The Spatial Spillover Effects of Export Shocks on Markups: Evidence from China *

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Abstract

Using China's accession to WTO in 2001 as an episode for trade liberalization, this paper empirically investigates whether export expansions affect firms' markup adjustments through local production networks. Following Helm (2020), we construct an indirect local export exposure measure to capture how much firms in each prefecture-industry cell are indirectly affected by export expansions of other local industries. We further decompose indirect export shocks into upstream and downstream shocks to analyze the role played by local production networks. Combining this with markups estimated following De Loecker et al. (2016), our empirical results suggest that the average level of indirect export shocks would lead to a 0.363 decrease in markups. This magnitude accounts for 6.862% of overall markup changes during the 2000-2007 period. In particular, the baseline results are driven by local indirect shocks from downstream industries. Further empirical analysis shows that reductions in firms' markups are induced by increased competition and increased demand for local upstream inputs, which can be summarized as the "indirect pro-competitive effects" and "competition for local intermediate inputs effects". Further analysis at the prefecture-industry level reveals that the impact mainly exists at the within-firm margin, not at the between-firm, or entry/exit margin.

Keywords: Indirect local export exposures; production networks; markup changes; upstream and downstream industries

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1 Introduction

Trade liberalization is believed to affect firm performance in different aspects. Plenty of literature uses trade liberalization policies as exogenous shocks to examine the direct impact of trade on firm outcomes such as productivity, wage changes, and innovation.[1] In addition to these first-order effects, production network linkages are also found to propagate the impact of trade by involving non- or less-traded firms and industries in the global production process.[2] However, most of the previous studies consider production networks at the national level, and less attention has been paid to local production networks. This paper makes use of a novel indirect trade exposure measure developed by Helm (2020) to examine whether export expansions could affect firm outcomes through local production networks using China's data from 2000 to 2007, a period featuring fast export growth in China.

The outcome of interest we consider is firm-level markup changes. Defined as the ratio of price to marginal cost, markup is an indicator of firm market power and has important implications for aggregate allocative efficiency. Indirect local export exposures from upstream and downstream industries can potentially lead to adjustments in prices or costs, which in turn drives markup changes. Studying the determinants of markup changes has important welfare implications. Recent literature finds that markups of large firms have been rising over the past several decades in both developed and developing countries, which indicates a higher market concentration level and a fall in labor share.[3] The relationship between trade liberalization and markup changes has been extensively studied in theoretical and empirical literature as well. [4]. Empirical papers study markup differences between different groups of firms, such as exporters and non-exporters, domestic firms, and foreign affiliates (De Loecker and Warzynski, 2012; Zhang and Zhu, 2017). However, most of the literature considers direct exposure to trade. The focus on the impact of indirect local export exposures on markup changes can thus extend our knowledge of both the determinants of markup changes and the consequences of trade liberalization.

China provides a good setting to study this issue. Apart from its phenomenal export growth since the entry into WTO, local production networks play an important role in China in the 2000s. Using data from the inter-province Input-Output table of 2002, Figure 1 exhibits the share of inputs sourced from within the province or outside the province for 15 manufacturing sectors. It is clear that the majority of inputs are sourced within province

1. See Brandt et al. (2017); Chen et al. (2017); Bloom et al. (2016); Liu and Ma (2020).

2. See Caliendo and Parro (2015); Dhyne et al. (2021); Baqaee and Farhi (2019).

3. See De Loecker and Eeckhout (2018); Autor et al. (2020); De Loecker et al. (2020); Díez et al. (2021).

4. Trade theory considers heterogeneous firms with variable markups, which usually concludes that high productivity firms enjoy cost advantage and charge higher markups (Bernard et al., 2003; Melitz and Ottaviano, 2008)

for all 15 manufacturing industries, suggesting that distance to suppliers matters in firms' sourcing decisions.[5] The role of geographic proximity in forming production linkages has been studied in the context of other countries as well.[6] Therefore, if export expansions affect the aggregate economy through production networks, the role of local production linkages cannot be ignored. Moreover, due to the Hukou system in China that ties individual benefits and children's schooling to locations, large-scale cross-region migration is not prevalent in the early 2000s, making the labor market highly local at that period of time as well (Fan 2019). Using population census in 2000 and 2005, Li (2018) shows that less than 4.5% working-age population migrated to other prefectures from 1995 to 2000, and the number is around 4.8% from 2000 to 2005.

[**Insert Figure 1 here**]

Local indirect export exposures could potentially affect markups through *Demand* and *Supply* channels. On the *Demand* side, assume the local downstream industries of industry i are highly exposed to export demand shocks, then firms in industry i are indirectly exposed to the global market, leading to rising demand for outputs of industry i. Consequently, prices may rise and lead to increased markups. However, the rising markups might in turn intensify competition within the industry i and attract more entrants into the industry, which could depress markups. On the *Supply* side, if upstream industries for industry i are highly exposed to global markets, the input price for firms in industry i may rise, leading to decreased markups. Another potential channel is that industries highly exposed to the global market have a large demand for upstream inputs, then increased downstream export exposures would push up the cost for other local industries, causing downward pressure on markups. In addition to price changes in the input and output market, Helm (2020) suggests that exposure to export shocks may attract more labor into the local market, which may spill over to other local industries and increase labor supply in the local market. If changes in labor supply can influence wages, then labor cost adjustments can also be a source for markup changes.

Borrowing from the local trade exposure construction methodology in Autor et al. (2013), Helm (2020) constructs indirect export exposures at a prefecture-industry level to reflect how much an industry is affected by net export expansions of other local industries. We follow the method in Helm (2020) to construct indirect local exposures with industry-level exports from

5. On average, 76.2% of total inputs are sourced within the province. Among the 15 industries, the clothing industry sources the least from the same province with the average within-province input share being 67.4%; while the food processing sources the most locally, with the average within-province input share being 84.4%.

6. See Bernard et al. (2019); Bray et al. (2019).

2000 to 2007 and employment distribution information from the Annual Survey of Industrial Firms (ASIF). To further explore the impact of local production networks, we decompose local indirect export shocks into shocks from upstream and downstream industries. We first use the upstream measure calculated by Antràs and Chor (2013) to classify industries' position on the value chain. Then, we employ China's 2002 Input-Output table to identify upstream and downstream industries and use input/output shares as weights to construct weighted indirect export shocks as well.

In terms of markup construction, this paper adopts a quantity-based production function estimation approach proposed by De Loecker et al. (2016) to obtain markup estimates using the ASIF and the Industrial Firms Product Quantity Database (IFPQD). The majority of our empirical analysis considers within firm markup responses to local indirect export exposures, namely markup differences between 2000 and 2007. To establish causality, we further make use of tariff information from the Trade Analysis Information System Database (TRAINS) to predict China's export flows using tariffs charged by other countries.

Our empirical analysis offers four sets of results. First, our baseline results suggest that exposure to indirect local export exposures could decrease firm markups. Over the course of 2000 to 2007, the average of China's firm markups has risen by 0.0529. If the indirect export exposure channel is shut down, the rise in markups would have been 0.0565, which is a 6.862% increase. Secondly, when we decompose the overall indirect export shocks into upstream and downstream shocks, regression results suggest that downstream shocks negatively affect markups while the upstream shocks play little role. These patterns stand under a battery of robustness checks.

Our third sets of results involve the test for potential channels. The results suggest that two of the major channels driving the relationship between indirect export exposures and markup changes are intensified competition channel and the input demand increase channel. Within the prefecture-industry cells, increased indirect export shocks from downstream industries lead to more competition, driving down firm markups. This can be summarized as "indirect pro-competitive effects". Moreover, if industries demanding a higher share of inputs in the production process are more exposed to export shocks, indirectly exposed industries would face higher costs for inputs, thus lowering markups. This can be considered as "competition for local intermediate inputs effects". Additionally, our results suggest that labor market changes have little effect on markup adjustments.

Finally, we examine this issue at a more aggregate level, namely the prefecture-industry level. Simple average markup changes also negatively respond to local indirect export exposures. Nonetheless, the change in the average markup weighted by output is not significantly affected by indirect export shocks. We further consider markup changes for markups at different percentiles, which shows that markup changes at the lower percentiles are significantly affected by indirect shocks. Additionally, we employ a decomposition method as in Brandt et al. (2017) to split the overall markup changes into the within-firm, between-firm, entry and exit margins. Regressing indirect export exposures on those four margins respectively show that indirect export exposures mainly influence the within-firm margin.

Related literature

This paper relates to the studies on the ambiguous impact of trade liberalization on markups.[7] Tons of empirical studies show that trade liberalization reduces firms' markups by introducing more competition. De Loecker et al. (2016) document the pro-competitive effects of trade liberalization on output prices in India and decompose the reduction in output prices into marginal costs and markups. They find that although trade reduces input prices and ultimately marginal costs, firms raise markups to offset such reduction, which is also known as the incomplete cost pass-through of input tariff reduction. In addition, there is also another strand of literature examining the impact of intermediate goods trade liberalization on markups. Ludema and Yu (2016) theoretically predict and empirically investigate the incomplete pass-through of input tariff reductions in the presence of firms' heterogeneous quality-upgrading decisions. Brandt et al. (2017) instead show that cuts in output tariffs upon China's accession to WTO reduce markups and raise productivity, while cuts in input tariffs raise both markups and productivity of Chinese manufacturing firms. Li and Miao (2018) further take input-output linkages into account and find that the fixed costs of imports, reduction in marginal costs, and firm turnover jointly explain the increase in markups. Our paper, instead, complements prior empirical studies on trade and markups by investigating the local impact of export expansions through input-output linkages on firms' market power.

This paper also contributes to the literature analyzing the local economic outcomes of globalization with the Bartik approach, which relies on the initial regional differences in industry compositions to localize national trade shocks to the regional level. Previous research using this empirical strategy mainly focuses on local-level outcomes, especially on employment and educational outcomes (Autor et al., 2013; Li, 2018). We enrich the Bartik method by constructing indirect local export exposures following Helm (2020), and decomposing indirect shocks according to their position on the value chain. Additionally, the outcome of interest in this paper is firm-level markup changes, which have been paid little attention to in this strand of literature. The micro-level approach also provides us with more flexibility

7. See Levinsohn (1993); Harrison (1994); Krishna and Mitra (1998); Konings et al. (2005); Chen et al. (2009); De Loecker and Warzynski (2012); Bellone et al. (2016); Hsu et al. (2020); Fan et al. (2018); Caselli and Schiavo (2020); Amiti et al. (2019); Cajal-Grossi et al. (2019).

in exploring the underlying mechanisms driving the results.

Finally, this paper relates to the literature studying the economic impacts of trade liberalization through production linkages. There are numerous structural trade papers evaluating the welfare gains from trade in the presence of sectoral linkages or firm-to-firm production networks. Caliendo and Parro (2015) incorporate sectoral linkages into a multi-sector Ricardian model as developed by Eaton and Kortum (2002) and quantitatively evaluate the welfare gains from NAFTA. Based on a Ricardian trade model with a firm's endogenous network formation, Dhyne et al. (2021) study the effects of trade on firms' costs and real wages by employing Belgian firm-to-firm transactional data. Kikkawa et al. (2019) quantify the welfare loss of firms' *pricing to buyers* and find that the elimination of such markup distortions would increase welfare by 6%. Even though both firm-to-firm networks and sectoral linkages have been studied in previous literature, less is known about the role of local production linkages, which is the focus of the current paper.

The paper is organized as follows. Section 2 discusses the empirical strategy we apply in identifying the effects of indirect local export shocks on markups. Section 3 introduces data and provides summary statistics. Section 4 presents a firm-level empirical analysis for indirect export exposure and markups. Section 5 conducts mechanism testing and heterogeneity analysis. Section 6 explores further analysis at the prefecture-industry level. Section 7 concludes.

2 Empirical strategy

In this section, we first introduce the regression specification we use for the empirical analysis. Then, we lay out steps for the construction of firm markups and local indirect export exposures.

2.1 Regression specification

To establish the relationship between firm markup changes and indirect local export exposures, the following regression specification is used for estimation:

$$\Delta Mark\_up_{i,k}^{c} * 100 = \beta_1 \Delta IndirExpShock_{k}^{c} + \Gamma \mathbf{X_k^c} + \Psi \mathbf{X_i^c} + \delta_k + \delta_c + \epsilon_{i,k}^{c} \qquad (1)$$

The dependent variable is the change of markups between year 2000 and 2007 for firm i in industry k located in prefecture c.[8] The variable of interest is $\Delta IndirExpShock_{k}^{c}$, namely

8. We multiply the markup changes by 100 to make the interpretation of the estimates easier.

local indirect export shocks.

One potential endogeneity issue is that local indirect export shocks may correlate with other initial prefecture-industry conditions that also affect markup changes. To alleviate this concern, we control for a comprehensive set of initial prefecture-industry characteristics $\mathbf{X_k^c}$, including its initial market concentration, employment share, SOEs share, exporter share and skilled labor share. Initial firm level conditions $\mathbf{X_i^c}$ are controlled as well to further eliminate unobserved factors driving the results.

The outcome and explanatory variables of interest are in differences rather than in levels, which suggests that time-invariant prefecture-industry factors are wiped out. However, contemporary changes in this time period, such as prefecture GDP growth, population growth, and nation-wide industrial policies, may influence markup changes as well. Thus, we control for prefecture FE and industry FE in our baseline specification as well. Another source of endogeneity concern is that the construction of $\Delta IndirExpShock_k^c$ involves using national export values for each industry, which may itself be an outcome of domestic economic conditions. We solve this issue by predicting export flows from tariffs charged by other countries, as detailed in Section 2.2.

2.2 Measuring indirect export exposure

We follow the approach developed by Helm (2020) and construct a Bartik-type measure for local indirect export exposure. The local indirect export exposure for a certain industry j in prefecture c is an aggregation of exposure to the other local industries of a worker from this industry. The construction process contains the following steps.

To start with, we construct changes in local direct export exposure for industry j in prefecture c by first taking the difference of export values between 2000 and 2007 and then dividing it by initial industry employment share:

$$\Delta DirExpShock_c^j = \left(\frac{L_{ct_0}^j}{L_{t_0}^j} \Delta Export^j \right)$$

Consider another industry k ($k \neq j$) located in prefecture c as well. Its indirect exposure to industry j's export shock can be expressed as:

$$\Delta IndirExpShock_c^{j,k} = \frac{1}{L_{ct_0}^k} \left(\frac{L_{ct_0}^j}{L_{t_0}^j} \Delta Export^j \right).$$

It measures how much each worker in k is affected by the local export shocks in industry j. Finally, indirect export shocks are summed up across all local industries except for k to get the overall local indirect export shocks for industry k used in the empirical analysis:

$$\Delta IndirExpShock_c^k = \sum_{j \neq k} \frac{1}{L_{ct_0}^k} \left(\frac{L_{ct_0}^j}{L_{t_0}^j} \Delta Export^j \right). \tag{2}$$

To avoid the endogeneity concerns brought about by $\Delta Export^j$, we use tariffs China's exporters face to predict export values and then take the difference to get $\Delta \widehat{X}_t^k$, and then use it for the construction of $\Delta IndirExpShock_c^k$. Tariffs charged by other countries are less subject to China's domestic economic conditions, and it also negatively affect export values. Therefore, export values predicted by tariffs can reflect China' export values driven by foreign policies and demand, rather than domestic conditions.

Tariffs are county-industry-year specific in the data. We first average tariffs to industry-year level using export share into different countries as weights:

$$Tariff_t^{k,X} = \sum_d \frac{X_{dt-3}^k}{X_{t-3}^k} Tariff_{dt}^k$$

Note that we choose export weights from $t-3$ to alleviate the concerns for endogenous weighting. Then we predict industry export values by estimating the following equation:

$$\ln X_t^k = \beta_{ROW} \ln(1 + Tariff_t^{k,X}) + \alpha_k + \alpha_t + \epsilon_t^k$$

We include industry and year FE to get more precise predicted export values. Our baseline specification takes a difference form and controls for industry fixed effects, which can rule out the potential endogeneity issues brought about by the inclusion of α_k and α_t. The unlogged predicted values are then given by:

$$\widehat{X}_t^k = \exp(\hat{\beta}_{ROW} \ln(1 + Tariff_t^{k,X}) + \hat{\alpha}_k + \hat{\alpha}_t)$$

The differences between 2000 and 2007's predicted export values are taken for each industry and then used for the construction of indirect local exposures. In baseline analysis, we choose the weighted-average effectively-applied tariffs (AHS) to predict export values. As the *ad-valorem* tariffs are completely price shifters, β_{ROW} is exactly the trade elasticity, which captures the effect of bilateral frictions (tariffs) on trade flows. Our estimated trade elasticity of exports to tariffs in the baseline regression is -5.2 and statistically significant at 1% level, which is within the range of estimates of tariffs using gravity equations as discussed in Head and Mayer (2014) and Yotov et al. (2016). We also report results for the weighted-average most-favored-nation (MFN) tariffs and simple-average AHS tariffs in table

A3 as robustness check[9].

2.3 Markup construction procedure

Markup is defined as the ratio of price to marginal costs. Due to lack of information, it is impossible to directly calculate markups from available data. Instead, we follow previous literature and estimate markups based on the method proposed by De Loecker et al. (2016).

Assume a firm f has the following production function:

$$Q_{ft} = Q_{ft}(L_{ft}, K_{ft}, M_{ft}, \omega_{ft})$$

With L_{ft}, K_{ft} and M_{ft} being labor, capital and intermediates inputs respectively. Cost minimization with respect to material—the inputs that can be adjusted freely—would yield the following expression:

$$\frac{\partial \mathcal{L}}{\partial M_{ft}} = p^m_{ft} - \lambda \frac{\partial Q_{ft}}{\partial M_{ft}} = 0$$

with λ being the marginal cost for production. Multiplying both sides by $\frac{M_{ft}}{Q_{ft}}$ leads to:

$$\frac{\partial Q_{ft}}{\partial M_{ft}} \times \frac{M_{ft}}{Q_{ft}} = \frac{1}{\lambda_{ft}} \frac{p^m_{ft} M_{ft}}{Q_{ft}}$$

Define markup as $\mu_{ft} \equiv \frac{P_{ft}}{\lambda_{ft}}$. Then markup can be shown parts:

$$\mu_{ft} = \theta^m_{ft} \times (\frac{p^m M_{ft}}{P_{ft} Q_{ft}}) = \theta^m_{ft} (\alpha^m_{ft})^{-1} \tag{3}$$

Where $\theta^m_{ft} = \frac{\partial Q_{ft}(.)}{\partial M_{ft}} \times \frac{M_{ft}}{Q_{ft}}$ is the output elasticity for intermediate inputs. And α^m_{ft} is the input share for intermediates. Since α^m_{ft} could be directly calculated from the dataset, the key is to estimate output elasticities.

Following De Loecker et al. (2016) and Lu and Yu (2015), we estimate a trans-log form of production function. Then the estimated output elasticity for material inputs is given by

$$\hat{\theta}^M_{ft} = \hat{\beta}_m + 2\hat{\beta}_{mm} m_{ft} + \hat{\beta}_{mk} k_{ft} + \hat{\beta}_{ml} l_{ft} + \hat{\beta}_{lk} l_{ft} k_{ft} \tag{4}$$

Output elasticities can be estimated with revenue data or output quantity data. With the availability of detailed output quantity data, the latter approach has become more popular

9. In table A3 , we further apply a cross-country regression by exploiting the variations in tariffs and bilateral trade flows

in recent literature, as it could avoid yearly revenue changes brought about by price level variations (De Loecker et al. 2016; Lu and Yu 2015; Zhang and Zhu 2017). However, estimation using quantity data requires dealing with the following challenges properly. First, there are many multi-product firms in the dataset. Even though output quantity data offers information on the output for each product category, the inputs information is only available at firm level. Secondly, the output and labor inputs are expressed in quantities in the dataset, but capital and material inputs are in value terms, which means that the variables cannot be directly used for production function estimation. We follow De Loecker et al. (2016) and deal with these challenges by first using the sample of single-product firm for estimation. And then we deflated capital expenditure to get the real capital inputs and construct an input price control function to take into account price factor for material inputs. Following the procedures above, we can obtain consistent estimates including $\hat{\beta}_m$, $\hat{\beta}_{mm}$, $\hat{\beta}_{mk}$, $\hat{\beta}_{ml}$, and $\hat{\beta}_{lk}$, which can be used to get the output elasticities $\hat{\theta}^M_{ft}$, and firm-level markups $\hat{\mu}_{ft}$.

3 Data sources and summary stats

3.1 Data sources

We make use of the following datasets to construct indirect local exposures, markups, as well as controls used for estimation.

Firm-level balance-sheet data.— The main firm-level database used in this paper is the Annual Survey of Industrial Firms (ASIF). Conducted by the National Bureau of Statistics of China, the ASIF covers all state-owned (SOE) manufacturing enterprises and the non-SOE enterprises with annual sales over 5 million RMB ("above the scale"). The ASIF database provides basic information such as firm's name, industry, location as well as detailed production and financial information including employment, sales, intermediate materials, and net value of fixed assets et al. We clean the data following Cai and Liu (2009) and the general accounting procedure.[10] The cleaned ASIF between 2000 and 2007 contains 482 China Standard Industry Classification (CSIC) 4-d manufacturing industries, more than 520,000 firms and over 2.04 million observations.

We then deal with inconsistencies in industry classification and administrative codes. As different industry classifications were applied before and after 2002, we convert the industry classification at 4-d National Standard GB/T 4754-1994 to 4-d GB/T 4754-2002, which is labeled as 2002 CSIC 4-d. We then aggregate CSIC 4-d observations to CSIC 3-d and finally

10. We construct a panel following Brandt et al. (2012) using the information on firm's identity, name, and legal representative et al.

obtain 169 manufacturing CSIC industries. As for the administrative codes, we convert administrative codes of all other years to 2003 and obtain consistent administrative codes over the sample period. We also exploit information on firms postal code and address to back out prefectures for missing observations. After cleaning up the prefecture codes, there are totally 339 prefectures in our regression sample.

Construction of markups and indirect exposures both make use of the ASIF. In particular, information on firms' revenue, employment, input expenditure, fixed asset is used to construct markups. We also use 2000's employment distribution information to construct indirect local export exposure. Finally, the controls used to estimate Eq. (1) are also constructed using variables from the ASIF.

Product-level physical quantity data.— As firm-level physical output quantities are not available in the ASIF, we employ a product-level physical quantity dataset in our study, namely the Industrial Firms Product Quantity Database (IFPQD), which is also constructed by the National Bureau of Statistics of China. This product-level dataset provides information on the output quantity for each five-digit product produced by a firm. More than 500 kinds of product categories are included in this dataset. As firms present in this quantity dataset and ASIF share the same firm ID, we are able to merge the two datasets into one and identify the variety of products firms produce and the output quantity for each product line.

Trade data.— We obtain China's industry export values from BACI CEPII, which documents bilateral trade flows since 1995 disaggregated at the HS 6-d level. Our regression analysis consider industry classification at CSIC 3-d level. Therefore, we aggregate export flows from HS 6-d to CSIC 3-d level with a manually matched the concordance table.

Tariff data.— We collect tariff data over the period 2000-2007 from the TRAINS Database. The TRAINS Database provides detailed product-level tariff data including the numbers of tariff lines and average *ad valorem* tariffs for both effectively applied tariffs (AHS) and mostly-favor-nation tariffs (MFN). As the tariff data is at the ISIC Rev.3 4-digit level, we match the ISIC Rev.3 4-digit to HS (2002) 6-digit level using the standard ISIC-HS concordance table provided in UN WITS.

Sample Construction

Since our regression specification considers within-firm markup changes from 2000 to 2007, the final sample consists of firms appearing in both years. Additionally, we only keep firms whose markup estimates are between 1 to 99 percentile range to ensure that the empirical results are not driven by extreme values. The final sample used for regression contains 55351 firms. Even though the sample size is small in comparison to the total number of surveyed firms in the ASIF, our sample covers firms that locate in 327 prefectures and operate in 160 CSIC 3-d industries, making it quite representative of all manufacturing firms. This provides us with rich variations across prefecture-industry cells to establish the causality from local indirect export exposures to markup adjustments.

3.2 Summary statistics

We estimated firm-level markups for firms in the ASIF dataset over 2000-2007 period. The median of the markups is during this time period is 1.236, and the mean is 1.288. The changes in markups are more of our interest. In the upper left panel of Figure 2, we show average markups over the 2000 to 2007 period for the whole sample. It is clear that markup displays a upward trend except for a small drop in 2003. Overall, The average markup rises for 5.1% from 2000 to 2007. In the upper right panel, we considers markup changes for firms with output above and below the industry output median. Larger firms have higher markups in the initial period, and the gap has widened over time. Similar patterns also hold for the comparison between SOEs and non-SOEs.[11] Finally, the lower right panel compares exporters and non-exporters and show that both type of firms witness markup increases and non-exporters have higher markups during this time period.[12] For the subsample of firms we use for estimation, the average of the markup change is 5.29%, close to that of the whole sample in the ASIF. In Appendix Table A1 and A2, we present different percentiles of markup changes by 2-digit industry and by province.

Summary statistics for variables of interest and controls are presented in Table 1. The mean of indirect export exposure is 3.594 million dollar per worker. The minimum is zero, indicating the rise of indirect export shocks over 2000-2007 is a common pattern across industries in different regions. Figure 3 presents the mean and standard deviations of residuals of a regression of indirect export exposure changes on initial own industry local employment share. As a result, such indirect export exposure variations could purely capture differences of other tradable industry composition in the local production network. It is clear that Figure 3 shows that there are considerable cross-prefecture variations for indirect export exposures within each tradable industry. Such cross-prefecture within-industry variations helps us to causally identify the impact of indirect exposure on markup adjustments over time.

11. Average markups rise by 5.7% for above output median firms and 3.7% for below median output firms. For SOEs and non-SOEs, the average markup increase over the period is 9% and 5.4% respectively.

12. Some literature finds that exporters have higher markups (De Loecker and Warzynski 2012). However, some studies focusing on China find that China's exporters are faced with more competition, leading to lower markups compared to non-exporters.

4 Indirect export exposure and markup changes

This and the next two sections presents empirical results. We start by showing the baseline results with the overall local indirect exposures. Then we present results using upstream and downstream indirect local export exposures as explanatory variables. We continue to test mechanisms and present heterogeneous analysis in Section 5. Finally, we present evidence at the industry level in Section 6.

4.1 Baseline results

Table 2 presents baseline results. Column 1 includes only prefecture and industry fixed effects, which indicates a negative effect of indirect local export exposure on markup changes. In column 2, we include initial conditions for prefecture-industry cells, such as its gross output to controls for its size, output HHI index to indicate its concentration, and initial employment share that shows industries' relative importance in the local labor market. Column 3 further controls for the share of SOEs and exporters. Column 4 considers worker shares of different skill levels, and the share of female workers.[13] The inclusion of three sets of prefecture-industry controls changes the coefficient from -0.078 to -0.126, indicating the existence of omitted variable bias when initial conditions are not controlled for. Column 5 further takes into account firm initial conditions, such as firms' initial markup levels, initial firm output, initial firm wages and export values.

The coefficient on key explanatory variable after the inclusion of fullest set of controls is -0.099. The mean of indirect export shocks during 2000 to 2007 is 3.65 million dollars per worker, which would lead to a decrease in firm markups by 0.363. Given that the average markup increase during this period of time is 5.29, we can predict that when export only affect markups through direct shocks, and the indirect channel is shut down, the markup increase would become 5.65, which is a 6.862% increase.

4.2 Indirect export shocks through IO linkages

We further consider how indirect shocks from upstream and downstream industries influence markups differently. We categorize upstream and downstream industries in three ways. To start with, we use the upstreamness measure from Antràs and Chor (2013) which measures the distance of an industry to the final demand. The higher the value of the upstreamness measure, more upstream the industry is. The original upstreamness measure is calculated

13. Since the 2000 ASIF doesn't contain information on worker skill levels, we use 2004 ASIF to construct share of high/middle skill and share of female workers for prefecture-industry cells.

in NAICS industry classification, and we employ several industry code concordances to map the measure into CSIC 3-d classification. For each firm observation in industry j, we can categorize another industry as upstream or downstream relative to industry j based on the measure. Then we calculate upstream and downstream local indirect export shocks respectively. In column 1 of Table 3, we use upstream shocks as the explanatory variable, in column 2 we use downstream shocks, and in column 3, both upstream and downstream local indirect shocks are included.

Upstreamness measure from Antràs and Chor (2013) reflects industries relative positions on the value chain. However, it doesn't reflect cross-industry input-output linkages. To fix this issue, we employ China's 2002 IO table to identify upstream and downstream industries, which better indicate the inputs used for production, and where the outputs go to. The relevant results are shown in column 4 to 6. In column 1 and column 4 where only upstream indirect shocks are included, the effect is small in magnitude and insignificant. In column 2 and 5 where only downstream indirect shocks are included, the effect is significantly negative. The results still stand when both upstream and downstream shocks are put into one regression, as in column 3 and 6.

In column 7-9, we consider weighted indirect shocks. Specially, using input-output value information from I-O table, we calculate input/output share for each industry pair and construct weighted local export indirect shocks as follows:

$$\Delta IndirExpShock_{ct}^{j} = \sum_{k \neq j} \frac{1}{L_{c,t0}^{j}} \left[\omega_{jk} \left(\frac{L_{c,t0}^{k}}{L_{t0}^{k}} \Delta Export_{t}^{k} \right) \right] \tag{5}$$

where ω_{jk} represents either industry j's input share from industry k, or industry j's output share to industry k.

The input weighted results in column 7 and 9 are small in magnitude and insignificant as well, while the results for output weighted indirect shocks are negative and significant. This echos the findings in column 1-6, which also indicates a pronounced negative impact of downstream industries on markup changes. We use estimates from column 9 to quantify the effect of output-weighted downstream indirect shocks. The average of the output-weighted downstream indirect shocks is 1.77 million dollar per person, which translates into a 0.29 decrease in firm markups. This accounts for almost 80% of markup decreases caused by the average level of overall indirect exposures. Taken together, Table 3 offers convincing evidence that negative impacts of local indirect export shocks in the baseline results are mainly driven by shocks from downstream industries.

4.3 Robustness checks

In Table 4, we perform several robustness checks on the baseline regression and the specification using input-output weighted export shocks in column 9 of Table 3. We start with alternative employment distribution. The indirect shocks in baseline regressions are constructed with 2000's employment share from ASIF as weights, which is the starting year of our analysis. To alleviate concerns for endogenous weighting, in column 1 and 2 of Table 4, we instead use 1998's ASIF employment share as weights for construction. The results remain similar. Column 3 and 4 further consider local exposure of net exports as in Helm (2020) instead of exports alone.[14] The impact of net export exposure is still negative and significant at 10% level. And in column 4, the effect is also more pronounced for output weighted indirect shocks. Column 5 and column 6 predict export flows with country-pair trade flows and tariffs. Then predicted export flows are aggregated. The results using this way of prediction lead to similar results as in the baseline.

5 Mechanism testing and heterogeneity analysis

5.1 Mechanisms

How indirect local export shocks affect markups through input-output linkages? Why indirect export shocks from downstream industries in the local market have a significantly stronger impact? In the introduction, we lay out the *Demand* and *Supply* side factors that can make indirect local export exposures affect markup changes. Among all the channels discussed, the "indirect pro-competitive" channel and "competition for local intermediate inputs" channel can lead to decreased markups by indirect local export shocks from local downstream industries.

The "indirect pro-competitive" channel states that export demand increases in the downstream industries would indirectly boost the demand for outputs in upstream industries. This could potentially intensify competitions as incumbent firms might try to capture a larger market share and more competitors might enter the market. To test the "indirect pro-competitive" channel, we construct the average markup in the prefecture-industry cell, excluding firm's own markup, to measure the markup level for local competitors. Then, the difference between 2000 and 2007 of the measure is taken and included as a control in the baseline regression. If competition exists in the local market, we expect to see a positive relationship between changes in firm's markup and its peers' average markups. If indirect

14. Imports are predicted with China's import tariffs. Predicted net exports are constructed as the difference between predicted exports and predicted imports.

local export exposures influence firm markup changes through the competition channel, the inclusion of competitors' average markup would reduce the magnitude and significance of the coefficient on indirect local export exposures.

Column 1 of Table 5 reports the result for this regression. As is clear from column 1, the inclusion of competitors' average markups leads to a drop in both the magnitude and the significance of coefficient on the key variable, showing that the indirect local export exposure reduces markup levels through the competition channel. The coefficient on competitors' average markup is positive and significant, proving the existence of competition at the local market. We repeat the exercise with input and output weighted indirect export shocks, which gives similar results. Results in column 2 confirm the hypothesis that indirect exposure to downstream industries affect firm markup changes through intensified competitions.

We provide further evidence on the local market competition channel with two placebo tests in column 3 and 4. We create a variable that measures the difference in the average of markups for firms in the same industry but outside the prefecture with the firm. This captures markup changes of peers in relatively distant markets. The inclusion of this control in column 3 and 4 barely changes the magnitude or significance of coefficients on key explanatory variables. Additionally, average markup changes for firms inside the same industry but outside the prefecture have little effect on firm markup changes. All in all, column 1 to column 4 show that competition is more intensive at the local level, and local indirect export exposures exert an influence on markup changes through the competition channel.

A second potential channel at work is "competition for local intermediate inputs" channel. Industries located downstream relative to the firm might require inputs from more upstream industries as well. As a result, expansions in the output due to export shocks would lead to increased demand for more upstream inputs, causing increased input costs and thus lowered markups. To test this hypothesis, we interact indirect exposures with an input intensity measure, which is defined as the the share of intermediates inputs to the sum of intermediates and labor compensation. A higher input intensity implies that intermediates plays a larger role in the production process. Column 5 and 6 show results with interaction terms. The negative coefficients in column 5 suggest that indirect export exposure lead to larger markup decreases in high input intensity industries. When input intensity is interacted with input- and output-weighted indirect local export exposures respectively, the coefficients on interaction terms are both negative, but only significant for the output-weighted indirect shocks.

In addition to the two channels above, it is also possible that employment spillovers might change labor costs and thus markups. To see whether this is the case, we include firm's changes in firms' average wage as a control to see whether changes in labor cost is the potential channel. Results in column 1 and column 2 of Table 6 suggest that changes in average wage have little effect on markup changes, and inclusion of the control has no effect on baseline coefficients. An important feature of China's cross-region migration is the Hukou Policy. In Fan (2019), a destination-based prefecture-level Hukou Reform Index for year 1997-2010, where a larger value indicates higher probability for settling down. We calculate the difference of the index for each prefecture between year 2000 and 2007 to reflect Hukou policy changes, and then interact it with indirect shocks to check whether labor pooling effect exists in prefectures with different levels of Hukou policy stringency. The coefficients on interaction terms in column 3 and 4 are not significant, providing further evidence that labor flows induced by indirect export shocks are not responsible for markup changes.

Previous literature suggests a labor pooling effect brought about by export expansions. Helm (2020) show that increased indirect local export exposures would cause labor inflows into local labor market, leading to more labor supply. There is also similar findings in China. Facchini et al. (2019) studies how China's integration into the world economy affects its internal migration. They find that if a region experienced declines in export uncertainty, then it would attract "non-hukou" migrants into the region. However, those papers have little evidence on how wages are affect by such export expansion shocks. It is possible that labor demand and labor supply both shifted outside due to indirect local export shocks, leaving relative wages levels unchanged.

5.2 Heterogeneity analysis

Another exercise we look at is how the effects of indirect export shocks vary over different subsamples. The results are presented in panel A and panel B of Table 7. In column 1 and 2, we consider firms with initial output level below or above the industry medians. The results indicate that indirect local export shocks only significantly and negatively affect markups of the below-median firms. Column 3 and 4 examine subsamples below and above the initial total factor productivity (TFP) industry median, which shows that the below-median subsample is driving the baseline result. These results echo the "indirect pro-competitive" channel examined in Table 5, as smaller and low-productivity firms have less market power and might be subject to more competitions with peers. Another possible explanation is that larger and more productive firms have greater capacity to source from more distant suppliers, making them comparatively less reliant on the local production networks.

Column 5 and 6 further split firms into exporters and non-exporters, which shows that the effect is more pronounced for non-exporters. These results provide evidence that trade liberalization can indirectly influence performances of non-exporters through local production networks. Exporters are more involved with foreign markets, it is likely that they source their inputs from and sell their products to foreign partners. Thus, they are less affected by indirect local shocks.

6 Evidence at the industry level

The empirical results above provide comprehensive evidence on the impact of indirect local export exposures on within-firm markup adjustments. A natural question to ask is whether this pattern still holds true at a more aggregate level. One may also wonder, in addition to within-firm adjustments, does other margins, such as firms' entry and exist play a role as well? We answer those questions in this section.

We start by taking the simple average of markups at the prefecture-industry level, and use the 2000-2007 difference as the outcome variable. The result is in column 1 of Table 8, which also displays a negative and significant effect of indirect exposure on markup changes. Column 2 uses changes in the average of prefecture-industry markups weighted by initial output values as the outcome variable. The coefficient on indirect local export exposure is still negative but insignificant. This is consistent with the heterogeneity analysis since lower output firms are responsible for the negative effect. When firms of larger output are given more importance, the effect on overall indirect export exposures becomes insignificant. Column 3 to 5 consider markup changes for firms with markups at 25, 50, and 75 percentile respectively. The results suggest that markups at different percentiles decrease in response to indirect shocks; but the effect is less significant and smaller in magnitude for 75th percentile, which are also the largest firms.

We perform a decomposition with the method used in Brandt et al. (2017). The decomposition equation is as follows:

$$\Delta M_{ckt} = \sum_{i\in C} \Big(\overline{s}_i \Delta M + \Delta s_{it}\left[\overline{M}_i - M_{ck,t-1}\right]\Big) + \sum_{i\in E} s_{it}\left[M_{it} - M_{ck,t-1}\right] - \sum_{i\in X} s_{i,t-1}\left[M_{i,t-1} - M_{ck,t-1}\right] \tag{6}$$

with C, E and X representing continuing, newly entering and exiting firms in the prefecture-industry cell ck. ΔM_{ckt} is the change in output-weighted average markups, and it is decomposed into four parts. The first is within-firm adjustments that resemble firm-level regressions we study in previous sections. The second is the between-term effect that captures changes in firms' output share. It will lead to higher ΔM_{ckt} if firms with higher markups increase its output during 2000-2007. The third term is the entry term that shows how entrants of different markup levels can affect overall prefecture-industry markup changes. The fourth is the exit term measuring exiters' impact. It will increase if a large share of low markup firms exit the market.

Table 9 presents the results with different decomposition terms as outcome variables. The effect of indirect exposures on output-weighted markup changes is negative yet insignificant. Among the four terms, only the coefficient for within-firm adjustment term is significantly negative, consistent with firm-level regression results. Combining the results in mechanism testing, our results suggest that indirect local export exposure mainly leads to more within-firm adjustments through increased competition or competition for inputs. But such channels have little effect in changing the composition between high and low markup firms, drawing in low-markup new entrants, or forcing out high-markup incumbents.

7 Conclusion

This paper investigates how exposure to export shocks can propagate through local production networks. Following Helm (2020), we construct indirect local export shocks at the prefecture-industry level. Combining this with markups constructed from De Loecker et al. (2016), we show that indirect export shocks lead to decreases in firm markups. In particular, indirect shocks from downstream industries are driving the pattern in the baseline results. Further analysis for the channels suggests that increased competition and increased input demand can explain the negative responses of markups to indirect local export exposures. Markups have been rising overtime in China in past several decades, indicating the trend for less competition and more market concentration. Indirect exposure to the global economy can slow down this process to some degree.

These results have important economic and policy implications. Many developing countries consider a path for economic growth through more participation into the global markets. However, direct exposure to the foreign market only consists of a modest share in the whole economy for most countries. Therefore, policy makers should take into account the indirect shocks brought about by trade liberalization. Additionally, many developing countries lack highly efficient infrastructure such as expressways and high-speed rails, making sourcing from distant locations rather difficult. In this case, trade shocks are likely to propagate in the local economy. Understanding the magnitude and channels of those impacts can help policy makers design trade and industrial policies to better promote economic growth.

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Figures and Tables

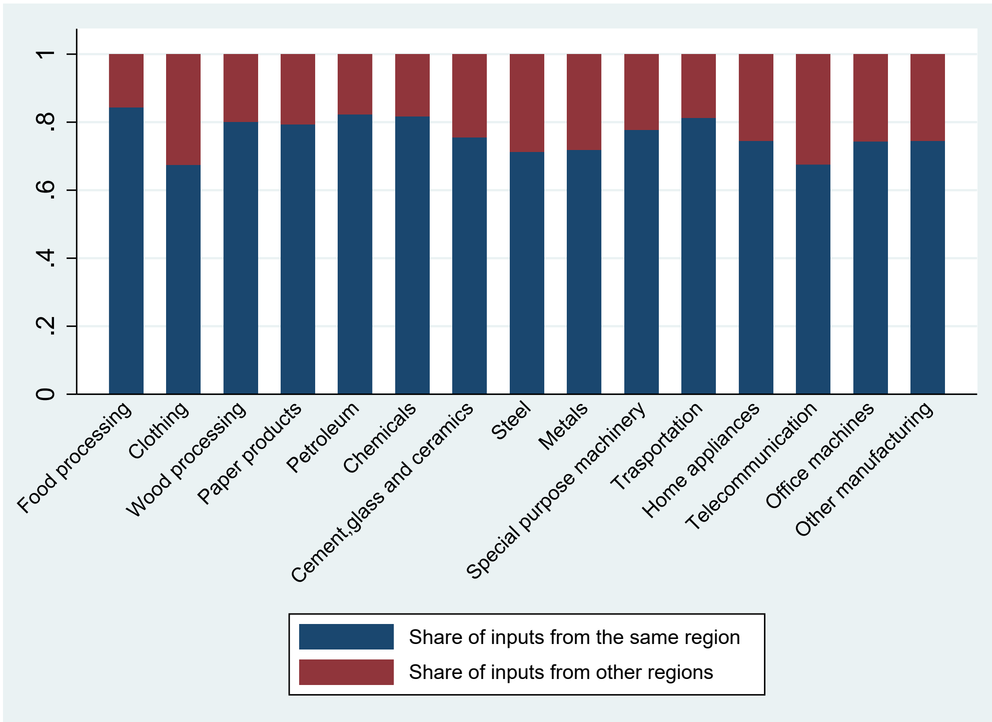

FIGURE 1 The share of inputs from the same/other regions

Notes: This figure shows the average share of inputs sourced from the same or other regions for 15 manufacturing industries. Data from China's 2002 input output table for 30 regions and 21 sectors.

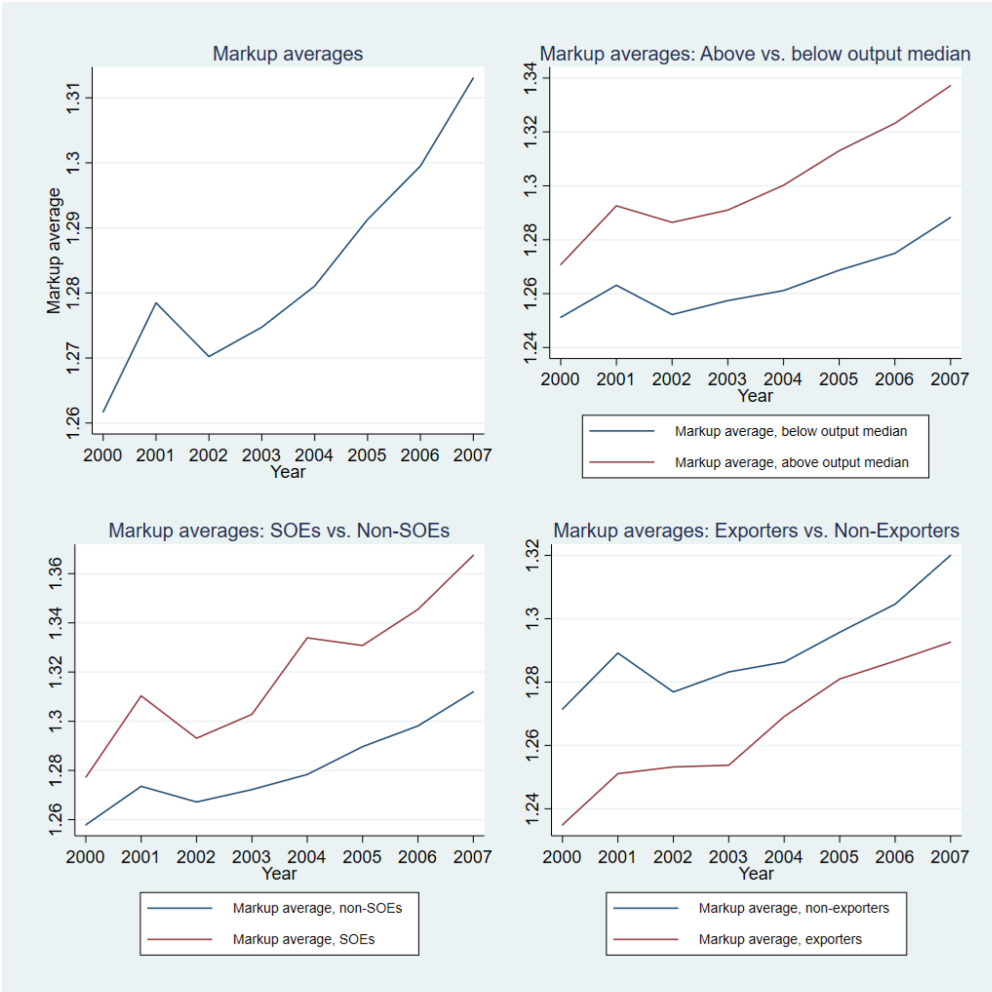

FIGURE 2

Average markup changes over time

Notes: This figure shows changes in average markups from 2000 to 2007. The upper left panel shows the changes in overall markup averages. The upper right panel displays average markup changes for firms above or below industry output median. The lower left panel shows average markup changes for SOE vs. non-SOE firms. The lower right panel shows average markup changes for exporters vs. non-exporters.

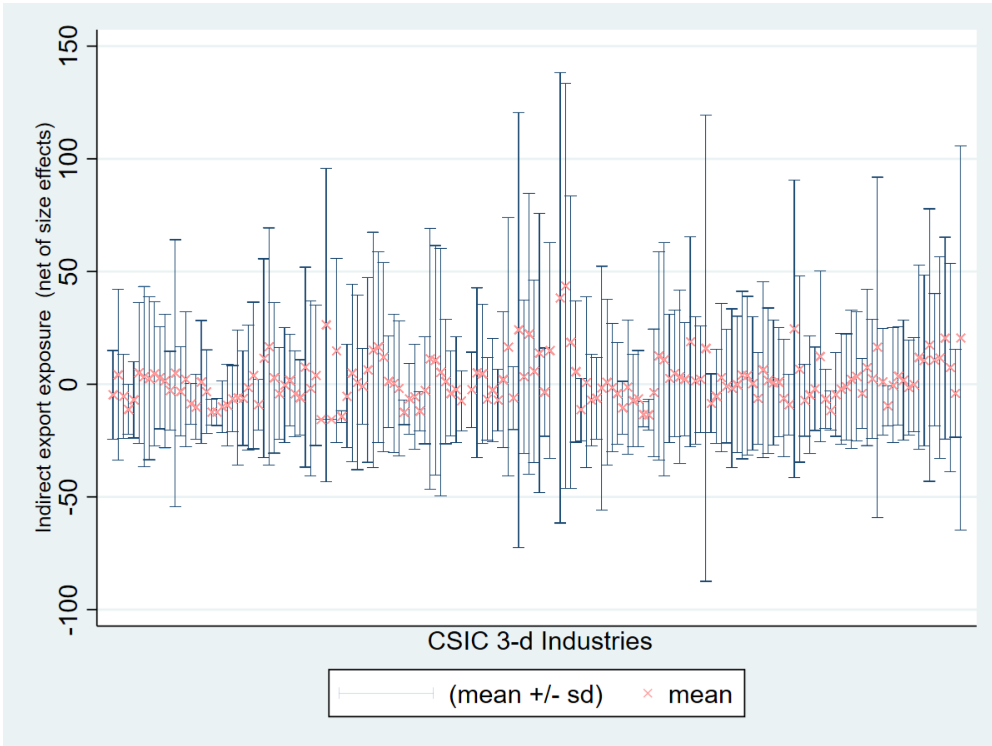

FIGURE 3

Indirect export exposure changes, net of size effects

Notes: This figure shows the mean and standard deviations of the residuals of a regression of indirect export exposure changes on initial local employment share at CSIC 3-d industry level from 2000 to 2007.

TABLE 1

Summary Statistics, 2000-2007

Variable names	Mean (1)	S.D. (2)	Min. (3)	Max (4)	Obs. (5)
Firm's markup changes	0.053	0.365	-5.434	4.693	55351
Indirect export exposure changes					
Indirect export exposure, Wgt. avg. AHS	3.594	6.185	0.000	51.527	55351
Indirect export exposure, upstream	1.127	2.246	0.000	20.605	55033
Indirect export exposure, downstream	2.144	3.682	0.000	30.032	55075
Indirect export exposure, upstream IO	1.445	2.821	0.000	26.071	55113
Indirect export exposure, downstream IO	1.699	3.069	0.000	23.570	54954
Indirect export exposure, input weighted	1.046	1.900	0.000	18.131	55094
Indirect export exposure, output weighted	1.774	3.205	0.000	25.279	54486
Indirect export exposure, 1998 weight	3.457	5.933	0.000	52.227	54963
Indirect net export exposure	2.864	4.902	-4.499	40.810	55259
Indirect export exposure, c.c gravity	2.278	3.793	0.000	33.996	55311
Firm characteristics					
Markups, 2000	1.265	2.664	0.092	6.617	55351
Log of output value, 2000	10.169	1.228	1.392	17.432	55351
Average wages, 2000	2.221	0.791	-8.732	8.728	55349
Log of export value, 2000	3.337	4.643	0.000	16.054	55351
TFP, 2000	3.961	1.154	-2.13	9.581	55351
Average wage changes, 2000-2007	0.738	2.626	-13.638	17.328	55350
Prefecture-industry variables in 2000					
Log of output value	13.260	2.029	0.000	17.961	55351
Herfindahl-Hirschman Index (HHI)	0.254	0.253	0.000	1.000	55069
Local employment share	0.033	0.054	0.000	0.755	55351
Share of SOE firms	0.173	0.225	0.000	1.000	55351
Share of exporters	0.300	0.292	0.000	1.000	55351
Share of high-skill workers	0.040	0.047	0.000	1.000	55351
Share of middle-skill workers	0.425	0.148	0.000	1.000	55351
Share of female workers	0.428	0.184	0.000	0.952	55351
Prefecture-level variable					
Hukou reform index changes, 2000-2007	1.703	1.550	0.000	6.000	55337
Industry-level variable					
Average wage changes, 2000-2007	11.742	5.104	3.652	29.279	55351

Notes: This table reports summary statistics for markups changes, indirect export exposure changes and other related variables in regression analysis. Indirect export exposure changes are in million dollar per worker. Firm level average wage is computed by (wagebill/employment). TFP is estimated following Olley and Pakes (1996). The sample contains 55351 firms from 160 CSIC-3d manufacturing industries and 327 prefecture-level administrative units.

TABLE 2

Baseline Results

	No controls	Pref-Ind controls			Pref-Ind+Firm controls
	(1)	(2)	(3)	(4)	(5)
	Markup diff.	Markup diff.	Markup diff.	Markup diff.	Markup diff.
Indirect local export exposure	-0.078**	-0.120**	-0.137**	-0.126**	-0.099**
	(0.039)	(0.053)	(0.054)	(0.053)	(0.049)
ln initial output		-0.583***	-0.722***	-0.655***	-0.330*
		(0.222)	(0.235)	(0.233)	(0.194)
Initial HHI		-1.027	-0.590	-0.324	0.083
		(1.000)	(1.011)	(1.027)	(0.820)
Initial employment share		11.989*	13.743**	12.916**	9.778**
		(6.318)	(6.345)	(6.271)	(4.157)
Initial SOE share			-4.152***	-3.928***	-3.122***
			(1.330)	(1.310)	(0.926)
Initial exporter share			-0.443	-0.665	-1.408
			(1.012)	(1.064)	(1.202)
Initial high skill employment share				-7.139	12.139**
				(7.355)	(5.956)
Initial mid skill employment share				-2.234	-0.545
				(2.335)	(1.819)
Initial female share				4.026	4.794**
				(2.557)	(2.168)
Initial firm markups					-0.841***
					(0.011)
Initial firm output					-0.043
					(0.167)
Initial firm wage					0.581
					(0.371)
Initial export level					-0.031
					(0.064)
Prefecture FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Observations	55351	55069	55069	55069	55067
R^2	0.046	0.046	0.047	0.047	0.386

Notes: Standard errors are clustered at prefecture level; ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The dependent variable is the changes in firm-level markups between 2000 and 2007. Estimation is by OLS.

TABLE 3

Export shocks through input-output linkages

	upstreamness measure			IO table			Input-output weighted		
	(1) Markup diff.	(2) Markup diff.	(3) Markup diff.	(4) Markup diff.	(5) Markup diff.	(6) Markup diff.	(7) Markup diff.	(8) Markup diff.	(9) Markup diff.
Indirect local export exposure,upstream	0.029		0.112						
	(0.082)		(0.089)						
Indirect local export exposure,downstream		-0.227***	-0.283***						
		(0.074)	(0.076)						
Indirect local export exposure, upstream IO				-0.040		-0.066			
				(0.069)		(0.071)			
Indirect local export exposure, downstream IO					-0.219***	-0.220***			
					(0.083)	(0.085)			
Indirect local export exposure, input weighted							-0.097		-0.080
							(0.118)		(0.134)
Indirect local export exposure, output weighted								-0.159**	-0.164**
								(0.071)	(0.076)
Prefecture-industry controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	55168	54946	54473	55202	54940	54432	55204	54544	54067
R^2	0.386	0.385	0.387	0.386	0.385	0.386	0.385	0.389	0.388

Notes: Standard errors are clustered at prefecture level; ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The dependent variable is the changes in firm-level markups between 2000 and 2007. Prefecture-industry controls include initial output, initial HHI, initial employment share, initial SOE share, initial exporter share, initial highskill labor share, initial middle skill labor share, initial female labor share. Firm controls include initial firm markups, initial firm output, initial firm wage and initial firm export level. Estimation is by OLS.

TABLE 4

Robustness checks

	1998 weight		Net export shocks		CC. pred.	
	(1) Markup diff.	(2) Markup diff.	(3) Markup diff.	(4) Markup diff.	(5) Markup diff.	(6) Markup diff.
Indirect local export exposure,1998 weight	-0.091***					
	(0.032)					
Indirect local export exposure, input weighted/1998		-0.034				
		(0.100)				
Indirect local export exposure, output weighted/1998		-0.140***				
		(0.052)				
Indirect local net export exposure			-0.113*			
			(0.065)			
Indirect local export exposure, net/input weighted				-0.005		
				(0.170)		
Indirect local export exposure, net/output weighted				-0.207**		
				(0.086)		
Indirect local export exposure, cc					-0.145**	
					(0.072)	
Indirect local export exposure, cc/input weighted						-0.163
						(0.168)
Indirect local export exposure, cc/output weighted						-0.309***
						(0.110)
Prefecture-industry controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	55213	54292	55001	53936	55141	54163
R^2	0.387	0.389	0.386	0.389	0.385	0.387

Notes: Standard errors are clustered at prefecture level; ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The dependent variable is the changes in firm-level markups between 2000 and 2007. Prefecture-industry controls include initial output, initial HHI, initial employment share, initial SOE share, initial exporter share, initial highskill labor share, initial middle skill labor share, initial female labor share. Firm controls include initial firm markups, initial firm output, initial firm wage and initial firm export level. Estimation is by OLS.

TABLE 5

Test for mechanisms

	Within-industry competition				Input intensity	
	(1) Markup diff.	(2) Markup diff.	(3) Markup diff.	(4) Markup diff.	(5) Markup diff.	(6) Markup diff.
Indirect local export exposure	-0.086		-0.099**		0.041	
	(0.053)		(0.049)		(0.083)	
Indirect local export exposure, input weighted		-0.126		-0.080		0.028
		(0.150)		(0.134)		(0.291)
Indirect local export exposure, output weighted		-0.096		-0.164**		0.143
		(0.077)		(0.076)		(0.178)
Change in averge markups,pref-ind	0.074***	0.073***				
	(0.017)	(0.017)				
Change in averge ind. markups, outside pref.			-0.027	0.001		
			(0.096)	(0.093)		
Indirect local export exposure × Industry input intensity					-0.012**	
					(0.005)	
Indirect local export exposure, input weighted × Industry input intensity						-0.011
						(0.017)
Indirect local export exposure, output weighted × Industry input intensity						-0.025**
						(0.012)
Prefecture-industry controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	52437	51605	55067	54067	55067	54067
R^2	0.388	0.390	0.386	0.388	0.387	0.388

Notes: Standard errors are clustered at prefecture level; ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The dependent variable is the changes in firm-level markups between 2000 and 2007. Prefecture-industry controls include initial output, initial HHI, initial employment share, initial SOE share, initial exporter share, initial highskill labor share, initial middle skill labor share, initial female labor share. Firm controls include initial firm markups, initial firm output, initial firm wage and initial firm export level. Estimation is by OLS.

TABLE 6

Test for mechanisms: labor pooling channel

	(1) Markup diff.	(2) Markup diff.	(3) Markup diff.	(4) Markup diff.
Indirect local export exposure	-0.099**		-0.074	
	(0.049)		(0.067)	
Indirect local export exposure, input weighted		-0.080		0.012
		(0.134)		(0.196)
Indirect local export exposure, output weighted		-0.164**		-0.178
		(0.076)		(0.123)
Changes in average wage	0.058	0.046		
	(0.071)	(0.069)		
Indirect local export exposure × Hukou Policy Index			-0.012	
			(0.020)	
Indirect local export exposure, input weighted × Hukou Policy Index				-0.046
				(0.053)
Indirect local export exposure, output weighted × Hukou Policy Index				0.006
				(0.039)
Prefecture-industry controls	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	55066	54066	55053	54053
R^2	0.386	0.388	0.386	0.388

Notes: Standard errors are clustered at prefecture level; ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The dependent variable is the changes in firm-level markups between 2000 and 2007. Prefecture-industry controls include initial output, initial HHI, initial employment share, initial SOE share, initial exporter share, initial highskill labor share, initial middle skill labor share, initial female labor share. Firm controls include initial firm markups, initial firm output, initial firm wage and initial firm export level. Estimation is by OLS.

TABLE 7
Heterogeneity analysis

	Output		TFP		Export	
	(1) Below Med.	(2) Above Med.	(3) Below Med.	(4) Above Med.	(5) Non-Exp.	(6) Exp.
Panel A: Indirect local export exposure						
Indirect local export exposure	-0.203***	-0.017	-0.171***	-0.018	-0.162***	0.046
	(0.056)	(0.063)	(0.056)	(0.056)	(0.042)	(0.091)
Observations	24950	30103	25320	29732	43989	11033
R^2	0.411	0.385	0.386	0.412	0.401	0.378
Panel B: Input and output weighted indirect local export exposure						
Indirect local export exposure, input weighted	-0.318**	0.052	-0.139	-0.001	-0.144	0.192
	(0.128)	(0.207)	(0.157)	(0.170)	(0.133)	(0.318)
Indirect local export exposure, output weighted	-0.245**	-0.066	-0.291***	-0.021	-0.192**	-0.102
	(0.110)	(0.082)	(0.108)	(0.085)	(0.084)	(0.122)
Observations	24456	29594	24840	29209	43193	10831
R^2	0.412	0.386	0.386	0.415	0.402	0.384
Prefecture-industry controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors are clustered at prefecture level; ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The dependent variable is the changes in firm-level markups between 2000 and 2007. Prefecture-industry controls include initial output, initial HHI, initial employment share, initial SOE share, initial exporter share, initial highskill labor share, initial middle skill labor share, initial female labor share. Firm controls include initial firm markups, initial firm output, initial firm wage and initial firm export level. Estimation is by OLS.

TABLE 8
Industry-level evidence

	Averge	Wgt Average	p25	p50	p75
	(1) Markup diff.	(2) Markup diff.	(3) Markup diff.	(4) Markup diff.	(5) Markup diff.
Indirect local export exposure	-0.085**	-0.062	-0.111***	-0.084**	-0.073
	(0.040)	(0.040)	(0.037)	(0.039)	(0.056)
Prefecture-industry controls	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Observations	17268	17268	17268	17268	17268
R^2	0.120	0.105	0.119	0.119	0.101

Notes: Standard errors are clustered at prefecture level; ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The dependent variable is the changes in prefecture-industry level markups between 2000 and 2007. Prefecture-industry controls include initial output, initial HHI, initial employment share, initial SOE share, initial exporter share, initial highskill labor share, initial middle skill labor share, initial female labor share. Estimation is by OLS.

TABLE 9

Industry-level decomposition

	Overall	Within	Between	Entry	Exit
	(1)	(2)	(3)	(4)	(5)
	Markup diff.	Markup diff.	Markup diff.	Markup diff.	Markup diff.
Indirect local export exposure	-0.062	-0.065**	-0.002	0.006	-0.000
	(0.040)	(0.026)	(0.008)	(0.033)	(0.005)
Prefecture-industry controls	Yes	Yes	Yes	Yes	Yes
Prefecture FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Observations	17268	17268	17268	17268	17268
R^2	0.105	0.068	0.051	0.091	0.030

Notes: Standard errors are clustered at prefecture level; ***, **, and * denote significance at the 1%, 5%, and 10% levels respectively. The dependent variable is the decomposition for changes in prefecture-industry level markups between 2000 and 2007. Prefecture-industry controls include initial output, initial HHI, initial employment share, initial SOE share, initial exporter share, initial highskill labor share, initial middle skill labor share, initial female labor share. Estimation is by OLS.

Online Appendix

A Background: China's accession to WTO

A dominant feature of China's economy over the past several decades is its rising role in global trade. Trade liberalization in China accelerated in two waves. The first occurred in the late 1980s and early 1990s, when China made a concerted effort to join the World Trade Organization (WTO). In 1986, China became an observer in the General Agreement on Tariffs and Trade (GATT), the WTO's predecessor, and initiated the process of rejoining the organization after a hiatus of nearly 40 years. After 15 years prolonged negotiations, China finally entered the WTO on November 10, 2001. Meanwhile, in 1992, Deng Xiaoping proposed an open policy and economic reform during a tour to southern China. Since then, a great number of liberalization policies have been adopted, which boosted exports from 62 billion USD in 1990 to 248 billion USD in 2000. The second wave which followed China's accession into the WTO in 2001, was more dramatic and abrupt, with an increase in exports from 248 billion USD in 2000 to 1577 billion USD in 2010. In 2014, China accounted for more than 12% of all world exports, with a nominal exports growth rate of about 17% during the last two decades.

To fulfill its commitment to the WTO, China reduced its tariffs significantly, from 35% in 1994 to 17% in 1997. After joining WTO, average tariff rates were further reduced to 15% for agricultural goods and 8.9% for manufacturing goods. At the same time, China benefited from the lower import tariff rates of their trading partners after joining the WTO. Since the formation of the GATT in 1947, eight rounds of trade negotiations have taken place, mainly to lower import tariffs. By the mid-1990s, import tariff rates on manufacturing goods fell to less than 4% for industrial countries. The WTO stipulates that countries cannot discriminate between trading partners. If a special favor is given to one trading partner, it must be given to all WTO members, which is referred as Most Favored Nation (MFN) treatment. In addition to MFN tariff rates, there are bound tariff rates, which are the maximum tariff levels a country can impose on another WTO member country. Prior to entering the WTO, many developed countries had already granted China their MFN rate on an annual basis. Joining the WTO made China's NTR status permanent, eliminating potential uncertainties in tariff rates (Pierce and Schott, 2016). The weighted average of effectively applied tariff rates (AHS) imposed on Chinese manufacturing exports was 8.7% in 1990 and dropped to about 3.7% in 2010.4 Previous studies have exploited the setting of China's WTO accession to examine the effect of trade liberalization on various socioeconomic outcomes.[15]

15. See Lu et al. (2013); Fan et al. (2015); Lu and Yu (2015)

Tables

TABLE A1

Markup changes by Industry

Industry code	Markup diff. p5	Markup diff. p25	Markup diff. p50	Markup diff. p75	Markup diff. p95	Markup diff. mean	Number of firms
13	-29.923	-3.46	9.867	24.685	55.196	10.933	2943
14	-45.154	-11.337	3.038	17.606	60.637	5.503	1273
15	-41.862	-9.22	4.69	22.953	86.373	11.44	1056
16	-68.825	-7.469	34.891	69.338	135.705	29.47	72
17	-27.893	-6.66	4.11	14.883	41.737	4.849	4587
18	-31.236	-4.904	7.374	21.919	67.356	10.457	2557
19	-24.353	-2.651	9.714	23.97	61.639	12.912	1267
20	-33.987	-7.653	4.291	17.038	46.556	5.099	675
21	-37.429	-9.494	3.018	13.637	42.504	2.606	519
22	-31.332	-8.569	2.641	13.96	41.157	3.397	1763
23	-49.84	-13.055	1.612	16.884	48.217	.784	1159
24	-35.225	-6.428	4.039	16.1	55.626	7.183	766
25	-39.527	-11.171	1.807	14.18	40.003	.557	314
26	-33.408	-8.21	3.93	17.079	52.978	5.336	4683
27	-63.76	-10.587	4.482	22.087	81.957	5.701	1085
28	-74.622	-17.694	10.977	43.603	88.407	11.869	252
29	-34.665	-8.008	3.982	16.323	56.529	5.557	715
30	-37.68	-11.47	1.263	13.902	45.164	1.567	2243
31	-40.471	-10.678	2.782	16.133	47.481	2.678	5459
32	-31.387	-9.798	1.362	10.668	42.75	2.448	1073
33	-33.04	-5.992	5.23	16.656	46.132	5.792	928
34	-42.087	-9.178	2.527	13.572	49.5	3.036	2626
35	-36.859	-8.69	3.595	16.591	49.647	4.525	4606
36	-41.884	-9.899	2.875	17.697	66.84	6.5	2218
37	-43.866	-10.084	3.153	16.162	52.01	3.798	2953
39	-35.75	-8.302	2.703	14.109	48.869	3.703	3749
40	-47.285	-12.822	.585	15.773	69.671	4.406	1888
41	-41.779	-9.801	5.14	19.631	74.398	7.177	909
42	-31.622	-4.555	7.859	21.288	61.363	10.645	1021

Notes: This table presents present markup changes between 2000 and 2007 at different percentiles for each 2-digit industry.

TABLE A2

Markup changes by province

Province id	Markup diff. p5	Markup diff. p25	Markup diff. p50	Markup diff. p75	Markup diff. p95	Markup diff. mean	Number of firms
11	-99.806	-26.707	-7.628	10.151	54.256	-11.888	1174
12	-50.722	-11.85	2.599	17.256	75.236	3.849	1390
13	-50.462	-14.219	.64	12.827	42.572	-1.307	2231
14	-39.272	-13.552	-.55	12.706	52.888	1.964	657
15	-44.905	-7.819	8.379	29.087	65.548	9.719	379
21	-43.295	-7.709	8.806	23.484	60.62	8.102	1949
22	-67.265	-12.701	5.653	24.348	70.08	6.287	526
23	-50.954	-14.645	2.819	20.203	57.998	3.671	528
31	-47.848	-13.038	3.18	20.302	76.288	6.034	3636
32	-29.513	-6.677	3.531	13.641	39.013	3.469	8181
33	-24.711	-6.812	2.23	10.803	31.186	2.355	7543
34	-37.581	-6.799	8.033	22.74	54.502	9.26	1235
35	-42.087	-10.75	4.1	20.265	52.355	4.413	2772
36	-33.58	-1.724	12.275	26.266	50.634	9.478	605
37	-25.767	-7.147	4.606	17.95	50.079	7.696	4472
41	-47.322	-8.523	5.904	20.142	79.185	7.844	2507
42	-46.479	-11.697	5.205	20.482	66.568	6.175	1627
43	-25.514	-2.414	10.475	24.516	57.243	12.388	1192
44	-31.821	-7.618	3.691	16.257	59.723	7.69	7260
45	-28.072	-4.006	9.099	25.711	69.906	14.26	662
46	-30.089	-7.981	4.351	19.378	54.757	7.164	116
50	-48.858	-8.452	6.186	21.032	47.979	3.696	675
51	-41.601	-4.956	12.075	29.593	83.326	14.318	1628
52	-51.052	-18.139	-5.291	13.813	54.543	-.039	397
53	-48.123	-19.717	-2.637	12.328	53.79	-1.644	606
54	-207.464	-24.691	-13.468	25.483	172.469	-10.804	13
61	-25.63	-3.872	9.83	24.85	68.093	15.071	669
62	-64.738	-16.567	5.236	22.645	65.045	5.132	324
63	-58.893	-8.882	5.042	25.905	91.017	5.734	64
64	-62.141	-13.89	2.331	20.935	36.869	1.555	115
65	-36.121	-14.334	-.951	15.366	60.497	2.134	226

Notes: This table presents present markup changes between 2000 and 2007 at different percentiles for each province.

Alternative approach to predict export exposure

We further apply a cross-country regression by exploiting the variations in tariffs and bilateral trade flows

$$\ln X_{dt}^{k} = \beta_{CC} \ln(1 + Tariff_{dt}^{k}) + \alpha_k + \alpha_{dt} + \epsilon_{dt}^{k} \tag{7}$$

where X_{dt}^{k} is China's export value in industry k to destination d in year t. $Tariff_{dt}^{k}$ is the import tariffs on goods in industry k imposed by country d. α_k is industry fixed effect and α_{dt} is importer-year fixed effect. ϵ_{dt}^{k} is an error term.

The predicted export demand at the national-industry level is such that

$$\widehat{X}_{t}^{k} = \sum_{d} \exp(\hat{\beta}_{CC} \ln(1 + Tariff_{dt}^{k}) + \hat{\alpha}_k + \hat{\alpha}_{dt})$$

The results are reported in Table A3 the estimated coefficients are smaller than those in the baseline but are still within the range of gravity estimates.

TABLE A3

Exports and tariffs

	CSIC 3-d×Year			Importer×CSIC 3-digit×Year	
	Wgt. Avg. (1)	Sim. Avg. (2)	MFN (3)	AHS; Wgt. Avg (4)	AHS; Sim. Avg. (5)
$\ln(1+Tariff)$	-5.263***	-5.008***	-5.343***	-1.673***	-2.354***
	(0.716)	(0.745)	(0.711)	(0.249)	(0.306)
	No	No	No	No	No
Year FE	Yes	Yes	Yes	No	No
Industry FE	Yes	Yes	Yes	No	No
Importer-Year FE	No	No	No	Yes	Yes
Observations	1,644	1,644	1,644	146,773	146,773
R^2	0.969	0.969	0.969	0.756	0.757

Notes: This table reports the impact of tariffs on exports. The dependent variables in Column 1-3 are China's export values at the CSIC-3d level, and the dependent variables in Column 4-5 are China's export values at the importer-CSIC 3d level. Standard errors are clustered at the prefecture level and ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.