0.056)
Predicted effects		0.003		-0.009		
Actual		0.046		-0.016		
N	500	500	500	500	500	500

Notes: Decimals have been rounded to four significant digits per Census Bureau disclosure guidelines. Number of observations has been rounded to hundreds. ΔC_{it}^{P20} is the change in the top-20 production concentration measure and ΔC_{it}^{20} is the change in the top-20 market concentration measure. Mean of ΔIP_{it} is 0.052; standard deviation is 0.098. The predicted effects are calculated by first predicting the change in import penetration as the first-stage coefficient times the instrument, and then multiplying this by the second-stage coefficient and taking a simple average across all industries. Year fixed effects are included.

D Derivation of Trade Shocks

We provide some more details on the construction of the trade shocks that we use to construct the instrument in our regressions. Start with a standard fixed effects regression model:

$$\triangle M_{ijkt} = \alpha_{ikt} + \beta_{ijt} + \epsilon_{ijkt}, \tag{D.1}$$

where the dependent variable is the change in imports from country j to k at time t in industry i. The right-hand side variables are source country-industry-time fixed effects and destination country-industry-time fixed effects. In order to identify these coefficients, there must be a connected set of source country and destination country trade, and the error term must satisfy $E[\epsilon_{ijkt}] = 0$.

A major shortcoming in using standard fixed effects regressions to estimate the coefficients is that the dependent variable is undefined for new trading relationships, i.e., country-industry pairs that trade in t but not in $t-5$. So the gap between the predicted aggregate imports and actual imports is going to depend on how important new trading relationships are in explaining the variation in aggregate trade. Our methodology overcomes this problem by incorporating new trade relationships, estimating supply and demand shocks that exactly match aggregate imports. In fact, the methodology collapses to weighted least squares estimation, with lagged trade weights, and the dependent variable defined as the percentage change in trade, if there are no new trade relationships (see Amiti and Weinstein (2018) Appendix A for proof).

The percentage change in a country j's total exports of industry i, D_{ijt}, can be obtained by summing equation (D.1) cross all destination countries k; and the percentage change in a country k's total imports of industry i, D_{ikt}, can be obtained by summing equation (D.1) across all source countries to give us the following moment conditions:

$$D_{ijt} \equiv \frac{\sum_k M_{ijkt} - \sum_k M_{ijk,t-5}}{\sum_k M_{ijk,t-5}} = \beta_{ijt} + \sum_k \phi_{ijk,t-5}\alpha_{ikt}, \text{with } \phi_{ijk,t-5} \equiv \frac{M_{ijk,t-5}}{\sum_k M_{ijk,t-5}};$$

and

$$D_{ikt} \equiv \frac{\sum_j M_{ijkt} - \sum_j M_{ijk,t-5}}{\sum_j M_{ijk,t-5}} = \alpha_{ikt} + \sum_j \theta_{ijk,t-5}\beta_{ijt}, \text{with } \theta_{ijk,t-5} \equiv \frac{M_{ijk,t-5}}{\sum_j M_{ijk,t-5}}.$$

These are $J+K$ equations in $J+K$ unknowns, which will produce unique α_{ikt} and β_{ijt} up to a numeraire in each industry i. These adding-up constraints ensure that exporting equals importing, and the predicted values will exactly match aggregate exporting at the exporting country level, importing country level, and time level. Note that the denominator in the first equation is country $j's$ total exports of industry i, since it is summed across imports from all the countries that imported that product at time $t-5$; so new relationships that form between these countries will still be included provided there was an export to at least one country in industry i.