Wage Markdowns and FDI Liberalization*

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Abstract

This paper examines whether liberalization of inward foreign direct investment (FDI) reduces firms' monopsony power in labor markets. We estimate firm-level wage markdown, wage over marginal revenue of labor, from China's production data and identify the causal effect of FDI liberalization on wage markdown, using China's regulation changes upon its accession to the World Trade Organization. Large and productive firms, state-owned firms, exporters, and foreign firms exercise less monopsony power. FDI liberalization increased monopsony power and decreased labor share in value-added. These findings are contrast to classical theory based on concentration but consistent with modern theory based on search frictions.

Keywords: Foreign direct investment, Monopsony, Wage, Search, Firm heterogeneity

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1 Introduction

Globalization has the potential to limit firms' market power by increasing competition. Liberalization of imports increases competition among sellers in goods markets, and liberalization of inward foreign direct investment (FDI) increases competition among buyers in factor markets. Although trade and FDI have played equally important roles in globalization, the trade literature has almost exclusively investigated the competition effect of trade liberalization on goods markets.[1][2] The competition effect of FDI liberalization on factor markets has attracted relatively little attention.

This paper examines the competition effect of inward FDI liberalization on domestic firms' monopsony power in labor markets. Our study is motivated by recent research in labor economics highlighting firms' monopsony power in labor markets.[3] Employer concentration, worker's non-monetary preference for jobs and worker's search friction make labor supply curves to firms less elastic and allow firms to capture monopsonic rents by setting wages lower than the marginal revenue of labor (MRL). Wage markdown, the gap between wages and the MRL, determines not only the efficiency gains of FDI liberalization but also plays a crucial role in the distribution of the gains to local workers. When foreign firms enter, local firms lose their employees and their MRL increase. If wage markdown is constant as in standard models, the wages at local firms should increase as much as the MRL increases, but when wage markdown is variable, the wage increase could be larger or smaller than the MRL increases.

We develop an empirical framework for analyzing the effect of inward FDI liberalization on wage markdown at incumbent firms. We estimate firm-level wage markdown from Chinese manufacturing production data, using a method inspired by the price markup estimation by Hall (1988) and De Loecker and Warzynski (2012). Assuming that firms are price takers with respect to materials, we express wage markdown as a formula relating wage expenditure, material expenditure, the revenue (or output) elasticity of labor, and the revenue (or output) elasticity of materials. We obtain the input expenditures from data and the output and revenue elasticities by estimating gross output production functions in a recent non-parametric method by Ghandi, Navarro and Rivers

[1] For instance, during the 1990–2017 period, worldwide sales by foreign affiliates and worldwide exports have grown by roughly the same proportion (around 500%) (UNCTAD, 2018).

[2] See Tybout (2003), De Loecker and Goldberg (2014) and De Loecker and Van Biesebroeck (2016) for surveys of the literature.

[3] See, e.g., Manning (2003; 2011) and Ashenfelter, Farber and Ransom (2010) for surveys.

(2017). This method can be applied with typical production data available for many countries. We identify the causal effect of FDI liberalization on wage markdowns using variations in China's regulation on FDI inflow upon its accession to the World Trade Organization (WTO).

A main advantage of our framework is that it imposes no assumptions about labor market structure and the functional form of labor supply curves to individual firms. Such generality is crucial for our purpose. Theoretical predictions about the effect of FDI liberalization on wage markdowns are generally ambiguous and depend on labor market structures and the functional form of labor supply curves.[4] If one estimates wage markdown from a structural model, the choice of a specific model and specific functional forms might result in assuming the sign of FDI's competition effect *a priori*. Our framework can avoid that potential pitfall.

We apply our framework to firm-level Chinese manufacturing production data spanning 1998 to 2007. In that period, Chinese labor markets generally lacked institutions protecting workers from firms' monopsony power (Gallagher, Giles, Park and Wang, 2015). Employment without formal written contracts was common. Collective bargaining and strikes were prohibited. Workers often had to accept wages unilaterally set by employers. In 2008, right after our sample period, China introduced the Labor Contract Law which aimed to improve worker protection. The estimated wage markdowns are consistent with this background. First, employers ubiquitously exercise monopsony powers. In our sample, 75% of the firms set wage markdown smaller than one and the median wage markdown is 0.48. Second, firms known for offering well-paying jobs, or "good jobs" in China set larger wage markdown and exercise less monopsony power: in particular state-owned enterprises (SOEs), foreign-owned firms, and exporters. Finally, large markdowns (weak monopsony power) are associated with high productivity and large employment. Some of these patterns tend to contradict the concentration theory of monopsony according to which it is large firms that exercise monopsony power, but they are consistent with the search frictional theory whereby high productivity firms offer higher wages to attract more workers.

Our main contribution is to estimate the causal effect of FDI liberalization on wage markdowns. Following Lu, Tao and Zhu (2017), we utilize relaxation of China's regulations on FDI inflow upon its WTO accession at the end of 2001 where China liberalized 112 of its 424 four-digit manufac-

[4] In Appendix B, we consider three canonical models of labor monopsony and shows that the sign of FDI's competition effect on wage markdown depends on the choice of model and functional form.

turing industries. Following Topalova (2010) and Autor, Dorn and Hanson (2013), we map this industry-level FDI liberalization into Bartik-type prefecture-level exposure to FDI liberalization based on prefecture's initial employment across industries. We then conduct a simple difference-in-differences estimation of the impact of prefecture's exposure to FDI liberalization on firm-level wage markdowns with firm fixed effects and year fixed effects. To address potential endogeneity, we follow the recent literatures on Bartik approach (Adão, Kolesár and Morales, 2019; Borusyak, Hull and Jaravel, 2018; and Goldsmith-Pinkham, Sorkin and Swift, 2019) by carefully discussing the identification assumptions on (i) the exogeneity of the industry shares (the share exogeneity condition), and (ii) the exogenous industry shocks (the industry exogeneity condition).[5]

The estimation results are contrasting to the conventional wisdom. FDI liberalization induced the entry of foreign employers and enhanced competition among employers as expected. The conventional wisdom further predicts that wage markdowns at incumbent firms would then increase, by which the wage would be closer to the MRL, but instead wage markdowns actually decreased. In a prefecture with the mean level of exposure to FDI liberalization, incumbent firms reduced employment by 6.5% and increased MRL by 9.0%, as theory predicts. If wage markdown were constant as in traditional models, wages should have increased by the same 9.0%, but in fact wages did not change at all. The wage markdown therefore decreased by 9.0%. Statistics show that the average wage in China grew steadily during this period. Precisely speaking, firms in prefectures with high exposure to FDI liberalization increased wage at the same rate as firms in other prefectures, despite that the formers had labor shortage and increased MRL. Our findings suggest that the economic gain of FDI inflow distributed to local workers is substantially smaller than the prediction of traditional models featuring constant wage markdown.

The decrease in wage markdown after FDI liberalization also contributes to a decline in labor income share in manufacturing value-added. We decompose changes in labor income shares in value-added of each firm to changes in four components: wage markdowns, price markups, labor elasticity and value-added revenue share. Then, we estimate the impact of FDI liberalization on each component and calculate its impacts on labor income share in value-added of the manufacturing sector. At the individual firm-level, a firm in a prefecture with mean exposure to FDI liberalization reduced labor income share by 8.0%. In terms of relative contribution to decline in

[5]The Bartik shift-share design is valid if either of the two conditions is satisfied.

labor income share, the decrease in wage markdown accounts for 119% of the effect, while the increase in price markup accounts for 20%. This effect is attenuated by the changes in technology (labor elasticity and value-added revenue share), which account for -39% of the effect. At the aggregate level, FDI liberalization accounts for 30% of the decline in aggregate labor income share in the manufacturing sector during 2001–2007. The decrease in wage markdown accounts for 101% of the effect of FDI liberalization on the labor income share.

Finally, we provide a theoretical explanation for our two main findings that might appear puzzling: (i) large and productive firms set greater wage markdown; (ii) FDI liberalization decreased average wage markdown at incumbent firms. These two findings are contrast to a classical Cournot oligopsony model where employer concentration creates monopsony power, because FDI liberalization facilitates entry and weakens concentration. However, they are consistent with a canonical model of search frictional monopsony by Burdett and Mortensen (1998) where workers search on the job. Burdett and Mortensen (1998) already demonstrated that large and productive firms may set greater wage markdown to employ more workers and to earn profits from output markets. Our new finding is that when foreign firms with high productivity enter after FDI liberalization, the majority of domestic firms may expand their wage markdowns except for very high productive firms who can compete on wages with foreign firms. The intuition is that, when foreign firms enter, the labor supply elasticity to a domestic firm changes heterogeneously, depending on whether or not wage paid by the domestic firm is higher than that paid by foreign entrants. It is shown in the data that the majority of domestic firms pay much lower wages than foreign firms. Therefore, if these domestic firms increase their wage marginally, they would acquire only fewer workers than before because such a marginal wage increase is insufficient for attracting workers from foreign firms. In other words, these domestic firms now face less elastic labor supply curves and decrease wage markdown accordingly. On the other hand, for very productive firms that can pay as high wage as foreign entrants, a marginal wage increase can attract workers from foreign firms. Thus, these firms face more elastic labor supply curves and increase wage markdown. We have confirmed this prediction about the heterogeneous change in wage markdown. Our estimate suggests that the top 19% of firms in terms of initial TFP before liberalization reduced their wage markdowns, while other firms increased them.

Related Literature This paper contributes to the empirical literature on the effect of international competition on firm's market power. To our knowledge, our study is the first to empirically examine the effect of FDI liberalization on firm's monopsony power in labor markets. The literature has mostly focused on the impact of trade liberalization on price markups. Empirical studies using micro-level data include those of Levinsohn (1993), Harrison (1994), Krishna and Mitra (1998), Konings, Van Cayseele and Warzynksi (2001), Chen, Imbs and Scott (2009), De Loecker, Goldberg, Khandelwal and Pavcnik (2016), Brandt, Van Biesebroeck, Wang and Zhang (2017) and Feenstra and Weinstein (2017). Another strand of the literature conducts general equilibrium analyses such as those of Holmes, Hsu and Lee (2014), Edmond, Midrigan and Xu (2015), and Arkolakis, Costinot, Donaldson and Rodriguez-Clare (2018).

Among the above montioned studies, our study closely follows the spirit of De Loecker, Goldberg, Khandelwal and Pavcnik (2016) and Brandt, Van Biesebroeck, Wang and Zhang (2017) where the authors estimate price markups without imposing assumptions about market structure and functional forms and investigate the effect of import liberalization in India and China. De Loecker, Goldberg, Khandelwal and Pavcnik (2016) found that India's import liberalization of final goods decreased output price markups (after controlling for the effect of import liberalization of intermediate goods). Brandt, Van Biesebroeck, Wang and Zhang (2017) found that China's tariff reduction upon its WTO accession reduced the output markups. A current consensus in the literature seems that import liberalization decreased firm's market power in goods markets. In contrast, we found that FDI liberalization increased firm's market power in labor markets.

There is large literature about the impact of FDI on wage levels in host countries (see Javorcik, 2013 and Hale and Xu, 2016 for surveys). The literature commonly found that foreign firms paid higher wages than domestic firms (e.g., Aitken, Harrison and Lipsey, 1996; Heyman, Sjoholm and Tingvall, 2007). Several studies found the entry of foreign firms increased the wages paid by other firms in the labor market, including in China (e.g., Feenstra and Hanson, 1997; Hale and Long, 2011). Our focus is different. The question addressed in this paper is not whether wages increase or not, but whether wages increase as much as the MRL increases or not.

The paper is related to existing studies on imperfect competition in labor markets using production function estimates. Crépon, Desplatz and Mairesse (2005) and Dobbelaere (2004) estimate efficient bargaining models. Dobbelaere and Mairesse (2013) and Dobbelaere, Kiyota and

Mairesse (2015) also incorporate labor market monopsony. These studies classify the market structures of labor markets and output markets across industries and across groups of firms including exporters and multinational firms (Dobbelaere and Kiyota, 2018). As we will explain in section 2, there are two differences between their approach and ours. First, their measure of market imperfection non-linearly includes both output markup and wage markdown, while we measure only wage markdown. Second, their main focus is on the *existence* of monopsony power (or other forms of imperfection competition), while our focus is on the causal effect of FDI liberalization on the *degree* of monopsony power.

The current paper is related to recent research in labor economics estimating firm-level labor supply elasticities and monopsony power. Dal Bó, Finan and Rossi (2013), Falch (2010), Matsudaira (2014), Naidu, Nyarko and Wang (2016), and Staiger, Spetz and Phibbs (2010) estimate industry-level average markdowns. Naidu, Nyarko and Wang (2016) is the closest to the current paper. The authors analyze the impact of an expansion of immigrant workers' outside options on (industry-level) wage markdowns, while we examine the effect of increased competition among employers induced by FDI liberalization.

The rest of the paper is organized as follows. Section 2 presents our framework for examining the effect of FDI liberalization on wage markdowns. Section 3 discusses our data and China's FDI liberalization. Section 4 reports empirical results. Section 5 concludes the paper.

2 Empirical Framework

2.1 Wage Markdown Measurement

2.1.1 Setting

Firm j produces output Y_{jt} at time t with the gross production function:

$$Y_{jt} = F_{jt}\left(L_{jt}, K_{jt}, M_{jt}\right) \exp\left(\omega_{jt}\right) \tag{1}$$

where L_{jt} is labor, K_{jt} is capital, M_{jt} is materials and ω_{jt} is total factor productivity. The profit maximization problem with respect to labor can be expressed as:

$$\max_{L_{jt}} R_{jt}\left(Y_{jt}\right) - w_{jt}(L_{jt})L_{jt} \text{ s.t. (1)} \tag{2}$$

where $R_{jt}(Y_{jt}) = P_{jt}(Y_{jt})Y_{jt}$ is a firm's revenue as a function of its output Y_{jt}, $P_{jt}(Y_{jt})$ is an inverse demand function, and $w_{jt}(L_{jt})$ is the reduced form inverse labor supply function that the firm faces. The first order condition is

$$MRL_{jt} - w'_{jt}(L_{jt})L_{jt} - w_{jt} = 0.$$

where $MRL_{jt} \equiv \frac{\partial R_{jt}}{\partial Y_{jt}} \frac{\partial F_{jt}}{\partial L_{jt}}$ is the marginal revenue of labor (MRL). Then, wage markdown, the ratio of wage to the MRL, is obtained as

$$\eta_{jt} \equiv \frac{w_{jt}}{MRL_{jt}} = \frac{\varepsilon_{jt}}{\varepsilon_{jt}+1}. \tag{3}$$

where $\varepsilon_{jt} \equiv \frac{w_{jt}}{w'_{jt}(L_{jt})L_{jt}}$ is the elasticity of the labor supply curve that firm j faces.

The inverse labor supply $w_{jt}(L)$ expresses a tradeoff between wage and employment for an individual firm. Therefore, its elasticity varies across different labor market structures. In a perfectly competitive market, a firm faces a flat labor supply curve, $\varepsilon_{jt} = \infty$. Then the wage equals the MRL so that $\eta_{jt} = 1$. In a monopsonic labor market, a firm faces upward sloping labor supply curve and ε_{jt} is finite positive because even if a firm cuts its wage, it will not lose all employees for several reasons. One reason is that workers cannot switch to alternative employers either because of employer concentration (e.g. corporate towns) or search friction. Another reason is job differentiation. Some workers may have preference over the characteristics of jobs other than wage. Then, they would not leave the current jobs even if their wages are unilaterally decreased. Appendix B reviews canonical models of monopsony theories. With positive finite ε_{jt}, a firm sets its wage lower than the MRL so that $\eta_{jt} < 1$. Note that in our notation a smaller markdown η_{jt} expresses greater monopsony power.

Under certain labor market structures, elasticity ε_{jt} becomes even negative so that "wage markup" ($\eta_{jt} = 1/\left(1 + 1/\varepsilon_{jt}\right) > 1$) arises instead of wage markdown. An example is the Stole and Zwiebel (1996) model where a firm and an individual employee sequentially bargain in a de-

centralized way without being unionized.[6] In equilibrium, a worker and a firm share their surplus according the Shapley rule:

$$\beta MRL_{jt} = (1-\beta)\left(w_{jt} - w_{0t}\right),$$

where $\beta \in (0,1)$ is worker's surplus share representing worker's bargaining power and w_{0t} is workers' outside option (e.g., unemployment benefit). Stole and Zwiebel (1996) showed that since worker's portion βMRL_{jt} is decreasing in L_{jt}, wage $w_{jt}(L)$ is decreasing in L_{jt}, which implies $\varepsilon_{jt} < 0$ (Appendix A.1 reproduces its derivation).

2.1.2 Wage Markdown Measurement

We measure wage markdown under the following assumptions:

Assumption 1. *(A1) Material is a flexible input; (A2) Firm j is a price taker of material.*

Assumption 1 implies firm's profit maximization problem with respect to material becomes

$$\max_{M_{jt}} R_{jt}\left(Y_{jt}\right) - P_{jt}^{M} M_{jt} \text{ s.t. (1)} \tag{4}$$

where P_{jt}^{M} is the price of materials. From the first order condition,

$$\frac{\partial R_{jt}}{\partial Y_{jt}} \frac{\partial F_{jt}}{\partial M_{jt}} = P_{jt}^{M}, \tag{5}$$

the MRL is written as

$$MRL_{jt} \equiv \frac{\partial R_{jt}}{\partial Y_{jt}} \frac{\partial F_{jt}}{\partial L_{jt}} = P_{jt}^{M} \left(\frac{\partial F_{jt}}{\partial M_{jt}}\right)^{-1} \frac{\partial F_{jt}}{\partial L_{jt}}. \tag{6}$$

From (5) and (6), wage markdown η_{jt} can be simplified as

$$\eta_{jt} \equiv \frac{w_{jt}}{MRL_{jt}} = \left(\frac{w_{jt} L_{jt}}{P_{jt}^{M} M_{jt}}\right) \frac{\theta_{jt}^{M}}{\theta_{jt}^{L}} = \left(\frac{w_{jt} L_{jt}}{P_{jt}^{M} M_{jt}}\right) \frac{\tilde{\theta}_{jt}^{M}}{\tilde{\theta}_{jt}^{L}}, \tag{7}$$

[6] Helpman and Itskohi (2008) integrated Stole and Zwiebel (1996) with an international trade model with firm heterogeneity. Mortensen (2009, 2010) and Acemoglu and Hawkins (2014) integrated Stole and Zwiebel (1996) with worker-firm search and matching models. Acemoglu and Hawkins (2014) also showed that with search friction, which itself may be a reason for monopsony power, ε_{jt} can be positive, depending on parameters.

where $\theta_{jt}^M \equiv \frac{\partial F_{jt}}{\partial M_{jt}} \frac{M_{jt}}{Y_{jt}}$ and $\theta_{jt}^L \equiv \frac{\partial F_{jt}}{\partial L_{jt}} \frac{L_{jt}}{Y_{jt}}$ are the output elasticities of materials and labor, respectively; $\tilde{\theta}_{jt}^M \equiv \frac{\partial R_{jt}}{\partial M_{jt}} \frac{M_{jt}}{R_{jt}}$ and $\tilde{\theta}_{jt}^L \equiv \frac{\partial R_{jt}}{\partial L_{jt}} \frac{L_{jt}}{R_{jt}}$ are the revenue elasticities of materials and labor, respectively. The ratio of the revenue elasticities equals the ratio of the output elasticities because of the chain rule $\frac{\partial R_{jt}}{\partial Z_{jt}} = \frac{\partial R_{jt}}{\partial Y_{jt}} \frac{\partial F_{jt}}{\partial Z_{jt}}$. A firm's total wage payment $w_{jt} L_{jt}$ and total material purchases $P_{jt}^M M_{jt}$ are available from typical production datasets. Revenue and output elasticities can be estimated from production data by applying production function estimation techniques.

2.2 Discussion

Generality about Market Structure and Functional Forms The formula (7) is general about output and labor market structures and functional forms of demand and supply functions. It rests only on the first order condition for materials (5) and imposes no assumption about how wages and employment are determined. The firm-level inverse demand function $P_{jt}(Y_{jt})$ is consistent with all major models of imperfect competition, and it allows various types of firm heterogeneity.

The generality of this formulation about labor market structure and functional forms is crucial for the study of FDI liberalization on wage markdown. Theoretical predictions about the effect of FDI liberalization on domestic firm's wage markdowns vary depending on models and functional forms. In Appendix B, we examine three canonical models of labor monopsony: the Cournot oligopsony model of employer concentration (e.g. Naidu, Nyarko and Wang, 2016), the Logit model of job differentiation (e.g. Card, Cardoso, Heining and Klein, 2018), and the Burdett-Mortensen model of worker's on the job search. The Cournot model predicts that FDI liberalization usually weakens domestic firm's monopsony power and increases wage markdown, while the other two models can predict the opposite that FDI liberalization strengthens domestic firm's monopsony power and decreases wage markdown even with standard functional forms and parameters. This disagreement of prediction across models poses a challenge to our empirical study. If one estimates wage markdown from a structural model, the choice of a specific model may determine the sign of FDI competition effect *a priori*.

The generality of the formula (7) does not, however, imply that its implementation is free from assumptions. The estimation of revenue and output elasticities requires some assumptions about data generating process and market structure. We choose an estimation method which is general

about labor market structure and where a production function and a labor supply curve are non-parametric.

Existing Approach Using Production Function Estimates Our approach is related to an existing approach to identifying labor market monopsony from production function estimates by Dobbelaere and Mairesse (2013), Dobbelaere, Kiyota and Mairesse (2015) and Dobbelaere and Kiyota (2018). Estimating a Cobb-Douglas production function with constant elasticities θ^M and θ^L of materials and labor, respectively, they identify the market structure of an output market and a labor market by examining two measures:

$$\mu_{jt}^M = \frac{R_{jt}}{P_{jt}^M M_{jt}}\theta^M \text{ and } \psi_{jt} = \frac{R_{jt}}{P_{jt}^M M_{jt}}\theta^M - \frac{R_{jt}}{w_{jt}L_{jt}}\theta^L, \tag{8}$$

where μ_{jt}^M is the formula measuring firm j's output markup developed by Hall (1988) and De Loecker and Warzynski (2012), and ψ_{jt} is a parameter of "joint market imperfection" that simultaneously captures imperfect competition both in an output market and a labor market. The authors showed $\psi_{jt} < 0$ holds in a monopsonic labor market.

There are two important differences between their approach and ours. First, their measures do not directly estimate wage markdown. Using (7), the parameter ψ_{jt} can be written as:

$$\psi_{jt} = \mu_{jt}^M \left(1 - \frac{1}{\eta_{jt}}\right) \tag{9}$$

The parameter ψ_{jt} can correctly identify the *existence* of monopsony since $\psi_{jt} < 0$ if and only if $\eta_{jt} < 1$. However, the parameter ψ_{jt} is not suitable for examining the impact of certain policies on the *degree* of monopsony as in our study because it depends on both output markup and wage markdown. Second, the data requirement is different. Strictly speaking, the formula for ψ_{jt} (8) requires output elasticities, while the wage markdown formula (7) can be applied with either revenue elasticities or output elasticities. A typical production dataset reports only firm revenue without output price information. It is a common practice to use firm revenue as a proxy for output and to estimate revenue elasticities instead of output elasticities.[7]

[7] Klette and Griliches (1996) discuss the difficulty of estimating output elasticity from revenue data and a feasible method.

Monopsony Power for Materials As in the DLW markup, our markdown formula assumes that firms are price takers with respect to materials. Note that the material market does not have to be perfect competition to satisfy this assumption. FOC (5) allows the sellers of materials to charge markups, but it does not allow buyers to holds monopsony power. If a firm buying materials holds monopsony power in materials, it charges the material price markdown $\delta_{jt} \equiv \frac{P^M_{jt}}{\frac{\partial R_{jt}}{\partial Y_{jt}} \frac{\partial F_{jt}}{\partial M_{jt}}} \leq 1$. Then, (7) reduces to η_{jt}/δ_{jt}, labor monopsony power relative to material monopsony power. Therefore, the existence of material monopsony would lead to the under-estimation of labor monopsony power (and the over-estimation of η_{jt}), which is a bias against our argument.

Material monopsony is less likely to cause a major problem in our analysis. Buyers usually hold monopsony power when sellers cannot easily find alternative buyers. The seller's difficulty is particularly acute for workers who cannot easily move across labor markets and find buyers for their labor, compared with sellers of materials. This is especially applicable in China where migration across regions is restricted due to the *Hukou* (household registration) system while materials are freely tradable across regions.[8]

Heterogeneous Labor Skills While we have considered the case that firms employ homogeneous labor, firms normally employ workers of several skill types and may set different wage markdowns for different skill types. If the wage and employment for each skill type can be observed as data, the formula (7) can easily be extended to measure wage markdown by type s of worker η^s_{jt} by replacing $w_{jt}L_{jt}$, $\tilde{\theta}^L_{jt}$, and θ^L_{jt} with the corresponding variables for each type s worker.

Typical production datasets like the one we use usually report only firm's total labor input without skill level breakouts. But even then, our markdown measure is still informative about a firm's monopsony power because workers' skills would increase both the numerator (wages) and the denominator (MRL) simultaneously. To see this, suppose that workers of different types are perfectly substitutable. That is, the production function includes labor L^*_{jt} in an efficiency unit such that $L^*_{jt} = \sum_s \nu^s_{jt} L^s_{jt}$ where L^s_{jt} is type s labor and ν^s_{jt} is a skill converter. As we show in Appendix A.2, in this case, a firm sets identical markdown for all types, $\eta_{jt} = \eta^s_{jt}$ for

[8] A recent study by Morlacco (2019) examines the *relative* monopsony power of buyers between imported intermediate goods and domestic intermediate goods from French customs data. The author's finding of the relative difference in monopsony power between imported and domestic intermediate goods (materials) is not necessarily informative about whether overall material monopsony (combining both domestic and imported materials) is large or small relative to labor monopsony, which essentially determines the bias in our wage markdown measurement.

all s since they are perfectly substitutable. Our markdown formula (7) then correctly measures the firm's wage markdown. Even when workers of different types are imperfectly substitutable, our markdown measure (7) is the average markdown weighted by output elasticities such that $\eta_{jt} = \sum_s \left(\frac{\theta^s_{jt}}{\sum_{s'} \theta^{s'}_{jt}} \right) \eta^s_{jt}$ where θ^s_{jt} is the output elasticities of type s workers.

Non-Profit Maximizing Firms Profit maximization may not be the objective for some firms such as state-own enterprises (SOE), firms in public sectors, and non-profit organizations. In China, SOE firms are large employers and often considered to care more about employment than about maximizing profits (e.g., Berkowitz, Ma and Nishioka, 2017). Suppose an SOE j seeks to maximize $\pi_{jt} + \gamma_j L_{jt}$ where π_{jt} is profits and $\gamma_j > 0$ is a weight for employment. With $\gamma_j > 0$, the SOE firm neither maximizes profit nor minimizes cost. Nevertheless, our formula (7) correctly estimates such an SOE's wage markdown η^{SOE}_{jt} since the first order condition for materials remains in the same form as (5). However, the relationship between wage markdown and labor supply elasticity changes. In Appendix A.3, we show that the wage markdown of SOE firms is then

$$\eta^{SOE}_{jt} \equiv \frac{w_{jt}}{MRL_{jt}} = \left(\frac{\varepsilon_j}{\varepsilon_j + 1} \right) \left(\frac{1}{1 - \frac{\gamma}{w} \left(\frac{\varepsilon_j}{\varepsilon_j + 1} \right)} \right) > \left(\frac{\varepsilon_j}{\varepsilon_j + 1} \right). \tag{10}$$

If SOEs and private firms face similar labor supply elasticities, the SOEs would be expected to charge greater wage markdown than the private firms.

2.3 Production Function Estimation

We estimate gross production function using a nonparametric estimation method by Gandhi, Navarro and Rivers (2017) (hereafter GNR). The literature of production function estimation has developed to cope with an endogeneity problem that firm's input choices may be correlated with unobservable total factor productivity (TFP). A series of seminal papers by Olley and Pakes (1996), Levinsohn and Petrin (2003) and Ackerberg, Caves and Frazer (2015) have developed the so-called proxy approach using firm's factor usages as a proxy for TFP. Although the proxy approach can validly identify value-added production function, GNR recently show that the identification of gross output production function via the proxy approach (or the dynamic panel GMM approach) requires

an additional independent source of firm-level variations in the demand for flexible inputs such as input prices, which is not included in typical datasets including ours.

GNR proposes an alternative identification method that additionally estimates the first order condition for materials (5). To utilize the first order condition, GNR's method has to specify output market structure, though it is still general about the labor market structure and non-parametric about production function and labor supply curve. Since output markups potentially affect wage markdowns, we use a version of GNR's method (GNR, Appendix) for a monopolistic competitive output market as in De Loecker (2011) where firms charge time-varying output markups and where markups can respond to FDI liberalization. Following De Loecker (2013), we also allow the stochastic process of productivity to depend on characteristics of the firms, industries and regions. Appendix C explains our implementation of GNR's method in detail.

2.4 Impacts of FDI Liberalization

2.4.1 FDI Regulation in China

In December 1978, the then leader of China, Deng Xiaoping, initiated an open door policy to promote foreign trade and investment. It dramatically altered the situation which had prevailed under rigid central planning. Before 1978, China hosted almost no foreign-invested enterprises, but during the 1980s, it introduced a series of laws and implementation measures to attract FDI.[9] Foreign-invested enterprises enjoy preferential policies in terms of taxes, land use, and other matters, often in the form of policies for special economic zones. They have been expected to bring advanced technologies and management know-how to China and to promote China's integration into the world economy. As a result of these laws and implementation measures, China experienced rapid growth in FDI inflows from 1979 to 1991. After Deng Xiaoping took a tour of Southern China in the spring of 1992 to revive a slowing economy, the FDI inflows to China grew even faster, reaching US$ 27.52 billion in 1993.

Most significantly, the central government decided the policies designating in which industries

[9] In July 1979, a "Law on Sino–Foreign Equity Joint Ventures" was passed to attract foreign direct investment. In September 1983, the "Regulations for the Implementation of the Law on Sino–Foreign Equity Joint Ventures" was issued by the State Council of China; it was revised in January 1986, December 1987, and April 1990. In April 1986, the "Law on Foreign Capital Enterprises" was enacted. In October 1986, "Policies on Encouragement of Foreign Investment" was issued by the State Council of China.

FDI were encouraged or discouraged. In June 1995, the central government published a *Catalogue for the Guidance of Foreign Investment Industries* (hereafter, the *Catalogue*). There were modifications made in 1997, but it became the government's unique guideline for regulating FDI inflows. Specifically, the *Catalogue* classified products into four categories: (i) those where FDI was supported, (ii) those where FDI was permitted, (iii) those where FDI was restricted, and (iv) those where FDI was prohibited. Importantly, the guideline was implemented uniformly nationwide. The central government prohibited discretional policies on FDI entry by regional governments.[10]

During the negotiations to join the WTO, China was asked to open itself up for trade and FDI. After China's entry into the WTO in November 2001, its central government substantially revised the *Catalogue* in March 2002 and relaxed FDI regulation to illustrate its commitment to WTO rules.[11] In this study we exploit this regulation change to identify the FDI liberalization effect.

2.4.2 Bartik Approach

While FDI liberalization is nation-wide, firms are likely to exercise monopsony power within local labor markets. Following Topalova (2007) and Autor, Dorn and Hanson (2013), we apply so called "Bartik approach", a difference-in-differences (DD) approach based on local labor market-level exposure to FDI liberalization. We use prefecture as a unit of local labor market because the restriction of migration via the *Hukou* system is managed at the level of prefecture. According to Li (2018), around 4.8% of the population aged 16–59 changed their prefecture of residence between 2000–2005. There are 340 prefectures in China and on average, a prefecture has population of 3.7 million in year 2000. As a geographic unit, a prefecture in China roughly corresponds to a U.S. metropolitan statistical area (392 areas in the US in total). In Appendix E.3, we conduct our analysis with county being an alternative unit of labor market, which corresponds to a U.S. commuting zone analyzed by Autor, Dorn and Hanson (2013), and find all main results are robust to this change.

We first map industry-level FDI liberalization into local labor market-level exposure to FDI liberalization. The industrial activity varies substantially among prefectures before China's WTO

[10]On May 4, 1997, the State Council issued the Termination of Unauthorized Local Examination and Approval of Commercial Enterprises with Foreign Investment, which forbid the location discretions about FDI entry regulations.

[11]There was another minor revision of the Catalogue in November 2004. The National Development and Reform Commission and the Ministry of Commerce jointly issued fifth and sixth revised versions of the Catalogue in October 2007 and December 2011, beyond the period studied.

accession, so the sudden FDI regulation changes upon WTO accession impact the prefectures differently based on their initial employment structures. The prefecture-level exposure to FDI liberalization FDI_{ct} is constructed using Bartik approach as a local employment-weighted average of FDI regulation changes:

$$FDI_{ct} = \sum_{s} \frac{L_{cs1998}}{L_{c1998}} \times Liberalized_{st} \text{ and } Liberalized_{st} = Treatment_s \times Post2002_t, \quad (11)$$

where s represents a four-digit manufacturing industry; $Treatment_s$ is an indicator of whether inward FDI is liberalized for industry s; $Post2002_t$ is a dummy variable indicating the post-WTO period, i.e., $Post2002_t = 1$ if $t \geq 2002$, and 0 if $t \leq 2001$; and L_{cs1998}/L_{c1998} is industry s's share of employment in the total manufacturing employment of prefecture c in 1998, the initial year of the sample period. By construction, FDI_{ct} takes its minimum value of zero if the prefecture had no initial employment in liberalized industries and its maximum value one if all the prefecture's initial employment is in liberalized industries.

The local labor market DD estimation has the following specification:

$$\ln \eta_{jct} = \alpha_j + \alpha_t + \phi FDI_{ct} + \mathbf{X}'_{ct}\Psi + \varepsilon_{jct}, \quad (12)$$

where j, c, and t represent firm, prefecture and year, respectively. α_j is the firm fixed effect, controlling for all time-invariant differences across firms. The estimation is conducted based on a sample of firms that do not change between different prefectures, and thus the firm fixed effect also controls for all time-invariant differences among prefectures such as geographical factors, etc.[12] α_t is the year fixed effect controlling for any annual shocks common to the nation such as business cycles, monetary policies, exchange rate shocks, etc; and ε_{jct} is the error term which contains all factors that are uncorrelated with the controls (i.e., α_j, α_t, $\mathbf{X}_{ct}$) but may affect firm markdowns in the absence of FDI liberalization.

To isolate the effect of FDI regulation changes, we control for a vector of prefecture characteristics $\mathbf{X}_{ct}$ (to be explained later) that may affect the outcome variable. To deal with potential heteroskedasticity and serial autocorrelation, the standard errors are clustered at the prefecture

[12] Less than 1% of the firms moved to different prefectures over the sample period.

level. The coefficient of interest ϕ captures the impact of prefecture's exposure to FDI liberalization on wage markdown at an average firm. Since firms are heterogeneous in employment size, the effect on wage markdown to an average worker might be different. We therefore also conduct a weighted regression using employment share at initial year 1998 as the weight.

Recent studies on the Bartik approach (Adão, Kolesár and Morales, 2019; Borusyak, Hull and Jaravel, 2018; and Goldsmith-Pinkham, Sorkin and Swift, 2019) have revealed that the unbiased estimation of ϕ hinges on two different sources of identification. First, conditional on the control variables (i.e., α_j, α_t, $\mathbf{X}_{ct}$), the error term ε_{jct} is uncorrelated with industry shocks at the national level variable $Liberalized_{st}$ (or the industry exogeneity condition). Second, conditional on the control variables, the error term ε_{jct} is uncorrelated with the local employment share $\frac{L_{cs1998}}{L_{c1998}}$ (or the share exogeneity condition). The estimator $\hat{\phi}$ is consistent for the causal effect ϕ if either of the above two conditions is satisfied. We discuss these identifying assumptions in sequence.

Industry Exogeneity Condition If FDI liberalization is as-good-as randomly assigned to industry and timing, then the industry exogeneity condition is satisfied. There are only two possible sources of violation of this identifying assumption; if either $cov\left(Treatment_s, \varepsilon_{jct}|\alpha_j, \alpha_t, \mathbf{X}_{ct}\right) \neq 0$ or $cov\left(Post02_t, \varepsilon_{jct}|\alpha_j, \alpha_t, \mathbf{X}_{ct}\right) \neq 0$.

The condition $cov\left(Treatment_s, \varepsilon_{jct}|\alpha_j, \alpha_t, \mathbf{X}_{ct}\right) \neq 0$ challenges the comparability of the treatment and the control industry, indicating that the selection of which industries to open up to FDI was non-random. The liberalized industries and the non-liberalized industries could have been experiencing different trends initially and those differences might affect wage markdown across industries after FDI liberalization. We address the issue of the nonrandom selection of liberalized industries in the following ways. First, we carefully characterize the important determinants of the changes in FDI regulations. The State Council issued the "Provisions on Guiding the Orientation of Foreign Investment" in 2002 and listed a bunch of criteria why and how the central government modified the *Catalogue* and relaxed the FDI regulations in 2002. As shown in Lu, Tao and Zhu (2017), four determinants are identified at the industry level: new product intensity, export intensity, number of firms, and the average age of firms in the industry.[13]

[13]New product intensity is the ratio of new product output to total output. Export intensity is the ratio of total exports to total output. New product intensity and number of firms are statistically positively correlated with the FDI deregulation, while export intensity and industry average age are negatively correlated. The positive correlation of new

Let the four determinants from the *Catalogue* be measured in 1998 denoted as Z_{s1998}. We construct the controls as $Z_{ct} = \sum_s \frac{L_{cs1998}}{L_{c1998}} \times Z_{s1998} \times \alpha_t$ and add Z_{ct} in $\mathbf{X}_{ct}$. Hence, controlling for the FDI determinants ensures that differences in the time paths of wage markdown after FDI liberalization are not driven by the endogenous selection of industries for their changes in FDI regulations. To rule out the concern that prefecture's exposure to FDI liberalization might be magnified by inter-industry vertical linkages, we therefore control for prefecture-level exposures to FDI liberalization in backward and forward industries.[14]

The condition $cov\left(Post02_t, \varepsilon_{jct} | \alpha_j, \alpha_t, \mathbf{X}_{ct}\right) \neq 0$ indicates that the timing of FDI liberalization was not random. The concern comes from the possibility that the Chinese government had chosen to relax FDI in 2002 knowing that liberalized and non-liberalized industries would become different at that moment. Note that FDI liberalization was one of the commitments of China's WTO accession. The negotiations with the 150 WTO member countries to join the WTO were very lengthy and rather uncertain prior to 2001.[15] There could thus have been no anticipation of China's WTO accession by the end of 2001. Nevertheless, we perform a robustness check as in Jensen and Oster (2009) by adding an additional control—$\sum_s \frac{L_{cs1998}}{L_{c1998}} \times Treatment_s \times I\left(t = 2001\right)$, where $I(\cdot)$ is the indicator function—in the regression. We further control for other on-going policy reforms at the time of FDI liberalization that might have affected wage markdown. To control for the effects of tariff reductions by China and its trading partners after China's WTO accession, we include prefecture exposure to various tariffs, i.e., China's output and input tariffs (τ^o_{st} and τ^i_{st}), and its export tariffs (τ^e_{st}): $\sum_s \frac{L_{cs1998}}{L_{c1998}} \times \tau^v_{st}$, where $v \in \{o, i, e\}$.[16] Another reform in the early 2000s was the restructuring and privatization of SOEs, and we add a control SOE_{ct} capturing the employment share of SOEs in prefecture c and year t. China also adopted the special economic

product intensity indicates that more innovative industries are more likely to be deregulated. Also, infant industries (those with smaller firm ages) and industries with less export intensity are more likely to be deregulated.

[14]Prefecture's exposure to backward FDI liberalization is constructed as $\sum_s \frac{L_{cs1998}}{L_{c1998}} \sum_{k \text{ if } k \neq s} \chi_{sk} \times Treatment_k \times \alpha_t$, and prefecture's exposure to forward FDI is measured as $\sum_s \frac{L_{cs1998}}{L_{c1998}} \sum_{m \text{ if } m \neq s} \varrho_{sm} \times Treatment_m \times \alpha_t$. Here, χ_{sk} is the ratio of industry s's output supplied to industry k, and ϱ_{sm} is the ratio of inputs purchased by industry s from industry m. The measures on χ_{sk} and ϱ_{sm} are compiled from China's 2002 input-output table.

[15]It took more than 15 years of exhaustive negotiations with the 150 WTO member countries for China's WTO accession.

[16]The tariff data for HS-6 products are obtained from the World Integrated Trade Solution database. Mapping HS-6 products to ASIF 4-digit industries through the concordance table from China's National Bureau of Statistics allows calculating a simple average output tariff for each industry. The input tariffs are constructed as a weighted average of the output tariffs, using as the weight the share of the inputs in the output value from the China's 2002 input-output table. The export tariff is a weighted average of the destination countries' tariffs on Chinese imports, using China's exports to each destination country as the weight. Appendix D.2.3 describes various tariff measures in more detail.

zones (SEZs) policy aimed at attracting foreign direct investment, and we further add a dummy SEZ_{ct} which is 1 if prefecture c had a zone program in year t.[17]

Share Exogeneity Condition ϕ is an unbiased estimator when the shares are conditionally exogenous to error term. It relies on the identifying assumption that the potential prefecture-specific determinants of the wage markdown are uncorrelated with a prefecture's initial industry composition. The assumption could be violated if prefectures with initially different industry specialization patterns would experience subsequent changes in wage markdown, regardless of FDI liberalization.[18] To alleviate this concern, we include the interactions between year dummies and the following prefecture-level characteristics in 2000 (the first year in our sample period that demographic data from the Population Census are available): agriculture employment share, manufacturing employment share, Herfindahl-Hirschman Index (HHI) of manufacturing employment, GDP per capital, share of population with college education or above, overall wage markdown and distance to the nearest port.[19]

3 Data

Panel Data on Industrial Firms The main dataset used in this study comes from the *Annual Survey of Industrial Firms* (ASIF), conducted by the National Bureau of Statistics of China for the 1998–2007 periods.[20] The surveys cover all of the state-owned enterprises (SOEs) and non-SOEs with annual sales exceeding 5 million Chinese yuan (about US$827,000). The number of firms covered in the surveys varies from approximately 162,000 to approximately 270,000. Though the title of ASIF includes "firms", all information is reported on the firm-province level, so that the

[17]The China's Ministry of Land and Resources reports administrative divisions at the prefecture level.

[18]Consider two prefectures specializing in textile and car industries, respectively. They may experience different FDI_{ct} if for example the car industry receives a larger FDI shock.

[19]Appendix D.2.1 describes the definition and construction of each prefecture-level variable in more detail.

[20]This is the most comprehensive and representative firm-level dataset in China, and the firms surveyed contribute the majority of China's industrial value-added. The dataset has been widely used by economic researchers in recent years, including Brandt, Van Biesebroeck and Zhang (2012), and Khandelwal, Schott and Wei (2013). In 2003, a new classification system for industry codes (GB/T 4754-2002) was adopted in China to replace the GB/T 4754-1994 system that had been used from 1995 to 2002. To achieve consistency in the industry codes over the period studied (1998–2007), we use the concordance table constructed by Brandt, Van Biesebroeck and Zhang (2012).

dataset is closer to a plant-level dataset in contrast to the firm-level datasets in other countries.[21] The dataset includes the basic information about each plant, such as its identification number, ownership structure, and industry affiliation, and the financial and operating information extracted from accounting statements, such as sales, employment, intermediate inputs, and the total wage bill, from which we construct variables for production function estimation. The total wage bill is measured as the sum of firm's wage bills and supplementary compensation such as bonuses and insurance.[22]

Although the constructed wage includes all monetary benefits reported, the possible under-reporting of wage in the ASIF has been pointed out (e.g., Brandt, Van Biesebroeck and Zhang, 2014). Following Hsieh and Klenow (2009), we multiply wage by a constant adjustment factor 1.59 so that the labor income share in manufacturing value-added aggregated from the ASIF data in 1998 becomes 0.5. The adjustment makes total labor income share aggregated from the firm-level data consistent with national accounts. Note that this adjustment only affects the *level* of wage markdown, but it does not affect the DD estimation of log wage markdown in (12).[23] The summary statistics of wage markdown without adjustment are reported in Appendix E.1.

Data on China's FDI Regulations We classify each 4 digit industry into liberalized industries and non-liberalized industries, following Lu, Tao and Zhu (2017). We use the *Catalogue* to obtain information on FDI regulation changes of each industry upon China's WTO accession at the end of 2001. Using the *Catalogue* for year t, we classify the products into four groups and assign an index of FDI regulation Reg_{st} for product s that could take one of four values: (ii) the supported products $Reg_{st} = 1$ where FDI was supported; (ii) the permitted products $Reg_{st} = 2$ where FDI

[21] According to Article 14 of the Company Law of the People's Republic of China, however, for a company to set up a plant in a region other than its domicile, "it shall file a registration application with the company registration authority, and obtain the business license." For example, Beijing Huiyuan Beverage and Food Group Co., Ltd. has six plants, located in Jizhong (Hebei Province), Youyu (Shanxi Province), Luzhong (Shandong Province), Qiqihar (Heilongjiang Province), Chengdu (Sichuan Province), and Yanbian (Jilin Province). Our data set accordingly counts them as six different observations belonging to six different regions.

[22] To convert nominal values of output and input into real terms, we use industry-level ex-factory price indices for sales, and input price indices for intermediate inputs. Both price indices are provided by Brandt, Van Biesebroeck and Zhang (2012) (the updated version in 2018). The real capital stock is constructed using the perpetual inventory method proposed by Brandt, Van Biesebroeck and Zhang (2012). Specifically, we first calculate firm's real capital stock in its founding year. Then we use firm's fixed investment with depreciation rate of 9% to calculate its real capital stock in each year. The investment deflator is provided by Perkins and Rawski (2008). We are grateful to the authors for providing those invaluable resources.

[23] Note that the adjustment factor is absorbed by the constant term in the estimation.

was permitted; (iii) the restricted products $Reg_{st} = 3$ where FDI was restricted; (iv) the prohibited products $Reg_{st} = 4$ where FDI was prohibited. Products not mentioned in the *Catalogue* are classified into the permitted category.

We then compare the 1997 and 2002 versions of the *Catalogue* and identify products into three groups: (i) liberalized products $\Delta Reg_s \equiv Reg_{s1997} - Reg_{s2002} > 0$; (ii) no change products $\Delta Reg_s = 0$; (iii) regulated products $\Delta Reg_s < 0$. Finally, we aggregate the changes in FDI regulation from the *Catalogue*'s product level to the ASIF 4-digit industry level. The aggregation process leads to four possible scenarios: (i) FDI encouraged industries where all of the products are either liberalized or not changed; (ii) no change industries where all of the products are unchanged; (iii) FDI discouraged industries where all of the products are either more tightly regulated or unchanged; and (iv) mixed industries where some products are liberalized and others become more regulated. Among the 424 four-digit industries, 112 are FDI *encouraged industries*, 300 are *no-change industries*, 7 are FDI *discouraged industries* and 5 are *mixed industries*. We define an indicator of liberalized industries in (11) as follows: $Treatment_s = 1$ if industry s belongs to *encouraged industries* and $Treatment_s = 0$ otherwise.

Using information of prefecture-level employment, we construct the prefecture-level exposure to FDI liberalization FDI_{ct}. Its summary statistics are as follows: mean 0.31 with a standard deviation 0.11 for the sample after 2001. Table 1 shows FDI entry after China's FDI liberalization, comparing prefectures with above-mean exposure to FDI liberalization (the treatment group) and those with below-mean exposure (the control group). The treatment group shows a greater increase in FDI entry. To further examine the effect of FDI liberalization on FDI inflows, we conduct a DD analysis using (12) and the estimation results are presented in Table A.3. It is shown that there is a statistically positive effect of FDI liberalization on FDI inflows into prefectures.[24] This indicates that there were more FDI inflows into prefectures experiencing higher exposure to FDI liberalization, thereby establishing the FDI competition linkage.[25]

[24] FDI inflows are measured as (i) the share of number of foreign investors, and (ii) output share of foreign equity share.

[25] We also verify in Columns (2) and (4) of Table A.3 that estimates on $\sum_s \frac{L_{cs1998}}{L_{c1998}} \times Treatment_s \times I\,(t = 2001)$ are statistically insignificant and small in magnitudes, implying no expectation effect.

Table 1: FDI Entry after Liberalization

	(1)	(2)	(3)
	1998−2001	2002−2007	Change (%)
Panel A. Foreign equity share			
Prefectures with high FDI exposure	0.071	0.093	30.99
Prefectures with low FDI exposure	0.107	0.127	18.69
Panel B. Share of number of foreign firms			
Prefectures with high FDI exposure	0.055	0.079	43.64
Prefectures with low FDI exposure	0.082	0.104	26.83

Note: This table reports the summary statistics of prefectures with high FDI exposure and those with low FDI exposure. A prefecture with high (low) FDI exposure refers to a region that its exposure to FDI is above (below) the average in 2001. Foreign equity share in Panel A and share of number of foreign firms in Panel B calculated over the pre-WTO 1998-2001 period, the post-WTO 2002-2007 period, and their percentage changes, respectively are reported.

4 Empirical Results

4.1 Wage Markdowns and Firm Characteristics

Table 2 reports summary statistics on estimated revenue elasticities for each two-digit industry. The substantial heterogeneity on elasticities within industries confirms the advantage of using a flexible production function. Overall, the estimated elasticities look reasonable. They are positive for most industries. Although the estimated capital elasticities are relatively small, this pattern has been observed in previous studies of Chinese firms using different estimation methods (e.g., Lu and Yu, 2015). It is thus the feature of the Chinese data rather than an artifact of the estimation method. We dropped two industries with negative median labor elasticities ("electric & telecommunication equipment" and "other manufacturing"), which would imply negative wage markdowns.

Table 3 reports firm-level wage markdowns and output price markups. First of all, labor monopsony is ubiquitous in Chinese manufacturing industries. Column (1) reports median wage markdowns for each 2 digit industry. In our sample, 75% of the firms set wage markdowns smaller than one, and the median wage markdown for the entire sample is 0.48. Columns (3) and (4) report price markups. The median markup in the entire sample is 1.13, which is reasonably close to previous estimates of industry average markups ranging from 0.825 to 1.372 in Lu and Yu (2015) that were estimated from the same dataset but with different methodology. Third, Columns (5) and (6) report median markdowns weighted by firm's employment, which suggests the markdown

Table 2: Production Function Estimation

	Revenue Elasticity With Respect to …						Obs.
	Labor		Capital		Materials		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Industry	Median	(p25, p75)	Median	(p25, p75)	Median	(p25, p75)	
Food processing	0.35	(0.24, 0.44)	0.30	(0.22, 0.37)	0.69	(0.64, 0.73)	129,975
Food manufacturing	0.31	(0.26, 0.37)	0.34	(0.26, 0.43)	0.67	(0.63, 0.71)	52,333
Beverage manufacturing	0.45	(0.28, 0.59)	0.36	(0.25, 0.5)	0.63	(0.59, 0.68)	35,865
Textile industry	0.24	(0.17, 0.3)	0.25	(0.18, 0.32)	0.74	(0.7, 0.77)	170,353
Garments & other fiber products	0.22	(0.14, 0.29)	0.18	(0.13, 0.23)	0.70	(0.66, 0.75)	97,194
Leather, furs, down & related products	0.37	(0.27, 0.45)	0.20	(0.13, 0.26)	0.72	(0.68, 0.76)	48,522
Timber processing, bamboo, cane, palm fiber & straw products	0.17	(0.15, 0.2)	0.23	(0.17, 0.28)	0.71	(0.67, 0.74)	44,491
Furniture manufacturing	0.21	(0.18, 0.24)	0.17	(0.13, 0.21)	0.71	(0.67, 0.74)	23,656
Papermaking & paper products	0.27	(0.15, 0.37)	0.29	(0.22, 0.38)	0.73	(0.7, 0.75)	61,096
Printing industry	0.25	(0.16, 0.34)	0.73	(0.55, 0.9)	0.66	(0.6, 0.71)	43,597
Cultural, educational & sports goods	0.21	(0.19, 0.24)	0.20	(0.14, 0.25)	0.73	(0.69, 0.76)	26,550
Petroleum processing & coking	0.30	(0.18, 0.42)	0.30	(0.22, 0.4)	0.71	(0.67, 0.75)	17,977
Raw chemical materials & chemical products	0.29	(0.22, 0.35)	0.41	(0.31, 0.53)	0.71	(0.67, 0.74)	149,424
Medical & pharmaceutical products	0.30	(0.25, 0.35)	0.49	(0.39, 0.58)	0.61	(0.57, 0.66)	43,060
Chemical fiber	0.28	(-0.25, 0.78)	0.28	(0.12, 0.51)	0.76	(0.73, 0.79)	10,304
Rubber products	0.60	(0.13, 1.01)	0.20	(0.1, 0.33)	0.71	(0.68, 0.74)	24,205
Plastic products	0.35	(0.27, 0.43)	0.44	(0.33, 0.55)	0.73	(0.69, 0.76)	94,307
Nonmetal mineral products	0.11	(0.08, 0.13)	0.34	(0.25, 0.42)	0.69	(0.65, 0.72)	175,768
Smelting & pressing of ferrous metals	0.06	(0.03, 0.1)	0.29	(0.22, 0.36)	0.74	(0.7, 0.77)	49,354
Smelting & pressing of nonferrous metals	0.02	(-0.05, 0.08)	0.30	(0.21, 0.38)	0.75	(0.7, 0.78)	36,339
Metal products	0.66	(0.47, 0.83)	0.32	(0.21, 0.43)	0.72	(0.69, 0.76)	109,990
Ordinary machinery	0.00	(-0.07, 0.08)	0.36	(0.28, 0.43)	0.71	(0.68, 0.74)	153,252
Special purpose equipment	0.48	(0.43, 0.52)	0.41	(0.3, 0.52)	0.67	(0.63, 0.72)	85,860
Transport equipment	0.37	(0.33, 0.42)	0.57	(0.41, 0.71)	0.67	(0.6, 0.73)	98,891
Electric equipment & machinery	-0.05	(-0.07, -0.03)	0.33	(0.24, 0.41)	0.73	(0.69, 0.76)	120,020
Electronic & telecommunications equipment	0.29	(0.18, 0.39)	0.50	(0.36, 0.64)	0.67	(0.62, 0.73)	67,530
Instruments, meters, cultural & office equipment	0.11	(0.03, 0.17)	0.41	(0.29, 0.53)	0.65	(0.6, 0.7)	29,001
Other manufacturing	-0.25	(-0.28, -0.22)	0.21	(0.15, 0.26)	0.71	(0.66, 0.75)	39,526

Note: The table reports median, 25 percentile (p25) and 75 percentile (p75) of revenue elasticities with respect to labor, capital, and materials and the number of observations for each two digit level industry.

of an average worker. The weighted median markdown of 0.68 is slightly larger than the simple median of 0.48, suggesting that small employers exercise greater monopsony power. Finally, firm-level wage markdowns are heterogeneous both across and within industries. Many industries show substantial heterogeneity in markdowns within industries.

Our estimates of wage markdown are comparable to estimates in previous studies. Sokolova and Sorensen (2018) collect 700 direct estimates of labor supply elasticities for individual firms reported in 38 articles published from 1977 to 2018. According to their report, the distribution of wage markdown implied from (3) has the median 0.52 with a 5% to 95% interval of $[-0.04, 0.80]$. Our median estimate 0.48 is close to typical previous estimates.

Table 4 examines correlations of wage markdowns with firm characteristics, reporting the regression of wage markdown on log TFPR in Column (1), on employment in Column (2), on dummy variables indicating state-ownership and foreign ownership in Column (3), on firm's export intensity (the share of firm's export in revenue) in Column (4) and on all the above mentioned variables in Column (5).[26] All regressions include year fixed effects and firm fixed effects. TFPR is revenue-based TFP (Foster, Haltiwanger and Syverson, 2008), the residuals of revenue unexplained by inputs, which may include not only physical TFP but also other positive shocks to firm revenue. Because such shocks also increases MRL and increase firm's incentive to hire more workers, TFPR rather than physical TFP corresponds to "productivty" in theoretical models in section 4.4 and Appendix B.

Those firms exhibiting larger markdowns are considered to offer "good jobs" in China. They are high-productivity firms, large employers, state-owned firms, foreign-owned firms and exporters. SOEs and foreign firms set 55% and 11% higher markdowns, respectively, than domestic private firms. The SOEs' higher markdowns are consistent with (10)—SOEs care about employment as well as their profits.

Although those associations presented in Table 4 do not necessarily imply causality, the associations indicating that large and productive firms exercise less monopsony power might appear strange in view of classic monopsony theory of employer concentration predicting that a large firm will exercise monopsony power. They are, however, consistent with modern monopsony theory

[26] A firm is classified as an SOE if (i) more than 50% of its registered capital is held directly by the state or (ii) the controlling shareholder of the firm is identified as the state. We classify a firm as a foreign firm if more than 25% of its equities are owned by foreign investors.

Table 3: Distributions of Firm-Level Wage Markdowns and Price Markups

	Wage Markdowns (Adjusted)		Price Markups		Wage Markdowns (Weighted, Adjusted)	
	(1)	(2)	(3)	(4)	(5)	(6)
Industry	Median	(p25, p75)	Median	(p25, p75)	Median	(p25, p75)
Food processing	0.15	(0.07, 0.35)	1.40	(1.36, 1.45)	0.36	(0.14, 0.94)
Food manufacturing	0.34	(0.17, 0.67)	1.08	(1.05, 1.12)	0.53	(0.27, 0.99)
Beverage manufacturing	0.23	(0.1, 0.53)	1.13	(1.12, 1.19)	0.52	(0.22, 1.17)
Textile industry	0.49	(0.24, 0.97)	1.06	(1.04, 1.08)	1.09	(0.51, 2.6)
Garments & other fiber products	0.93	(0.58, 1.46)	6.45	(6.23, 6.6)	0.71	(0.44, 1.13)
Leather, furs, down & related products	0.44	(0.19, 0.85)	1.02	(1.02, 1.06)	0.90	(0.42, 1.99)
Timber processing, bamboo, cane, palm fiber & straw products	0.56	(0.34, 0.92)	1.15	(1.14, 1.17)	0.68	(0.4, 1.1)
Furniture manufacturing	0.60	(0.36, 0.93)	1.20	(1.19, 1.21)	0.67	(0.44, 0.99)
Papermaking & paper products	0.34	(0.18, 0.69)	1.01	(1.01, 1.02)	0.60	(0.29, 1.43)
Printing industry	0.73	(0.42, 1.28)	1.16	(1.14, 1.16)	0.55	(0.32, 0.93)
Cultural, educational & sports goods	0.79	(0.47, 1.27)	1.06	(1.05, 1.08)	1.34	(0.76, 2.61)
Petroleum processing & coking	0.19	(0.08, 0.45)	1.04	(1.02, 1.09)	0.47	(0.2, 1.28)
Raw chemical materials & chemical products	0.29	(0.14, 0.61)	1.07	(1.04, 1.09)	0.88	(0.37, 2.06)
Medical & pharmaceutical products	0.37	(0.21, 0.61)	1.23	(1.2, 1.25)	0.34	(0.2, 0.54)
Chemical fiber	0.10	(0.04, 0.27)	1.03	(1.02, 1.05)	0.20	(0.07, 0.55)
Rubber products	0.17	(0.07, 0.4)	1.06	(1.04, 1.08)	0.34	(0.14, 0.94)
Plastic products	0.31	(0.19, 0.49)	1.03	(1.02, 1.04)	0.29	(0.18, 0.46)
Nonmetal mineral products	1.22	(0.73, 1.9)	6.95	(6.85, 7.1)	1.69	(1.05, 2.76)
Smelting & pressing of ferrous metals	1.01	(0.63, 1.67)	8.74	(8.53, 9.03)	0.81	(0.54, 1.23)
Smelting & pressing of nonferrous metals	0.83	(0.33, 2.14)	1.03	(1.01, 1.06)	1.72	(0.65, 4.58)
Metal products	0.17	(0.08, 0.36)	1.03	(1.02, 1.05)	0.35	(0.16, 0.83)
Ordinary machinery	2.39	(1.23, 5.22)	6.48	(6.34, 6.65)	1.15	(0.6, 2.15)
Special purpose equipment	0.29	(0.15, 0.53)	1.04	(1, 1.07)	0.55	(0.28, 0.92)
Transport equipment	0.36	(0.18, 0.67)	4.75	(4.56, 4.99)	0.48	(0.27, 0.86)
Electronic & telecommunications equipment	0.53	(0.29, 0.94)	9.09	(8.89, 9.48)	0.33	(0.17, 0.59)
Instruments, meters, cultural & office equipment	1.31	(0.62, 2.92)	1.07	(1.03, 1.12)	3.12	(1.34, 8.32)
All industries	0.48	(0.20, 1.06)	1.13	(1.05, 6.35)	0.69	(0.32, 1.42)

Note: The table reports median, 25 percentile (p25) and 75 percentile (p75) of wage markdown, those of output price markup, and those statistics weighted by firm employment of wage markdown. Wage markdowns are calculated with wages adjusted to be consistent with national accounts.

Table 4: Firm-Level Wage Markdown and Firm Characteristics

Log wage markdown	(1)	(2)	(3)	(4)	(5)
Log TFPR	0.078***				0.078***
	(0.004)				(0.004)
Log employment		0.314***			0.329***
		(0.004)			(0.004)
State owned dummy			0.056***		0.051***
			(0.006)		(0.006)
Foreign owned dummy			0.025***		0.019***
			(0.007)		(0.007)
Export intensity				0.039***	0.015**
				(0.008)	(0.007)
Firm fixed effects	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes
Observations	1,123,620	1,123,620	1,123,620	1,123,620	1,123,620

Note: Standard errors are clustered at the firm level in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent. TFPR is firm-level productivity. Employment is firm's total number of employees. State owned dummy is 1 if a firm is a state-owned enterprise. Foreign owned dummy is 1 if a firm is a foreign affiliate. Export intensity is the share of firm' export in revenue.

(Burdett and Mortensen, 1998) in which it is search friction that creates monopsony. Firms with high productivity pay higher wages, hire more workers and produce more output than firms with low productivity. In Section 5, we will show that wage markdown and employment can be both increasing in productivity in the model.

Table 5 reports the regressions of log wage markdown on prefecture characteristics in 2000 together with log prefecture's GDP per capita: on college graduate shares in population in Column (1), on manufacturing employment shares and SOE employment shares in manufacturing in Column (2), and on the manufacturing employment HHI in Column (3). Wage markdown is larger in prefectures with more college graduates, with more manufacturing and SOE employment.

These results in Table 5 are also consistent with the job search theory. First, changing employers may be easier for college graduates than for less educated workers, giving them lower search costs and wider outside options. If so, firms would exercise less monopsony power against college graduates who have more elastic labor supply. Second, manufacturing firms and SOEs are considered to offer attractive jobs in China. In prefectures with plenty of such jobs, workers' better outside options may limit firms' monopsony power. Third, the positive relationship between wage

Table 5: Firm-Level Wage Markdown and Prefecture Characteristics in 2000

Log wage markdown	(1)	(2)	(3)	(4)	(5)	(6)	(6)
College graduates share	1.962***			2.120**			2.735***
	(0.538)			(0.941)			(0.882)
Manufacturing employment share		0.974***			1.247***		1.431***
		(0.135)			(0.214)		(0.187)
SOE employment share		0.713***			0.726***		0.543***
		(0.108)			(0.107)		(0.103)
Manufacturing employment HHI			0.263			0.316	0.110
			(0.454)			(0.475)	(0.385)
GDP per capita				-0.012	-0.081*	0.067**	-0.219***
				(0.055)	(0.045)	(0.034)	(0.058)
Province fixed effects	yes	yes	yes	yes	yes	yes	yes
Industry fixed effects	yes	yes	yes	yes	yes	yes	yes
Observations	86,373	86,373	86,373	86,373	86,373	86,373	86,373

Note: Standard errors are clustered at the prefecture level in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent. College graduates share is the ratio of population with college or graduate degree to population aged above 6. Manufacturing employment share is the ratio of population employed in the manufacturing industry to total employed population. SOE employment share is the ratio of population employed in state-owned enterprises to total employed population. Manufacturing employment HHI is the prefecture's herfindahl index in manufacturing industry. GDP per capita is prefecture's GDP per capital.

markdown and the HHIs is at odds with the concentration theory, but not necessarily with the job search theory. These patterns are robust after controlling for prefecture GDP per capita in Columns (4)–(6) and including all variables simultaneously in Column (8).

4.2 FDI Liberalization

Table 6 presents the DD estimation results. In addition to firm and year fixed effects, we step-wisely include a set of controls as elaborated in the previous section. The inclusion of these controls allows us to isolate the effect of FDI liberalization from other confounding factors such as the potential endogenous selection of open-up industries and other on-going policy reforms. Specifically, we include FDI determinants Z_{ct} in Column (2). Other policy controls are additionally included in Column (3). Backward and forward FDI are added in the estimation reported in Column (4). Controls for prefecture's industry composition are added in Column (5), which is our benchmark estimation.

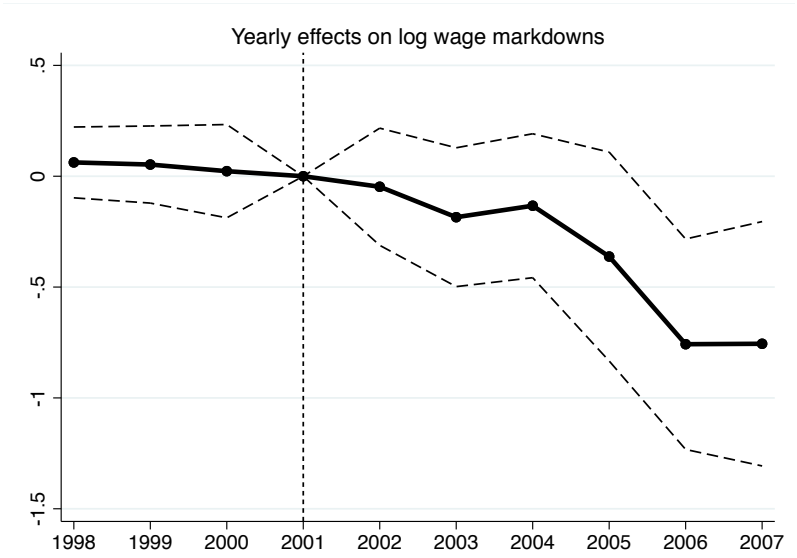
The estimated coefficients of our regressor of interest, FDI_{ct}, are consistently negative and statistically significant. The negative coefficients indicate that the wage markdowns decrease and firms exercise greater monopsony power in prefectures more exposed to FDI liberalization. To see

Table 6: FDI Liberalization and Firm-Level Wage Markdowns

Log wage markdown	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FDI Liberalization	-0.418***	-0.364***	-0.342***	-0.289**	-0.288**	-0.295**	-0.308*
	(0.115)	(0.114)	(0.119)	(0.115)	(0.113)	(0.125)	(0.174)
FDI Liberalization ×						-0.018	
Year2001 dummy						(0.078)	
Controls:							
FDI determinants	no	yes	yes	yes	yes	yes	yes
Other policy	no	no	yes	yes	yes	yes	yes
Vertical FDI	no	no	no	yes	yes	yes	yes
Prefecture characteristics	no	no	no	no	yes	yes	yes
Prefecture emp. weighted	no	no	no	no	no	no	yes
Firm fixed effects	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes
Observations	1,022,448	1,022,448	1,022,448	1,022,448	1,022,448	1,022,448	1,022,448

Note: Standard errors are clustered at the prefecture level in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent. FDI determinants controls include new product intensity, export intensity, number of firms, and age at initial year. Other policy controls include: (1) prefecture's exposures to tariffs (output tariffs, input tariffs, and tariffs by foreign countries); (2) the share of state-owned enterprises among firms in a prefecture, (3) a dummy variable indicating whether a prefecture is a special economic zone or not. Vertical FDI controls include prefecture's exposure to FDI liberalization in backward and forward industries. Prefecture characteristics controls includes interactions between year dummies and the following variables in 2000: agriculture employment share, manufacturing employment share, GDP per capita, share of population with college education or above, manufacturing employment HHI, overall wage markdown and distance to the nearest port. Column (7) reports weighted regression with prefecture employment being the weight.

Figure 1: Yearly Effects of FDI Liberalization on Wage Markdown



Note: the solid line expresses the coefficients of interaction terms of FDI liberalization and year dummies in the regression of log wage markdown with main regressors. The dashed lines express 95% confidence intervals.

the economic magnitude, we rely on the estimates in column (5) of Table 6 and the mean value 0.31 of FDI_{ct} at the prefecture level. A firm in an average prefecture decreases wage markdown by $9.0\%(\simeq 28.9\% \times 0.31)$. As our sample covers 6 years after the FDI regulation changes, it can be translated into a $1.5\%(\simeq 9.0\%/6)$ drop annually.

Column (6) in Table 6 checks the robustness of the results. It adds an interaction term $\sum_s \frac{L_{cs1998}}{L_{c1998}} \times Treatment_s \times I\,(t = 2001)$, where $I\,(t = 2001) = 1$ if the year is 2001, one year before the FDI liberalization. The regression examines whether wage markdowns changes in anticipation of the FDI liberalization. The coefficient of the interaction term is close to zero and statistically insignificant, indicating that there is no expectation effect.

Our baseline regression estimates the effect of FDI liberalization on an average firm. To see the effect on an average worker in a prefecture, Column (7) conducts a weighted regression using prefecture's initial employment in 1998 as the weight. The coefficient is almost identical to the unweighted estimates, which suggests that prefectures with small and large population receive similar effects.

Figure 1 plots yearly effects of FDI liberalization. We estimate a regression with baseline covariates in Column (5) of Table 6 with time-varying treatment $\widetilde{FDI}_{ct}$, which is constructed by

Table 7: Decomposition and Mechanism

	(1)	(2)	(3)	(4)
Dependent variables:	Log employment	Log MRL	Log wages	Log markdown
FDI Liberalization	-0.211***	0.289**	0.001	-0.309***
	(0.079)	(0.118)	(0.090)	(0.113)
Log TFPRC				-0.100***
				(0.005)
Controls:				
FDI determinants	yes	yes	yes	yes
Other policy	yes	yes	yes	yes
Vertical FDI	yes	yes	yes	yes
Prefecture characteristics	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Observations	1,123,620	1,123,620	1,123,620	1,123,620

Note: Standard errors are clustered at the prefecture level in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent. FDI determinants controls include new product intensity, export intensity, number of firms, and age at initial year. Other policy controls include: (1) prefecture's exposures to tariffs (output tariffs, input tariffs, and tariffs by foreign countries); (2) the share of state-owned enterprises among firms in a prefecture, (3) a dummy variable indicating whether a prefecture is a special economic zone or not. Vertical FDI controls include prefecture's exposure to FDI liberalization in backward and forward industries. Prefecture characteristics controls includes interactions between year dummies and the following variables in 2000: agriculture employment share, manufacturing employment share, GDP per capita, share of population with college education or above, manufacturing employment HHI, overall wage markdown and distance to the nearest port.

replacing $Post2002_t$ in (11) with its interaction with year dummies. Figure 1 reports the coefficients of $\widetilde{FDI}_{ct}$ with 95% confidence intervals. The negative effect of FDI liberalization becomes stronger in later years. It suggests that the discrepancy between wages and MRL did not occur as a short-run adjustment process such as wage stickiness. It is a long run transition process from one equilibrium to another. Furthermore, it is apparent that in the pre-WTO period, the coefficients are stable around zero, which suggests that with our main control variables, prefectures highly exposed to FDI liberalization and other prefectures show quite similar trends. This alleviates the concern that prefectures with high exposure to FDI and those with low FDI exposures are systematically different *ex ante*, lending support to our DD identifying assumption.

Next we investigate the mechanism behind the decrease in wage markdown. Because our dataset records firm-level wages, we can obtain each individual firm's MRL as the ratio of wages to wage markdown. Theories commonly predict that the entry of foreign firms after liberalization

makes incumbent firms lose employees and increases their MRL. Columns (1) and (2) of Table 7 regress log employment and log MRL as a dependent variable on the main regressors in Column (5) of Table 6 and find evidence confirming this prediction. In an average prefecture, incumbent firms reduced employment by $6.5\%(\simeq 21.1\% \times 0.31)$ and increased their MRL by $9.0\%(\simeq 28.9\% \times 0.31)$. If wage markdown is constant as in traditional models of FDI, worker's wage should also increase by 9% as much as the increase in MRL. However, Column (3) regresses log wages on the same regressors, and it shows that the actual wage change was virtually zero. By construction, the coefficient from the wage markdown regression is equal to the coefficient from the wage regression in Column (3) minus the coefficient from the MRL regression in Column (2). Note that the zero coefficient in Column (3) does not imply that wages were stable over the period. Instead, during 2002–2007, the average wage of Chinese manufacturing firms grew steadily at an average annual growth rate of 12%. Column (3) thus implies that firms with high exposures to FDI liberalization increased their wages only at the same speed as the national average even though firms faced labor shortages and increases in MRL.

One might think that the wage stagnation simply reflects a drop in labor quality at incumbent firms. Namely, wages might decrease relative to estimated MRL if high skilled workers move to new foreign firms, and incumbent firms replace them with low-skilled workers paying them lower wages. Given the fact that we do not control for labor quality in the production function estimation, a fall in labor quality should be reflected in a fall in firm-level TFP. To rule out the concern that the impact of FDI liberalization on wage markdowns are mainly driven by the change in firm-level TFP, we include a core component of TFPR (TFPRC), which removes industry-level demand shocks from TFPR, as a control in our benchmark regression and the estimation results are reported in Column (4) of Table 7. With the inclusion of firm-level TFP, the coefficient of the FDI liberalization on wage markdown remains statistically significant and the magnitude barely changes.[27] Therefore, a drop in labor quality is unlikely to be the main reason for our findings.

[27] Even if we use TFPR instead of TFPRC, the coefficient of FDI liberalization remains almost the same (-0.290 with s.e. 0.114).

4.3 Labor Income Share in Manufacturing Value-Added

The labor income share of GDP has been declining over the past decades in many countries (e.g. Karabarbounis and Neiman, 2014). The Chinese economy shows a similar trend: in our dataset, labor income share in the aggregate manufacturing value-added declined by 26% from 0.50 to 0.37 during 1998–2007 (remember that the labor share in 1998 is normalized to 0.50). There is active ongoing research into the causes of the labor share decline. Two candidates often mentioned are technological changes and a rise in firm's market power in goods markets. In the study of the latter candidate, for instance, Autor, Dorn, Katz, Patterson and Van Reenen (2019) investigate labor income share and industry concentration; De Loecker, Eeckhout and Unger (2019) examine output price markups. These studies focus on firm's market power in good markets, but not in labor markets.

In theory, a rise in firm's monopsony power in the labor markets also contributes to a decrease in labor income share. As shown in Appendix A.4, firm j's labor income share in value-added can be decomposed as four margins:

$$\ln \frac{w_{jt} L_{jt}}{VA_{jt}} = \ln \eta_{jt} - \ln \mu_{jt} + \ln \theta^L_{jt} - \ln \frac{VA_{jt}}{P_{jt} Y_{jt}} \tag{13}$$

where η_{jt} is the wage markdown, μ_{jt} is the output markups, θ^L_{jt} is the labor elasticity of the gross production function, and $VA_{jt}/P_{jt}Y_{jt}$ is the share of value-added in total revenue. Equation (13) shows that lower wage markdowns and lower price markups both tend to decrease labor income share.

Using decomposition (13), we examine how much FDI liberalization decreased labor income share by increasing firm's monopsony power in the labor market. To be specific, we replace the outcome variable in equation (12) with labor share and each of its four margins in (13) and conduct estimation with the same set of controls as in Column (5) of Table 6. Each of the estimated coefficients of FDI_{ct} would express the response of each margin to a particular policy event, FDI liberalization. We remark that the estimates cannot tell the importance of each margin in other contexts. Particularly, our exercise is not informative about the mechanism behind the historically declining labor share, which is explored by Autor, Dorn, Katz, Patterson and Van Reenen (2019) and De Loecker, Eeckhout and Unger (2019).

Table 8: FDI Liberalization and Firm-Level Labor Income Share

Dependent variables:	Log labor share	Log wage markdown	Log output markup	Log labor elasticity	Log value-added share
	(1)	(2)	(3)	(4)	(5)
FDI Liberalization	-0.258*	-0.307**	0.051	0.040	-0.060
	(0.158)	(0.121)	(0.048)	(0.048)	(0.088)
Controls:					
FDI determinants	yes	yes	yes	yes	yes
Other policy	yes	yes	yes	yes	yes
Vertical FDI	yes	yes	yes	yes	yes
Prefecture characteristics	yes	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes
Observations	894,310	894,310	894,310	894,310	894,310

Note: Standard errors are clustered at the prefecture level in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent. FDI determinants controls include new product intensity, export intensity, number of firms, and age at initial year. Other policy controls include: (1) prefecture's exposures to tariffs (output tariffs, input tariffs, and tariffs by foreign countries); (2) the share of state-owned enterprises among firms in a prefecture, (3) a dummy variable indicating whether a prefecture is a special economic zone or not. Vertical FDI controls include prefecture's exposure to FDI liberalization in backward and forward industries. Prefecture characteristics controls includes interactions between year dummies and the following variables in 2000: agriculture employment share, manufacturing employment share, GDP per capita, share of population with college education or above, manufacturing employment HHI, overall wage markdown and distance to the nearest port.

Table 8 examines the impact of FDI liberalization on firm-level labor income share in value-added and its four components in (13). The logs of labor income share and each component in (13) are regressed on the same set of covariates as in (12) and the fixed effects. Each column reports the coefficients of FDI_{ct}. The decomposition in (13) indicates that the coefficient in Column (1) should equal that in Column (2) minus Column (3) plus Column (4) and minus Column (5). First of all, FDI liberalization decreases labor income share in value-added. With a mean FDI_{ct} of 0.31, a firm in an average prefecture reduces labor income share by 8.0% ($\simeq 25.8\% \times 0.31$). In terms of the relative contribution of each component to the decrease in labor share induced by FDI liberalization, the decline in wage markdown in Column (2) accounts for 119% of the labor share reduction. The increase in output markup in Column (3) accelerates the decline in labor share, with relative contribution 20% of the effect. These effects are attenuated by the change in technology (labor elasticity and value-added revenue share), which account for 38% of the effect.

To see the aggregate economic magnitude, we conduct a simple counter-factual analysis. Based on the estimates in Table 8, we calculate counter-factual labor income shares and the four components without FDI liberalization, i.e. $FDI_{ct} = 0$, for each firm and each year. Assuming that FDI liberalization does not change firm's value-added share in the industry, we calculate the counter-factual aggregate labor income share in the manufacturing sector under two scenarios. In row (2) in the table, all four components in (13) are counter-factual ones without FDI liberalization; in row (3), all components except the markdown in (13) are the counter-factual. FDI liberalization may not be the main cause of the decline in labor income share, but it seems to accelerate the declining trend. From 2001 to 2007, the aggregate labor income share declined by 21.5% (5.6 points) from 0.469 to 0.368 in data. FDI liberalization accounts for 30%($\simeq 1 - 15.1/21.5$) of the change, while the expansion of wage markdown accounts for 101%($\simeq (100 - 15.1)/(100 - 21.5)$) of the FDI liberalization effect. These rough estimates should be carefully interpreted, but they suggest that the expansion of monopsony power induced by FDI liberalization could have a non-negligible impact on the aggregate labor share.

Table 9: Aggregate Labor Income Share in Manufacturing Value-Added

Labor Income Share in Aggregate Manufacturing Value-Added			
Year	2001	2007	Change
(1) Data	0.469	0.368	21.5%
(2) Without FDI Liberaliztation	0.469	0.398	15.1%
(3) Without Markdown Channel	0.469	0.404	13.9%

Note: Table reports the share of labor income in the aggregate manufacturing value-added in data and those under two counterfactual scenarios: row (2) removes all channels of the impact of FDI liberalization on labor share; row (3) removes only the markdown channel of the impact of FDI liberalization on labor share. Note that labor shares reported in the table are adjusted following the approach by Hsieh and Klenow (2009). A constant adjustment factor 1.59 is multiplied to wages reported in the firm data so that the labor income share aggregated from the firm data equals to 0.5 in 1998, which is consistent with the national accounts.

4.4 An Explanation: Search Frictional Monopsony

The conventional wisdom suggests that monopsony power increases in firm size and that competition reduces monopsony power. We have found the exact opposite: large and productive firms tended to set large wage markdowns and FDI liberalization decreased incumbent firms' wage markdowns. In Appendix B, we show that these findings indeed contrast with a classical Cournot oligopsony model where employer concentration creates monopsony power. However, concentration is not the only reason for firm's monopsony power. In this section, we show that these findings are consistent with modern monopsony theory where search frictions create monopsony power.

Burdett and Mortensen (1998) demonstrated search friction creates firm's monopsony power. In their model, workers always search for better jobs even when they are employed, so that workers may accept low wage job offers, hoping to move up to better jobs in future. Therefore, even firms offering lower wage than other firms could hire some workers. The worker's search on the job makes the labor supply curves of individual firms less elastic and allows firms to set wages lower than their MRL. This logic does not rely on either concentration or firm size. Therefore, there is no guarantee that the entry of foreign firms would make labor supply curves more elastic.

We consider an original formulation of Burdett and Mortensen (1998) and introduce FDI liberalization. There exist continuums of homogenous workers with mass L and continuums of firms with mass N. Firms are heterogeneous in productivity φ that follows distribution function $J(\varphi)$ with continuous support $[b, \varphi_{max}]$. Firms produce a numeraire good under perfect competition for

labor and constant returns to scale technology.

The model infinitely repeats the following period game. First, each firm announces wage offer w that is common for its employees. Second, both employed and unemployed workers meet a new potential employer with Poisson rate λ. An unemployed worker accepts any offer with wage w higher than unemployment benefit b, while an employed worker only accepts a higher wage offer than the current wage. Third, firms produce goods. Fourth, workers leave their jobs with exogenous rate δ and become unemployed. The time discount rate of workers and firms is negligible so that they maximize their per-period payoffs.

In a steady state, there is a positive relationship between employment and wages, which represents the labor supply curve to an individual firm:

$$l\left(w\right)=\frac{Lk}{N\left[1+k(1-F(w))\right]^{2}}\text{ for }w\in[b,\bar{w}], \tag{14}$$

where $k\equiv\lambda/\delta$ and $F(w)$ is the distribution function of wage offers. The labor supply curve is upward sloping because a high-wage firm attracts workers from other firms as well as prevents its own workers from moving to other firms.

Firms maximize per-period profits, facing labor supply curves (14):

$$\max_{w}\pi\left(w,\varphi\right)\equiv\varphi l\left(w\right)-wl\left(w\right)\text{ subject to (14).} \tag{15}$$

Supermodularity $\partial^2\pi(w,\varphi)/\partial w\partial\varphi>0$ implies that the equilibrium wage is increasing in productivity, $w'(\varphi)>0$. The lowest wage is equal to the unemployment benefit $b=w(b)$. This positive sorting of wage and productivity implies that the wage distribution agrees with the productivity distribution: $F\left(w\left(\varphi\right)\right)=J(\varphi)$ for all φ.

From some calculations shown in Appendix B, we obtain equilibrium wage markdown as:

$$\eta(\varphi)=1-\left(\frac{\varphi-b}{\varphi}\right)\frac{\bar{L}(\varphi)}{L(\varphi)},$$

where $L(\varphi)=l(w(\varphi))\equiv\frac{Lk}{N[1+k(1-J(\varphi))]^2}$ is an equilibrium employment at firm with productivity φ and $\bar{L}(\varphi)\equiv\frac{1}{\varphi-b}\int_b^s L(s)ds$ is the average employment among firms with productivity lower than φ. Wage markdown increases when $L(\varphi)/\bar{L}(\varphi)$ increases. This is intuitive, because a firm increases

wages to attract workers from lower productive firms which set lower wages. Markdown can increase or decrease with productivity, depending on the productivity distribution J. For instance, when $J(\varphi) = \varphi$ is uniform, $\eta(\varphi) = \frac{k\varphi}{1+k}$ for $\varphi > 0$. In this case, larger and more productive firms set greater markdowns, as we found in the data.

Inward FDI affects wage markdown by changing the productivity distribution of firms in the labor market. There is a robust empirical finding that foreign-owned firms are more productive and pay higher wages than domestic firms. Following these stylized facts, we model inward FDI liberalization as the entry of foreign firms with productivity support $[\varphi^F_{min}, \varphi^F_{max}]$ and $\varphi^F_{min} > b$. Inward FDI liberalization affects markdown by shifting productivity distributions to the right. We establish the following proposition.

Proposition 1. *There exists a productivity threshold $\bar{\varphi} > \varphi^F_{min}$ such that domestic firms with productivity $\varphi \leq \bar{\varphi}$ decrease wage markdown after FDI liberalization.*

The intuition is simple. Consider an incumbent firm with $\varphi < \varphi^F_{min}$ and how many additional workers it can employ by marginally increasing wages. The marginal wage increase cannot attract workers from foreign firms and the increase leads to fewer additional employment opportunities than before. In other words, the labor supply curve to the firm becomes less elastic. From (3), a fall in labor supply elasticity implies an expansion of wage markdown. Due to strategic complementarities, domestic firms with slightly higher productivity than φ_F also reduce wages and expand wage markdown because less productive firms reduce wages. Therefore, the threshold $\bar{\varphi}$ is larger than the productivity threshold φ^F_{min} of foreign firms.

Proposition 1 is silent about domestic firms with higher productivity than some foreign entrants. In the case of uniform distribution, we have a clear-cut result. Let $J_0(\varphi) = \varphi$ for $\varphi \in [0, 1]$ be the productivity distribution of incumbent firms and $b = 0$. FDI liberalization is an exogenous entry of foreign firms with mass N^* and with a uniform productivity distribution with support $[\varphi^F_{min}, 1]$ where $\varphi^F_{min} > 0$.

Proposition 2. *In the case of uniform distribution, there exists a threshold productivity $\bar{\varphi} \in (\varphi^F_{min}, 1)$ such that domestic firms with productivity $\varphi > b$ decrease wage markdown if $\varphi < \bar{\varphi}$ and increase it if $\varphi \geq \bar{\varphi}$.*

For productive domestic firms with $\varphi > \bar{\varphi}$, a marginal wage increase can attract workers from foreign firms as well as domestic firms. This neck-to-neck competition with foreign firms makes the labor supply curve to those firms more elastic. It therefore increases their wage markdowns. Notice that the threshold is higher than φ^F_{min}. Thus it is possible to make a case that in terms of productivity, only the top few firms increase their wage markdowns and the rest of firms expand them. To our knowledge, Propositions 1 and 2 are new findings in the literature.

To bring Propositions 1 and 2 to data, we investigate whether the effect of FDI liberalization on wage markdowns is heterogeneous across firms with different initial productivity. Table 10 reports the results, including interaction terms of FDI_{ct} and TFPR in the first year that a firm is observed in the data. Column (1) reports the result with interactions with log TFPR. Column (2) adds a squared log TFPR and its interactions. Consistent with the model's prediction, markdown decreases more among firms with low TFPR. There is a threshold TFPR such that firms with higher TFPR than the threshold increase wage markdown and firms with lower TFPR decrease. Using Column (1), the threshold is approximately $4.74 \simeq 0.982/0.207$, which is positioned at the 81th percentile of the log TFPR. In sum, a vast majority of low productive firms decreased wage markdowns, while a few high productive firms increased them. On average, wage markdowns are estimated to have decreased.

5 Conclusion

Recent empirical research in labor economics and industrial economics has documented that firms exercise market power in labor markets as well as in product markets. This paper has developed an empirical framework to examine how FDI liberalization affects firm's monopsony power in labor markets. In contrast to the conventional wisdom and a fact that trade liberalization usually reduces firm's monopoly power, FDI liberalization increases firm's monopsony power on average. This finding is consistent with modern monopsony theory where the source of monopsony power is search friction rather than concentration.

Whether our finding can be applied to other countries is an open question. During our data period, the protection of worker's rights in China was weak as is common in other developing countries. An interesting question is whether better labor market institutions that reduce worker's

Table 10: Heterogeneous Effects of FDI Liberalization on Firm-Level Wage Markdowns

Log wage markdown	(1)	(2)
FDI Liberalization	-0.982***	-0.969***
	(0.210)	(0.261)
FDI Liberalization $\times$ log initial TFPR	0.207***	0.193*
	(0.050)	(0.115)
FDI Liberalization $\times$ (log initial TFPR)^2		0.003
		(0.015)
Controls:		
FDI determinants	yes	yes
Other policy	yes	yes
Vertical FDI	yes	yes
Prefecture characteristics	yes	yes
Post2002 $\times$ log initial TFPR	yes	yes
Post2002 $\times$ (log initial TFPR)^2	-	yes
Firm fixed effects	yes	yes
Year fixed effects	yes	yes
Observations	1,022,961	1,022,961

Note: Standard errors are clustered at the prefecture level in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent. Initial TFPR is firm's TFPR that the firm first appears in the dataset. FDI determinants controls include new product intensity, export intensity, number of firms, and age at initial year. Other policy controls include: (1) prefecture's exposures to tariffs (output tariffs, input tariffs, and tariffs by foreign countries); (2) the share of state-owned enterprises among firms in a prefecture, (3) a dummy variable indicating whether a prefecture is a special economic zone or not. Vertical FDI controls include prefecture's exposure to FDI liberalization in backward and forward industries. Prefecture characteristics controls includes interactions between year dummies and the following variables in 2000: agriculture employment share, manufacturing employment share, GDP per capita, share of population with college education or above, manufacturing employment HHI, overall wage markdown and distance to the nearest port.

search costs can mitigate the negative effect of FDI liberalization on monopsony power. Our estimation method of wage markdowns can be applied for typical firm-level production data in many other countries. Such international comparison is left for future research.

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Online Appendix (Not for Publication)

A Derivations

A.1 The Wage-Employment Relationship in the Stole and Ziebel (1996) Bargaining

Consider a firm hiring a continuum of workers, following Mortensen (2009). A firm's gross profit is

$$\pi(p, L) = pf(L) - w(L)L,$$

where p is productivity or a given good price, $f(L)$ is firm's production function and L is employment. Assume $f' > 0$ and $f'' < 0$. Stole and Ziebel (1996) showed

$$\beta \left(pf'(L) - w'(L)L - w(L)\right) = (1-\beta)\left(w(L) - w_0\right), \tag{16}$$

where w_0 is worker's outside option. A solution for this differential equation is

$$w\left(L\right) = (1-\beta)\, w_0 + p\int_0^1 z^{\frac{1-\beta}{\beta}} f'(zL)dz,$$

which is decreasing in L since

$$w'(L) = p\int_0^1 z^{\frac{1}{\beta}} f''(zL)dz < 0.$$

Note that

$$\begin{aligned} w'(L)L &= p\int_0^1 z^{\frac{1}{\beta}} \frac{d\left\{f'(zL)\right\}}{dz} dz \\ &= pf'(L) - \frac{p}{\beta}\int_0^1 z^{\frac{1-\beta}{\beta}} f'(zL)dz \\ &= pf'(L) - \frac{1}{\beta}\left[w\left(L\right) - (1-\beta)\, w_0\right], \end{aligned}$$

which is equivalent with (16).

A.2 Heterogenous Labor

A.2.1 Imperfectly Substitutable Case

Suppose there are S types of workers and firm j's production function is

$$Y_{jt} = Y_{jt}\left(L^1_{jt}, ..., L^S_{jt}, K_{jt}, M_{jt}, \omega_{jt}\right)$$

where L^s_{jt} is type s labor input. Firm j pays wage w^s_{jt} with markdown η^s_{jt} for type s labor.

$$\eta^s_{jt} = \frac{w^s_{jt}}{\frac{\partial R_{jt}}{\partial Y_{jt}}\frac{\partial Y jt}{\partial L^s_{jt}}} = \left(\frac{w^s_{jt}L^s_{jt}}{P^M_{jt}M_{jt}}\right)\frac{\tilde{\theta}^M_{jt}}{\tilde{\theta}^s_{jt}} = \left(\frac{w^s_{jt}L^s_{jt}}{P^M_{jt}M_{jt}}\right)\frac{\theta^M_{jt}}{\theta^s_{jt}},$$

where $w^s_{jt}L^s_{jt}$ is the wage expenditure for type s. $\tilde{\theta}^s_{jt} \equiv \frac{\partial R_{jt}}{\partial S_{jt}}\frac{S_{jt}}{R_{jt}}$ and $\theta^s_{jt} \equiv \frac{\partial Y_{jt}}{\partial S_{jt}}\frac{S_{jt}}{Y_{jt}}$ are the revenue and output elasticities of type s labor, respectively.

In our data we can observe only total employment $L_{jt} = \sum_s L^s_{jt}$ and total wage payments $w_{jt}L_{jt} = \sum_s w^s_{jt}L^s_{jt}$. To calculate output elasticities of total employment θ^L_{jt}, we assume that a firm maintains the current skilled ratio:

$$\frac{dL_{jt}}{L_{jt}} = \frac{dL^s_{jt}}{L^s_{jt}} \text{ for all } s.$$

Then, θ^L_{jt} becomes

$$\begin{aligned}
\theta^L_{jt} &= \frac{dY_{jt}}{dL_j}\frac{L_j}{Y_{jt}} \\
&= \left(\sum_s \frac{\partial Y_{jt}}{\partial L^s_{jt}}\frac{dL^s_{jt}}{dL_{jt}}\right)\frac{L_{jt}}{Y_{jt}} \\
&= \left(\sum_s \frac{\partial Y_{jt}}{\partial L^s_{jt}}\frac{L^s_{jt}}{L_{jt}}\right)\frac{L_{jt}}{Y_{jt}} \\
&= \sum_s \frac{\partial Y_{jt}}{\partial L^s_{jt}}\frac{L^s_{jt}}{Y_{jt}} \\
&= \sum_s \theta^s_{jt}.
\end{aligned}$$

From these relationships, our markdown measure (7) becomes a weighted average of skilled wage

markdown and unskilled wage markdown since

$$\begin{aligned}
\eta_{jt} &= \frac{w_{jt}L_{jt}}{P^M_{jt}M_{jt}}\frac{\theta^M_{jt}}{\theta_{jt}} \\
&= \frac{\theta^M_{jt}}{P^M_{jt}M_{jt}}\left(\frac{\sum_s w^s_{jt}L^s_{jt}}{\sum_s \theta^s_{jt}}\right) \\
&= \sum_s \left(\frac{\theta^s_{jt}}{\sum_s \theta^s_{jt}}\right)\left(\frac{w^s_{jt}L^s_{jt}}{P^M_{jt}M_{jt}}\right)\frac{\theta^M_{jt}}{\theta^s_{jt}} \\
&= \sum_s \left(\frac{\theta^s_{jt}}{\sum_s \theta^s_{jt}}\right)\eta^s_{jt}. \qquad (17)
\end{aligned}$$

A.2.2 Perfectly Substitutable Case

An interesting special case is when skill types are perfectly substitutable. The production function includes labor L^*_{jt} in an efficiency unit:

$$Y_{jt} = Y_{jt}\left(L^*_{jt}, K_{jt}, M_{jt}, \omega_{jt}\right) \text{ and } L^*_{jt} = \sum_s \nu^s_{jt}L^s_{jt}$$

where L^s_{jt} is the amount of type s labor and ν^s_{jt} is a skill converter that can vary across firms and time. Let w^*_{jt} be the wage for an efficiency unit. Perfect substitutability then implies that

$$w^s_{jt} = \nu^s_{jt}w^*_{jt} \text{ and } \frac{\partial Y_{jt}}{\partial L^s_{jt}} = \nu^s_{jt}\frac{\partial Y_{jt}}{\partial L^*_{jt}}.$$

Therefore, wage markdown against type s labor becomes

$$\eta^s_{jt} \equiv \frac{w^s_{jt}}{\frac{\partial R_{jt}}{\partial Y_{jt}}\frac{\partial Y_{jt}}{\partial L^s_{jt}}} = \frac{\nu^s_{jt}w^*_{jt}}{\nu^s_{jt}\frac{\partial R_{jt}}{\partial Y_{jt}}\frac{\partial Y_{jt}}{\partial L^*_{jt}}} = \frac{w^*_{jt}}{\frac{\partial R_{jt}}{\partial Y_{jt}}\frac{\partial Y_{jt}}{\partial L^*_{jt}}} \equiv \eta^*_{jt}.$$

Then, from equation (17), our markdown measure η_{jt} equals to this common markdown η^*_{jt}.

A.3 Wage Markdown by State-Owned Enterprises

SOE firm's maximization problem with respect to labor is:

$$\max_{L_{jt}} R_{jt}(Y_{jt}) - w_{jt}(L_{jt})L_{jt} + \gamma L_{jt}.$$

The first order condition implies that

$$
\begin{aligned}
MRL_{jt} \equiv \frac{\partial R_{jt}}{\partial L_{jt}} &= w_{jt}(L_{jt}) + w'_{jt}(L_{jt})L_{jt} - \gamma \\
&= w_{jt}\left[1 + \frac{1}{\varepsilon_{jt}} - \frac{\gamma}{w_{jt}}\right]. \\
&= w_{jt}\left(\frac{1+\varepsilon_{jt}}{\varepsilon_{jt}}\right)\left[1 - \frac{\gamma}{w_{jt}}\left(\frac{\varepsilon_{jt}}{1+\varepsilon_{jt}}\right)\right].
\end{aligned}
$$

The wage markdown is then

$$
\frac{w_{jt}}{MRL_{jt}} = \left(\frac{\varepsilon_{jt}}{\varepsilon_{jt}+1}\right)\left[1 - \frac{\gamma}{w_{jt}}\left(\frac{\varepsilon_{jt}}{1+\varepsilon_{jt}}\right)\right]^{-1}.
$$

A.4 Labor Share Decomposition

Using the first order condition for profit maximization $\frac{\partial R_{jt}}{\partial Y_{jt}} = mc_{jt}$, MRL can be simplified as

$$
\begin{aligned}
MRL_{jt} &= \frac{\partial R_{jt}}{\partial Y_{jt}}\frac{\partial F_{jt}}{\partial L_{jt}} \\
&= mc_{jt}\frac{\partial F_{jt}}{\partial L_{jt}} \\
&= \frac{mc_{jt}}{P_{jt}}\left(\frac{\partial F_{jt}}{\partial L_{jt}}\frac{L_{jt}}{F_{jt}}\right)\frac{P_{jt}Y_{jt}}{L_{jt}} \\
&= \frac{\theta^L_{jt}}{\mu_{jt}}\left(\frac{P_{jt}Y_{jt}}{L_{jt}}\right)
\end{aligned}
$$

The labor income share in value-added then becomes

$$
\begin{aligned}
\frac{w_{jt}L_{jt}}{VA_{jt}} &= \eta_{jt}L_{jt}\left(\frac{MRL_{jt}}{VA_{jt}}\right) \\
&= \frac{\eta_{jt}\theta^L_{jt}}{\mu_{jt}}\left(\frac{P_{jt}Y_{jt}}{VA_{jt}}\right).
\end{aligned}
$$

B FDI Liberalization in Canonical Monopsony Models

B.1 Employer Concentration

The concentration of employers (e.g. company towns) is a classic reason that firms face upward sloping labor supply curves. Consider Cournot oligopsony as a canonical model. There are N firms and each firm j decides employment L_i, taking other firm's employment as given. Let L^A be the aggregate employment and $w(L^A)$ be an inverse labor supply curve to the industry with elasticity $\varepsilon^A \equiv \frac{w(L^A)}{w'^A)L^A} > 0$. Let $R(\varphi_i, L_i)$, φ_i, L_i and $s_j \equiv L_j/L^A$ be firm j's revenue, productivity, employment and employment share, respectively. Firm j's profit maximization problem can then be written as

$$\max_{L_j} R(\varphi_i, L_j) - w\left(\sum_j L_j\right) L_j$$

The first order condition leads to wage markdowns

$$\eta_j = \frac{\varepsilon_j}{\varepsilon_j + 1} = \frac{\varepsilon^A/s_j}{\varepsilon^A/s_j + 1}. \tag{18}$$

Thus, the elasticity of labor supply to an individual firm $\varepsilon_j = \varepsilon^A/s_j$ depends on industry-level labor supply and the firm's employment share.

Cournot oligopsony conforms with the conventional wisdom. First, equation (18) implies that when we compare two firms j and k, $\eta_j > \eta_k$ if and only if $s_j < s_k$. Thus, large employers exercise greater monopsony power and exhibit smaller markdowns than small employers. In a typical case where $\partial^2 R/\partial\varphi\partial L > 0$, employment increases in productivity. Thus, monopsony power increases in productivity. Second, equation (18) implies a limit theorem for Cournot oligopsony. When the number of firms increases toward infinity and ε^A is finite, each firm's employment share approaches zero and markdowns converge to one as in a perfectly competitive labor market. This limit theorem contributes to the conventional wisdom that new entrants such as those after FDI liberalization would reduce incumbent firm's monopsonic power and increase their wage markdowns.[28]

[28] Of course, if new entry is finite, it is theoretically possible that markdowns decrease, i.e. ε^A/s_j decreases, when ε^A shrinks significantly and offsets a fall in employment shares s_j. However, this is not considered as a typical case.

B.2 Job Differentiation

In a goods market, a firm may face a downward-sloping demand curve because of product differentiation. Similarly, a firm may face an upward-sloping labor supply curve because of job differentiation. That is, workers may have preferences for jobs' non-monetary characteristics so that a wage cut does not necessarily lead to losing all of the employees. As a canonical model, we consider a logit model (e.g., Card, Cardoso, Heining and Klein, 2018). There are N firms that produce a homogenous numeraire good from labor and constant returns to scale technology. A worker n receives net utility $U_{nj} = \ln v_j(w_j) + \varepsilon_{nj}$ from working at firm j, where w_j is firm j's wage. The second term ε_{nj} is the worker's utility from non-monetary characteristics of working at firm j, and it independently follows the Gumbel distribution. There is a continuum of workers with mass L, and workers are homogenous except ε_{nj}. By standard arguments of the Logit model, a labor supply supply curve to firm j becomes

$$L_j(w_j) = \left(\frac{v_j\left(w_j\right)}{\sum_{k=1}^{N} v_k\left(w_k\right)} \right) L^A, \tag{19}$$

where N is the number of firms and L^A is the aggregate labor supply. Let $R(\varphi_i, L_i)$, φ_i, L_i and $s_j \equiv L_j/L^A$ be firm j's revenue, productivity, employment and employment share, respectively. Firm j's profit maximization problem is written as

$$\max_{w_j} R(\varphi_j, L_j(w_j)) - w_j L_j\left(w_j\right) \text{ subject to (19).}$$

In a typical case where $\partial^2 R/\partial\varphi\partial L > 0$, wage is increasing in productivity. Thus, more productive firms offer higher wages to hire more workers. Since the elasticity of labor supply is $\varepsilon_j = \kappa_j(w_j)\left(1 - s_j\right)$, wage markdown is

$$\eta_j = \frac{\varepsilon_j}{\varepsilon_j + 1} = \frac{\kappa_j(w_j)\left(1 - s_j\right)}{\kappa_j(w_j)\left(1 - s_j\right) + 1}, \tag{20}$$

where $\kappa_j\left(w\right) \equiv v_j'(w_j)w_j/v(w_j)$ is the elasticity of v_j and $s_j \equiv L_j/L^A$ is firm j's employment share.

In the logit oligopsony model, wage markdown is determined by the curvature of monetary

utility as well as by concentration. When κ_j is a common constant such as $\kappa_j = \kappa$ for all j, the logit model predicts similar results to Cournot oligopsony. First, equation (3) implies that when we compare two firms j and k, $\eta_j > \eta_k$ if and only if $s_j < s_k$. Larger and more productive employers exercise greater monopsony power and exhibit smaller markdowns than smaller and lower productive employers. FDI liberalization will shrink the wage markdowns of incumbents by decreasing their employment shares. When $\kappa_j(w_j)$ can vary with the wage, these predictions become ambiguous. When N is large and the market becomes monopsonically competitive, $\varepsilon_j = \kappa_j(w_j)$ holds and wage markdown becomes

$$\eta_j = \frac{\varepsilon_j}{\varepsilon_j + 1} = \frac{\kappa_j(w_j)}{\kappa_j(w_j) + 1},$$

which is determined solely by the curvature of the monetary utility κ_j. Therefore, it is theoretically possible that FDI liberalization decreases wage markdowns of incumbents away from the perfect competitive case.

B.3 An Equilibrium of the Burdett-Mortensen Model

This section presents calculations for obtaining an equilibrium in the Burdett-Mortensen model which are omitted from the main text.

Labor Supply Curve A stationary steady state requires the size of unemployed workers and that of each wage group to be stable overtime, which implies the following two conditions:

$$\begin{aligned} &\delta(1-u)L = \lambda u L, \\ &\lambda F(w) u L = [\delta + \lambda (1 - F(w))] N \int_b^w l(t)\, dF(t) \text{ for all } w \text{ on the support of } F(w), \end{aligned} \tag{21}$$

where u is unemployment rate, N is the number of firms in this labor market, $l(w)$ is the employment in a firm that offers wage w, and $F(w)$ is the distribution of wage offers among firms. The first equation represents the size of unemployed workers. The inflow into unemployment on the left-hand side equals the outflow from unemployment on the right-hand side. The second equation is the inflow and the outflow into a group of employed workers who currently receive

wages lower than w. The left-hand side expresses that a mass uL of unemployed workers join this group with probability $\lambda F(w)$. The right-hand side expresses that workers in this group with size $N \int_b^w l(t)\, dF(t)$ leave the group either because of being unemployed with rate δ or moving to better-paying job with rate $\lambda(1 - F(w))$.

A celebrated result by Burdett and Mortensen (1998) is that F has a continuous support $[b, \bar{w}]$ for some $\bar{w} > b$. See their paper for a formal proof. The intuition is that if the support is $[b, w_0] \cup [w_1, \bar{w}]$ and $w_1 > w_0$ with a gap, a firm setting w_0 can disproportionally increase employment and profits by infinitesimally increasing its wage to $w_0 + \varepsilon$. Differentiating (21) by w, we obtain a positive relation between employment and wage in a steady state:

$$l(w) = \frac{Lk}{N\left[1 + k(1 - F(w))\right]^2} \text{ for } w \in [b, \bar{w}], \tag{22}$$

where $k \equiv \lambda/\delta$.

Equilibrium Wage Markdown We obtain an equilibrium as follows. Substituting $F(w(\varphi)) = J(\varphi)$ into the labor supply curve, we obtain equilibrium employment of firm with productivity φ:

$$L(\varphi) = l(w(\varphi)) = \frac{Lk}{N\left[1 + k(1 - J(\varphi))\right]^2}. \tag{23}$$

By applying the envelop theorem for $\pi(\varphi)$ in (15), we obtain $\pi'(\varphi) = L(\varphi)$. Integrating and setting $\pi(b) = 0$ yields the profit function

$$\begin{aligned}
\pi(\varphi) &= \int_b^{\varphi} \pi'(x)\, dx + \pi(b) \\
&= \int_b^{\varphi} L(x)\, dx \\
&= (\varphi - b)\bar{L}(\varphi)
\end{aligned}$$

where

$$\bar{L}(\varphi) \equiv \frac{1}{\varphi - b} \int_b^{\varphi} l(s)\, ds \tag{24}$$

may be interpreted as a weighted average of employment among firms with productivity lower than φ. From the above, we obtain

$$\pi(\varphi) = (\varphi - w(\varphi))L(\varphi) = (\varphi - b)\bar{L}(\varphi).$$

Then, we obtain the markdown $\eta(\varphi) \equiv w(\varphi)/\varphi$ as

$$\begin{aligned}
\eta(\varphi) =& \frac{w(\varphi)}{\varphi} \\
=& 1 - \left(\frac{\varphi - b}{\varphi}\right)\frac{\bar{L}(\varphi)}{L(\varphi)} \\
=& 1 - \frac{1}{\varphi}\int_b^{\varphi}\left(\frac{1 + k(1 - J(\varphi))}{1 + k(1 - J(s))}\right)^2 ds \\
=& 1 - \frac{\int_b^{\varphi} f(s)ds}{f(\varphi)\varphi}
\end{aligned} \tag{25}$$

where

$$f(\varphi) \equiv \left(\frac{1}{1 + k(1 - J(s))}\right)^2.$$

Uniform Distribution Case Define

$$\vartheta(\varphi) \equiv \frac{1}{\varphi}\int_0^{\varphi}\left(\frac{1 + k(1 - J(\varphi))}{1 + k(1 - J(s))}\right)^2 ds \text{ and } v \equiv \frac{k}{1 + k}.$$

Then, it follows that

$$\begin{aligned}
\vartheta(\varphi) &= \frac{1}{\varphi}\int_0^{\varphi}\left(\frac{1 + k(1 - \varphi)}{1 + k(1 - s)}\right)^2 ds \\
&= \frac{(v - \varphi)^2}{\varphi}\int_0^{\varphi}\frac{1}{(v - s)^2}ds \\
&= \frac{(v - \varphi)^2}{\varphi}\int_0^{\varphi}\left(\frac{1}{v - s}\right)' ds. \\
&= \frac{(v - \varphi)^2}{\varphi}\left[\frac{1}{v - \varphi} - \frac{1}{v}\right] \\
&= \frac{(v - \varphi)^2}{\varphi}\left[\frac{\varphi}{v(v - \varphi)}\right] \\
&= \frac{v - \varphi}{v}.
\end{aligned}$$

We obtain the markdown function

$$\eta(\varphi) = 1 - \vartheta(\varphi) = \frac{\varphi}{v} = \frac{k}{1+k}\varphi.$$

Proof for Proposition 1 Define

$$a(s) \equiv \frac{f_0(s)}{f_1(s)} = \left(\frac{1-\rho J_1(s)}{1-\rho J_0(s)}\right)^2$$

where $\rho \equiv k/(1+k)$.We first prove the following lemmas.

Lemma 1. *If $a'(s) \geq 0$ for all $s \leq \varphi$, then $\eta_1(\varphi) < \eta_0(\varphi)$.*

Proof. Under the condition, it holds that

$$\frac{\int_b^\varphi f_0(s)ds}{f_0(\varphi)} = \frac{\int_b^\varphi a(s)f_1(s)ds}{a(\varphi)f_1(\varphi)} < \frac{a(\varphi)\int_b^\varphi f_1(s)ds}{a(\varphi)f_1(\varphi)} = \frac{\int_b^\varphi f_1(s)ds}{f_1(\varphi)}.$$

Thus, $\eta_1(\varphi) < \eta_0(\varphi)$ from (25). □

Lemma 2. *If φ is lower than productivities of all foreign entrants, then $a'(s) \geq 0$ for all $s \in (b, \varphi]$.*

Proof. Under the condition, the share of low productive firms decreases: $j_0(s) > j_1(s)$ and $J_0(s) > J_1(s)$ for all $s \leq \varphi$. Then,

$$\begin{aligned} a'(s) &= 2a(s)^{1/2}\left[\frac{-\rho j_1(s)(1-\rho J_0(s)) + \rho j_0(s)(1-\rho J_1(s))}{(1-\rho J_0(s))^2}\right] \\ &= 2a(s)^{1/2}\left[\frac{\rho\left(j_0(s)-j_1(s)\right)(1-\rho J_1(s)) + \rho^2 j_1(s)(J_0(s)-J_1(s))}{(1-\rho J_0(s))^2}\right] > 0. \end{aligned} \tag{26}$$

□

Proof for Proposition 2

Proof. Let $N_0 = N$ and $N_1 = N + N^*$ be the mass of firms before and after liberalization. In the uniform case, $J_0(s) = s$ and

$$J_1(s) = \begin{cases} \beta s & \text{for } \varphi \in [0, \varphi_{min}^F] \\ 1 - \theta(1-s) & \text{for } \varphi \in [\varphi_{min}^F, 1], \end{cases}$$

where $\beta = \frac{N_0}{N_1} < 1$ and $\theta \equiv (1 - a\beta)/(1 - a) > 1$. Then, their densities become $j_0(s) = 1$ and

$$j_1(s) = \begin{cases} \beta & \text{for } \varphi \in [0, \varphi^F_{min}] \\ \theta & \text{for } \varphi \in [\varphi^F_{min}, 1]. \end{cases}$$

From (26),

$$a'(\varphi) = \begin{cases} 2a(s)^{1/2}\left[\frac{\rho(1-\beta)}{(1-\rho s)^2}\right] > 0 & \text{for } \varphi \in (0, \varphi^F_{min}) \\ -2a(s)^{1/2}\left[\frac{\rho(\theta-1)(1-\rho)}{(1-\rho s)^2}\right] < 0 & \text{for } \varphi \in (\varphi^F_{min}, 1). \end{cases}$$

Since $a(0) = a(1) = 1$ and $a(s)$ is continuous, it holds that $a(s) > 1$ for $s \in (0, 1)$. There, we have $\eta_0(1) < \eta_1(1)$ since

$$\frac{\int_b^1 f_0(s)ds}{f_0(1)} = \frac{\int_b^1 a(s)f_1(s)ds}{a(1)f_1(1)} > \frac{a(1)\int_b^1 f_1(s)ds}{a(1)f_1(1)} = \frac{\int_b^1 f_1(s)ds}{f_1(\varphi)}.$$

From Proposition 1, $\eta_0(\varphi^F_{min}) > \eta_1(\varphi^F_{min})$. Since $\frac{\int_b^\varphi f_0(s)ds}{f_0(\varphi)}$ and $\frac{\int_b^\varphi f_1(s)ds}{f_1(\varphi)}$ are continuous, there exists a threshold $\bar{\varphi}$ such that

$$\frac{\int_b^{\bar{\varphi}} f_0(s)ds}{f_0(\bar{\varphi})} = \frac{\int_b^{\bar{\varphi}} f_1(s)ds}{f_1(\bar{\varphi})}.$$

□

C Production Function Estimation

Consider the following production function of firm j at time t in the level and log forms, respectively:

$$Y_{jt} = F(k_{jt}, l_{jt}, m_{jt}) \exp(\omega_{jt} + \varepsilon_{jt})$$
$$y_{jt} = f(k_{jt}, l_{jt}, m_{jt}) + \omega_{jt} + \varepsilon_{jt},$$

where $y_{jt} \equiv \ln Y_{jt}$, $k_{jt} \equiv \ln K_{jt}$, $l_{jt} \equiv \ln L_{jt}$, and $m_{jt} \equiv \ln M_{jt}$. Function $f \equiv \ln F$ takes a flexible form and will be approximated by polynomials below. Terms ω_{jt} and ε_{jt} are Hicks neutral productivity shocks: ε_{jt} is unanticipated to production and i.i.d. shocks with $E[\varepsilon_{jt}] = 0$

including measurement errors; ω_{jt} are known to firms when materials m_{jt} and labor l_{jt} are chosen, but unknown when capital k_{jt} (or investment at $t-1$) is chosen. In the estimation, f is assumed to be common throughout the 2-digit industry-level.

Following De Loecker (2011) and GNR, the output market is assumed to be monopolistically competitive in each 4 digit product market. Each firm faces an individual demand curve derived from the CES utility function:

$$Y_{jt} = \exp(\chi_{jt}) Y_{gt} \left(\frac{P_{jt}}{\Pi_{gt}} \right)^{\sigma_{st}} \text{ where } \sigma_t < -1, \tag{27}$$

P_{jt} is firm j's price, Π_{gt} is the product-level (4-digit industry level) price index, Y_{gt} is product-level demand-shifter and χ_{jt} is a firm-level demand shifter that is known to the firm. Following De Loecker (2011) and GNR, the elasticity of demand $\sigma_{st}(< -1)$ is defined as negative, is specific to a subgroup s of firms, and may vary over time. This implies that an expected output markup is also subgroup-time specific, though realized markups can vary across firms within subgroups. A subgroup s is obtained by dividing each 3-digit category into two groups of 4-digit products based on whether or not they are classified as FDI-liberalized products.[29]

From the demand function (27), firm's revenue $R_{jt} = P_{jt} Y_{jt}$ becomes

$$R_{jt} = Y_{gt}^{-1/\sigma_{st}} \Pi_t \exp\left(\tilde{\varepsilon}_{jt} + \omega_{jt}^{\mu}\right) \left[F(k_{jt}, l_{jt}, m_{jt})\right]^{(\sigma_{st}+1)/\sigma_{st}}, \tag{28}$$

where $\omega_{jt}^{\mu} \equiv \left(\frac{\sigma_{st}+1}{\sigma_{st}}\right)(\omega_{jt} + \chi_{jt})$ is a combined positive shock to firm revenue known to the firm at time t. Following De Loecker (2011; 2013), we assume that ω_{jt}^{μ} follow a Markov process $\omega_{jt}^{\mu} = h\left(\omega_{jt-1}^{\mu}, \mathbf{W}_{jt-1}\right) + \eta_{jt}^{\mu}$ where firms with different characteristics $\mathbf{W}_{jt-1}$ face different productivity motions, which will be specified below.

Consider the expected profit maximization with respect to materials,

$$\max_{M_{jt}} Y_{gt}^{-1/\sigma_{st}} \Pi_t \exp\left(\omega_{jt}^{\mu}\right) \left[F(k_{jt}, l_{jt}, m_{jt})\right]^{(\sigma_{st}+1)/\sigma_{st}} \tilde{\mathcal{E}} - P_{jt}^{M} M_{jt}$$

[29] Theoretically one could allow σ_{gt} to be product-time varying, but the sample becomes too small to obtain stable coefficients.

where $\tilde{\mathcal{E}} \equiv E\left[\exp\left(\tilde{\varepsilon}_{jt}\right)\right]$ and $\tilde{\varepsilon}_{jt} \equiv \left(\frac{\sigma_{st}+1}{\sigma_{st}}\right)\varepsilon_{jt}$. Using (28), we obtain the first order condition as:

$$\left(\frac{\sigma_{st}+1}{\sigma_{st}}\right)\exp\left(-\tilde{\varepsilon}_{jt}\right)\frac{R_{jt}}{F}\frac{\partial F(k_{jt},l_{jt},m_{jt})}{\partial M_{jt}}\tilde{\mathcal{E}} = P_{jt}^{M}$$

By taking the log of both sides, using $\frac{\partial f(k_{jt},l_{jt},m_{jt})}{\partial m_{jt}} = \frac{M_{jt}}{F}\frac{\partial F(k_{jt},l_{jt},m_{jt})}{\partial M_{jt}}$, and denoting $s_{jt} \equiv \ln \alpha_{jt}^{M} = \ln\left(\frac{P_{jt}^{M}M_{jt}}{R_{jt}}\right)$, the first order condition is simplified to

$$s_{jt} = \ln\left(\frac{\sigma_{st}+1}{\sigma_{st}}\right) + \ln\tilde{\mathcal{E}} + \ln\frac{\partial f(k_{jt},l_{jt},m_{jt})}{\partial m_{jt}} - \tilde{\varepsilon}_{jt}.$$

We approximate output elasticities on materials, $\frac{\partial f(k_{jt},l_{jt},m_{jt})}{\partial m_{jt}} = \exp\left(\mu\right)D^{\mu}(k_{jt},l_{jt},m_{jt};\gamma)$ where μ is constant to be estimated below and $D^{\mu}(k_{jt},l_{jt},m_{jt};\gamma)$ is a second order polynomials

$$\begin{aligned} D^{\mu}(k_{jt},l_{jt},m_{jt};\gamma) \equiv\ & \gamma_0 + \gamma_k k_{jt} + \gamma_l l_{jt} + \gamma_m m_{jt} + \gamma_{kk}k_{jt}^2 + \gamma_{ll}l_{jt}^2 \\ & + \gamma_{mm}m_{jt}^2 + \gamma_{kl}k_{jt}l_{jt} + \gamma_{km}k_{jt}m_{jt} + \gamma_{lm}l_{jt}m_{jt}, \end{aligned}$$

where $\gamma \equiv (\gamma_0, \gamma_k, \gamma_l, \gamma_m, \gamma_{kk}, \gamma_{ll}, \gamma_{mm}, \gamma_{kl}, \gamma_{km}, \gamma_{lm})$ is a vector of parameters.

The estimation consists of two steps. The first step is to estimate

$$\begin{aligned} s_{jt} &= \left[\ln\left(\frac{\sigma_{st}+1}{\sigma_{st}}\right) + \mu + \ln\tilde{\mathcal{E}}\right] + \ln D^{\mu}(k_{jt},l_{jt},m_{jt};\gamma) - \tilde{\varepsilon}_{jt} \\ &= \delta_{st} + \ln D^{\mu}(k_{jt},l_{jt},m_{jt};\gamma) - \tilde{\varepsilon}_{jt} \end{aligned} \tag{29}$$

by non-linear least squares where δ_{st} is subgroup-year fixed effects and $\tilde{\varepsilon}_{jt}$ is treated as an error term. Using the residuals $\hat{\tilde{\varepsilon}}_{jt}$, we construct $\hat{\tilde{\mathcal{E}}}$, an estimate of $\tilde{\mathcal{E}} \equiv E\left[\exp\left(\tilde{\varepsilon}_{jt}\right)\right]$, by the sample mean of $\exp(\hat{\tilde{\varepsilon}}_{jt})$.

Consider the log of the real revenue function deflated by the price index $r_{jt} \equiv \ln\left(R_{jt}/\Pi_t\right)$ from (28):

$$r_{jt} = \left(\frac{\sigma_{st}+1}{\sigma_{st}}\right)f(k_{jt},l_{jt},m_{jt}) - \frac{1}{\sigma_{st}}\ln Y_{gt} + \omega_{jt}^{\mu} + \tilde{\varepsilon}_{jt}. \tag{30}$$

Substituting $\left(\frac{\sigma_{st}+1}{\sigma_{st}}\right) = \exp\left(\hat{\delta}_{st} - \mu\right)/\hat{\bar{\mathcal{E}}}$, we obtain

$$r_{jt} = \frac{\exp\left(\hat{\delta}_{st}\right)}{\hat{\bar{\mathcal{E}}}} \exp\left(-\mu\right) f(k_{jt}, l_{jt}, m_{jt}) - \left[\frac{\exp\left(\hat{\delta}_{st} - \mu\right)}{\hat{\bar{\mathcal{E}}}} - 1\right] \ln Y_{gt} + \omega^{\mu}_{jt} + \tilde{\varepsilon}_{jt}. \tag{31}$$

Following Klette and Griliches (1996), De Loecker (2010) and GNR, we use the market share weighted average of deflated revenues $\ln \hat{Y}_{gt} \equiv \sum_{j=1}^{N} \left(R_{jt}/\sum_{k\in N_{gt}} R_{kt}\right) r_{jt}$ for the product demand shifter $\ln Y_{gt}$, where N_{gt} is the set of firms that produce positive output of product g in both t and $t-1$. Since $D^{\mu}(k_{jt}, l_{jt}, m_{jt}; \gamma) = \exp\left(-\mu\right) \frac{\partial f(k_{jt}, l_{jt}, m_{jt})}{\partial m_{jt}}$, its integration by m_{jt} leads to

$$\exp\left(-\mu\right) f(k_{jt}, l_{jt}, m_{jt}) = \int D^{\mu}(k_{jt}, l_{jt}, m_{jt}; \gamma) dm_{jt} + \exp\left(-\mu\right) \mathscr{C}(k_{jt}, l_{jt}), \tag{32}$$

where $\mathscr{C}(k_{jt}, l_{jt}) \equiv f(k_{jt}, l_{jt}, m_{jt}) - \int \frac{\partial f(k_{jt}, l_{jt}, m_{jt})}{\partial m_{jt}} dm_{jt}$ is the constant of the integration that is a function of k_{jt} and l_{jt}. We approximate $\mathscr{C}(k_{jt}, l_{jt})$ with second order polynomials in k_{jt} and l_{jt}:[30]

$$\mathscr{C}(k_{jt}, l_{jt}, \kappa) \equiv \kappa_k k_{jt} + \kappa_l l_{jt} + \kappa_{kk} k_{jt}^2 + \kappa_{ll} l_{jt}^2 + \kappa_{kl} k_{jt} l_{jt},$$

where $\kappa \equiv (\kappa_k, \kappa_l, \kappa_{kk}, \kappa_{ll}, \kappa_{kl})$ is a vector of parameters.

Using the estimated coefficients $\hat{\gamma}$, $\hat{\delta}_{st}$, residuals, $\hat{\bar{\mathcal{E}}}$ from (29) and real revenue r_{jt}, we can construct

$$\mathcal{R}_{jt} \equiv r_{jt} - \frac{\exp\left(\hat{\delta}_{st}\right)}{\hat{\bar{\mathcal{E}}}} \int D^{\mu}(k_{jt}, l_{jt}, m_{jt}; \hat{\gamma}) dm_{jt} - \hat{\bar{\varepsilon}}_{jt}$$

where

$$\begin{aligned}\int D^{\mu}(k_{jt}, l_{jt}, m_{jt}; \hat{\gamma}) dm_{jt} =& m_{jt} \Bigg(\hat{\gamma}_0 + \hat{\gamma}_k k_{jt} + \hat{\gamma}_l l_{jt} + \frac{\hat{\gamma}_m}{2} m_{jt} + \hat{\gamma}_{kk} k_{jt}^2 + \hat{\gamma}_{ll} l_{jt}^2 \\ &+ \frac{\hat{\gamma}_{mm}}{3} m_{jt}^2 + \hat{\gamma}_{kl} k_{jt} l_{jt} + \frac{\hat{\gamma}_{km}}{2} k_{jt} m_{jt} + \frac{\hat{\gamma}_{lm}}{2} l_{jt} m_{jt}\Bigg).\end{aligned}$$

[30]Note that $\mathscr{C}(k_{jt}, l_{jt})$ should not include a constant term because $f(k_{jt}, l_{jt}, m_{jt})$ does not contain it.

Substituting $\mathcal{R}_{jt}$ and (32) into (31), we obtain ω_{jt}^{μ} from (31) as a function of μ and κ:

$$\omega_{jt}^{\mu} = \mathcal{R}_{jt} - \frac{\exp\left(\hat{\delta}_{st} - \mu\right)}{\hat{\hat{\mathcal{E}}}} \mathscr{C}(k_{jt}, l_{jt}, \kappa) + \frac{\exp\left(\hat{\delta}_{st} - \mu\right)}{\hat{\hat{\mathcal{E}}}} \ln \hat{Y}_{gt}.$$

Letting $\rho \equiv \left[\hat{\hat{\mathcal{E}}} \exp(\mu)\right]^{-1}$ and $\upsilon \equiv \rho\kappa$ further simplifies ω_{jt}^{μ} as a function of ρ and υ:

$$\omega_{jt}^{\mu}(\rho, \upsilon) = \tilde{\mathcal{R}}_{jt} - \tilde{\mathscr{C}}(k_{jt}, l_{jt}, \upsilon) + \rho \ln \tilde{Y}_{gt}$$

where $\tilde{\mathcal{R}}_{jt} \equiv \mathcal{R}_{jt} - \ln \hat{Y}_{gt}$, $\ln \tilde{Y}_{gt} \equiv \exp\left(\hat{\delta}_{st}\right) \ln \hat{Y}_{gt}$ and $\tilde{\mathscr{C}}(k_{jt}, l_{jt}, \upsilon) \equiv \exp\left(\hat{\delta}_{st}\right) \mathscr{C}(k_{jt}, l_{jt}, \upsilon)$.

The dynamic motion of ω_{jt}^{μ} can be written as

$$\omega_{jt}^{\mu}(\rho, \zeta) = h\left(\omega_{jt-1}^{\mu}(\rho, \upsilon), \mathbf{W}_{jt-1}, \delta_p, \delta_g\right) + \xi_{jt}.$$

The control variables $\mathbf{W}_{jt}$ include the following variables on ownerships, trade and FDI that potentially affect productivity evolution: a dummy indicating the state-owned enterprises (SOEs dummy), a dummy indicating the foreign-invested enterprises (FIEs dummy), an export status dummy, output tariffs, input tariffs constructed from an input-output table, FDI equity shares in the industry (horizontal FDI), FDI equity shares in the upstream industries (backward FDI), FDI equity shares in the downstream industries (forward FDI). δ_p and δ_g are province fixed effects and four-digit industry fixed effects, respectively. We approximate h with the second order polynomials

$$\begin{aligned} h\left(\omega_{jt-1}^{\mu}, \mathbf{W}_{jt-1}, \delta_p, \delta_g\right) &= \delta_p + \delta_g + \zeta_{\omega}\omega_{jt-1}^{\mu} + \zeta_{\omega\omega}\left(\omega_{jt-1}^{\mu}\right)^2 + \mathbf{W}_{jt-1}'\boldsymbol{\zeta}_W. \\ &\quad + \omega_{jt-1}^{h}\mathbf{W}_{jt-1}'\boldsymbol{\zeta}_{\omega W} + \left(\omega_{jt-1}^{h}\right)^2 \mathbf{W}_{jt-1}'\boldsymbol{\zeta}_{\omega\omega z}. \end{aligned}$$

We estimate the parameters as follows. We first choose a given value of (ρ, υ) and regress $\omega_{jt}^{\mu}(\rho, \upsilon)$ on $h\left(\omega_{jt-1}^{\mu}(\rho, \upsilon), \mathbf{W}_{jt-1}, \delta_p, \delta_g\right)$ to obtain $\xi_{jt}(\rho, \upsilon)$ as a function of (ρ, υ). Following De Loecker (2011) and De Loecker and Warzynski (2012), we assume

$$\mathbf{M}_{jt} \equiv \left(k_{jt}, l_{jt-1}, k_{jt}^2, l_{jt-1}^2, k_{jt}l_{jt-1}, \ln \hat{Y}_{t-1}\right)'$$

are pre-determined at time t and orthogonal to the productivity innovation $\xi_{jt}(\rho, \upsilon)$. Then, we con-

struct six moment conditions $E\left(\xi_{jt}(\rho,\upsilon)\mathbf{M}_{jt}\right)=0$ and estimate six parameters (ρ,υ) by GMM.[31]

Once we obtain $(\hat{\rho},\hat{\upsilon})$, we first obtain $\exp(\hat{\mu})=\left[\hat{\bar{\mathcal{E}}}\hat{\rho}\right]^{-1}$ and $\hat{\kappa}=\hat{\upsilon}\left[\exp\left(\hat{\delta}_{st}\right)\hat{\rho}\right]^{-1}$. Then, we obtain output elasticities $\hat{\theta}^L_{jt}$ and $\hat{\theta}^M_{jt}$. First, material elasticities are obtained from $\hat{\theta}^M_{jt}=\frac{\partial f(k_{jt},l_{jt},m_{jt})}{\partial m_{jt}}=\exp\left(\hat{\mu}\right)D^{\mu}(k_{jt},l_{jt},m_{jt};\hat{\gamma})$. Defining $\tilde{\gamma}_i\equiv\hat{\gamma}_i\exp\left(\hat{\mu}\right)$, we obtain

$$\begin{aligned}\hat{\theta}^M_{jt}=&\exp\left(\hat{\mu}\right)\left(\hat{\gamma}_0+\hat{\gamma}_k k_{jt}+\hat{\gamma}_l l_{jt}+\hat{\gamma}_m m_{jt}+\hat{\gamma}_{kk}k^2_{jt}+\hat{\gamma}_{ll}l^2_{jt}\right.\\&\left.+\hat{\gamma}_{mm}m^2_{jt}+\hat{\gamma}_{kl}k_{jt}l_{jt}+\hat{\gamma}_{km}k_{jt}m_{jt}+\hat{\gamma}_{lm}l_{jt}m_{jt}\right).\end{aligned}$$

The estimated production function is then

$$\begin{aligned}\hat{f}(k_{jt},l_{jt},m_{jt})=&\exp\left(\hat{\mu}\right)\int D^{\mu}(k_{jt},l_{jt},m_{jt};\hat{\gamma})dm_{jt}+\mathscr{C}(k_{jt},l_{jt},\hat{\kappa}),\\=&\exp\left(\hat{\mu}\right)m_{jt}\left(\hat{\gamma}_0+\hat{\gamma}_k k_{jt}+\hat{\gamma}_l l_{jt}+\frac{\hat{\gamma}_m}{2}m_{jt}+\hat{\gamma}_{kk}k^2_{jt}+\hat{\gamma}_{ll}l^2_{jt}\right.\\&\left.+\frac{\hat{\gamma}_{mm}}{3}m^2_{jt}+\hat{\gamma}_{kl}k_{jt}l_{jt}+\frac{\hat{\gamma}_{km}}{2}k_{jt}m_{jt}+\frac{\hat{\gamma}_{lm}}{2}l_{jt}m_{jt}\right)\\&+\hat{\kappa}_k k_{jt}+\hat{\kappa}_l l_{jt}+\hat{\kappa}_{kk}k^2_{jt}+\hat{\kappa}_{ll}l^2_{jt}+\hat{\kappa}_{kl}k_{jt}l_{jt}.\end{aligned}$$

Thus, the labor elasticities $\hat{\theta}^L_{jt}=\frac{\partial\hat{f}(k_{jt},l_{jt},m_{jt})}{\partial l_{jt}}$ are obtained as

$$\hat{\theta}^L_{jt}=\exp\left(\hat{\mu}\right)m_{jt}\left(\hat{\gamma}_l+2\hat{\gamma}_{ll}l_{jt}+\hat{\gamma}_{kl}k_{jt}+\frac{\hat{\gamma}_{lm}}{2}m_{jt}\right)+\hat{\kappa}_l+2\hat{\kappa}_{ll}l_{jt}+\hat{\kappa}_{kl}k_{jt}.$$

Similarly, the capital elasticities $\hat{\theta}^K_{jt}=\frac{\partial\hat{f}(k_{jt},l_{jt},m_{jt})}{\partial k_{jt}}$ are obtained as

$$\hat{\theta}^K_{jt}=\exp\left(\hat{\mu}\right)m_{jt}\left(\hat{\gamma}_k+2\hat{\gamma}_{kk}k_{jt}+\hat{\gamma}_{kl}l_{jt}+\frac{\hat{\gamma}_{km}}{2}m_{jt}\right)+\hat{\kappa}_k+2\hat{\kappa}_{kk}k_{jt}+\hat{\kappa}_{kl}l_{jt}.$$

Once the production function coefficients have been estimated, we can calculate output elasticities $\hat{\theta}^L_{jt}$ and $\hat{\theta}^M_{jt}$ and estimate wage markdowns by (7). The revenue elasticities are obtained by

[31]For ρ to satisfy $\rho\in(0,1)$, we transform $\varsigma\equiv\ln\left(\frac{1-\rho}{\rho}\right)$, estimate ς and obtain $\hat{\rho}=1/(1+\exp(\hat{\varsigma}))$. We pick the initial value of (ρ_0,υ_0) as follows. We try 9 different initial values for ρ_0 $\{0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9\}$ and choose a case where the objective function is minimized. For a given ρ_0, we obtain a vector of initial values υ_0 as follows. We regress the OLS regression of r_j on the second order polynomials of (k_{jt},l_{jt}) and $\ln\hat{Y}_t$ with controls $\mathbf{W}_{jt-1}$, province fixed effects, and four-digit industry fixed effects. Then, we multiply estimated coefficients of $\{k,l,k^2,l^2,kl\}$ by ρ_0 to obtain υ_0, following (30).

multiplying $\exp\left(\hat{\delta}_{st}\right)\hat{\rho}$ by the output elasticities.

We obtain TFPR as the residual of revenue from inputs, which contains TFP and industry-level and firm-level demand shifters:

$$\ln TFPR_{jt} \equiv r_{jt} - \left(\frac{\sigma_{st}+1}{\sigma_{st}}\right) f(k_{jt}, l_{jt}, m_{jt}).$$

and its core component TFPRC:

$$\ln TFPRC_{jt} \equiv \ln TFPR_{jt} + \frac{1}{\sigma_{st}} \ln Y_{gt}. \tag{33}$$

D Definition, Construction, and Data Sources of Variables

D.1 Firm-Level Data

The firm-level outcome variables listed below are measured using the data from *Annual Surveys of Industrial Firms* (ASIF) for the period 1998–2007:

- Employment: total number of employees;
- Wages: labor compensation, which is the sum of wages, bonuses and benefits;
- TFPC: see equation (33) in Appendix C for the estimation;
- Labor share: ratio of labor compensation to value-added;
- Output markups $\mu_{jt} = \hat{\theta}^M_{jt}/\alpha_{jt}$, where $\hat{\theta}^M_{jt}$ is the estimated output elasticity of materials; α_{jt} is the material expenditure share in revenue. See Appendix C for details.
- Labor elasticity $\hat{\theta}^L_{jt}$: the estimated output elasticity of labor. See Appendix C for details;
- VA share: the value-added share, measured as the ratio of value-added to total revenue.

Other firm-level characteristics used in the analysis are also obtained from the ASIF data, including:

- State-owned dummy: 1 if a firm is a state-owned enterprise; 0 otherwise. A firm is classified as an SOE if (i) more than 50% of its registered capital is held directly by the state or (ii) the controlling shareholder of the firm is identified as the state;
- Foreign-owned dummy: 1 if a firm is a foreign affiliate; 0 otherwise. A firm is classified as a foreign firm if more than 25% of its equities are owned by foreign investors;
- Export intensity: the share of firm's export in revenue.

D.2 Prefecture-Level Data

D.2.1 Prefecture-Level Characteristics

The prefecture-level characteristics used as controls in the regressions are listed as below. All these controls are measured in year 2000. The following three variables are constructed using the 2000 China Population Census:

- Agricultural employment share: ratio of population employed in agriculture industry to total employed population;
- Manufacturing employment share: ratio of population employed in manufacturing to total employed population;
- College graduates share: ratio of population with college or graduate degree to those aged above six.

The following two variables come from China City Statistical Yearbook:

- GDP per capita.
- Distance to port: prefecture's distance to its nearest port.

The other two prefecture-level variables are constructed using the ASIF data:

- Manufacturing employment HHI: $HHI_c = \sum_{j \in \Omega_c} \left(\frac{L_{jc}}{L_c}\right)^2$, where L_{jc} is firm j's number of employees, and L_c is prefecture c's total employment;
- Overall wage markdown: prefecture-level average wage markdown.

D.2.2 Determinants of FDI Liberalization

We control for the determinants of FDI liberalization by prefecture c's labor share of those industries that satisfy the determinants of FDI liberalization, $Z_{ct} = \sum_s \frac{L_{cs1998}}{L_{c1998}} \times Z_{s1998} \times \alpha_t$, where L_{cs1998}/L_{c1998} is industry s's share of employment in prefecture c in 1998; Z_{s1998} contains four industry-specific variables in 1998:

- New product intensity: ratio of new product output to total output;
- Industry age: average industry age;
- Number of firms: total number of manufacturing firms;
- Export intensity: ratio of exports to revenue;

and α_t is year dummies. All these variables are measured from the ASIF data.

D.2.3 Other Policy Controls

Other policy controls include the restructuring and privatization of SOEs:

- SOE employment share: ratio of population employed in state-owned enterprises to total employed population in year t.

The place-based policy in China:

- Special economic zone dummy: 1 if prefecture has a special economic zone program; 0 otherwise.

Tariff reductions after China's WTO accession by prefecture c's exposure to tariffs: $\tau^v_{ct} = \sum_s \frac{L_{cs1998}}{L_{c1998}} \times \tau^v_{st}$, where τ^v_{st}, $v \in \{o, i, e\}$ denote for output tariff, input tariff and export tariff in year t, respectively. τ^v_{st} is constructed as follows:

- Output tariff τ^o_{st} , which are obtained from the World Integrated Trade Solution (WITS) website. The tariff data is at the HS-6 level, and we match the tariff data to industry classification data in the ASIF data using concordance between Chinese Industrial Classification (CIC) system and HS codes. The simple average ad valorem tariff for each industry from the period 1998–2007 is then calculated.

- Input tariff$\tau^i_{st} = \sum_k \tau^o_{st} \times \omega_{ks}$, where ω_{ks} is the share of inputs from industry k used by industry s, using the 2002 Chinese input-output table.

- Export tariff$\tau^e_{st} = \sum_o \tau^e_{ost} \times \frac{Export_{ost}}{Export_{ot}}$, where τ^e_{ost} is country o's tariffs on Chinese imports of industry s in year t; $Export_{ost}$ is China's exports of industry s to destination o in year t; and $Export_{ot}$ is China's exports to destination o in year t.

The inter-industry linkages of FDI liberalization by prefecture c's exposures to backward and forward FDI liberalization and their interactions with year fixed effects:

- Prefecture's exposure to backward FDI: $BFDI_{ct} = \sum_s \frac{L_{cs1998}}{L_{c1998}} \sum_{k \text{ if } k \neq s} \chi_{sk} \times Treatment_k \times \alpha_t$, where χ_{sk} is the ratio of industry s's output supplied to industry k, which is obtained from the 2002 Chinese input-output table; $Treatment_k$ is 1 if industry k experienced FDI liberalization in 2002; and α_t denote for year dummies.

- Prefecture's exposure to forward FDI: $FFDI_{ct} = \sum_s \frac{L_{cs1998}}{L_{c1998}} \sum_{m \text{ if } m \neq s} \varrho_{sm} \times Treatment_m \times \alpha_t$, where ϱ_{sm} is the ratio of inputs purchased by industry s from industry m; $Treatment_m$ is 1 if industry m experienced FDI liberalization in 2002; and α_t denote for year dummies.

D.2.4 Summary Statistics

Table A.1: Definition, Data Source and Summary Statistics of Variables

Variable	Definition	Data source	Mean	S.D.	Coverage
Firm-level variables					
Log wage markdown	See eqn (6) in section 2.2	ASIF	1.27	1.24	1998-2007
Log MRL	Marginal revenue of labor	ASIF	3.62	1.32	1998-2007
Log employment	Number of employees	ASIF	4.74	1.09	1998-2007
Log wages	Labor compensation (the sum of wages, bonuses and benefits) by employment	ASIF	2.35	0.73	1998-2007
Labor share	Ratio of labor compensation to value-added	ASIF	1.47	0.94	1998-2007
Log output markups	Materials elasticity divided by share of materials in revenue	ASIF	0.63	0.89	1998-2007
Log labor elasticity	Output elasticity of labor	ASIF	0.85	0.86	1998-2007
VA share	Value-added share; ratio of value-added to revenue	ASIF	1.39	0.49	1998-2007
Log TFPR	Revenue-based TFP	ASIF	3.67	1.36	1998-2007
Log TFPRC	TFPR with removal of industry-level demand shocks	ASIF	-0.73	4.61	1998-2007
State-owned dummy	1 if a firm is a state-owned enterprise; 0 otherwise	ASIF	0.18	0.39	1998-2007
Foreign-owned dummy	1 if a firm is a foreign affiliate; 0 otherwise	ASIF	0.17	0.37	1998-2007
Export intensity	Share of firm's export in revenue	ASIF	0.26	0.44	1998-2007
Prefecture-level variables					
Prefecture characteristics controls:					
Agricultural employment share	Ratio of population employed in agriculture industry to total employed population	China Population Census 2000	0.49	0.24	2000
Manufacturing employment share	Ratio of population employed in manufacturing to total employed population	China Population Census 2000	0.21	0.16	2000
College graduates share	Ratio of population with college or graduate degree to those aged above six	China Population Census 2000	0.05	0.04	2000
Log GDP per capita	Prefecture-level GDP per capita	China City Statistical Yearbook	9.32	0.72	2000
Distance to port	Distance to prefecture's nearest port	China City Statistical Yearbook	2.00	3.08	2000
Manufacturing employment HHI	Herfindahl-Hirschman Index (HHI) of manufacturing employment	ASIF	0.02	0.04	2000
FDI determinants controls:					
New product intensity	Ratio of new product output to total output	ASIF	0.06	0.02	1998
Age	Industry average age	ASIF	14.22	1.95	1998
Number of firms	Total number of manufacturing firms	ASIF	6.08	0.48	1998
Export intensity	Ratio of exports to revenue	ASIF	0.01	0.01	1998
Other policy controls:					
SOE employment share	Ratio of population employed in state-owned enterprises to total employed population	ASIF	0.22	0.12	1998-2007
SEZ dummy	1 if prefecture has a special economic zone program; 0 otherwise	China's Ministry of Land and Resources	0.97	0.18	1998-2007
Output tariffs	Prefecture exposure to output tariffs	WITS and ASIF	13.68	4.38	1998-2007
Input tariffs	Prefecture exposure to input tariffs	WITS, China IO Table and ASIF	7.22	2.25	1998-2007
Export tariffs	Prefecture exposure to export tariffs	WITS and ASIF	5.90	1.16	1998-2007
Backward FDI	Prefecture exposure to backward FDI	FDI Catalogue and China IO Table	0.26	0.05	1998
Forward FDI	Prefecture exposure to forward FDI	FDI Catalogue and China IO Table	0.33	0.05	1998

Note: Definitions, data source, means, standard deviation and time periods covered of firm and prefecture-level variables used in the regressions are reported. Appendix D describes data source, variable definition and construction in more detail.

E Additional Tables

E.1 Unadjusted Wage Markdown Estimates

Table A.2: Distributions of Firm-Level Wage Markdowns (Unadjusted)

	Wage Markdowns (Unadjusted)		Wage Markdowns (Weighted, unadjusted)	
	(1)	(2)	(5)	(6)
Industry	Median	(p25, p75)	Median	(p25, p75)
Food processing	0.09	(0.04, 0.22)	0.22	(0.09, 0.59)
Food manufacturing	0.21	(0.1, 0.41)	0.33	(0.17, 0.62)
Beverage manufacturing	0.14	(0.06, 0.33)	0.33	(0.14, 0.76)
Textile industry	0.29	(0.14, 0.59)	0.67	(0.31, 1.63)
Garments & other fiber products	0.56	(0.36, 0.87)	0.43	(0.27, 0.68)
Leather, furs, down & related products	0.27	(0.12, 0.51)	0.54	(0.26, 1.19)
Timber processing, bamboo, cane, palm fiber & straw products	0.34	(0.2, 0.55)	0.41	(0.24, 0.67)
Furniture manufacturing	0.36	(0.22, 0.56)	0.40	(0.26, 0.58)
Papermaking & paper products	0.21	(0.11, 0.42)	0.37	(0.18, 0.9)
Printing industry	0.45	(0.26, 0.8)	0.34	(0.2, 0.58)
Cultural, educational & sports goods	0.48	(0.29, 0.77)	0.83	(0.47, 1.59)
Petroleum processing & coking	0.12	(0.05, 0.28)	0.29	(0.12, 0.79)
Raw chemical materials & chemical products	0.17	(0.08, 0.38)	0.56	(0.22, 1.31)
Medical & pharmaceutical products	0.23	(0.13, 0.38)	0.21	(0.12, 0.34)
Chemical fiber	0.06	(0.02, 0.16)	0.12	(0.04, 0.33)
Rubber products	0.10	(0.04, 0.25)	0.21	(0.09, 0.57)
Plastic products	0.19	(0.12, 0.29)	0.18	(0.11, 0.28)
Nonmetal mineral products	0.75	(0.45, 1.18)	1.07	(0.66, 1.74)
Smelting & pressing of ferrous metals	0.62	(0.39, 1.01)	0.52	(0.33, 0.76)
Smelting & pressing of nonferrous metals	0.51	(0.2, 1.31)	1.06	(0.4, 2.81)
Metal products	0.11	(0.05, 0.22)	0.21	(0.1, 0.51)
Ordinary machinery	1.50	(0.78, 3.18)	0.74	(0.38, 1.37)
Special purpose equipment	0.17	(0.09, 0.33)	0.34	(0.17, 0.6)
Transport equipment	0.22	(0.11, 0.42)	0.31	(0.16, 0.55)
Electronic & telecommunications equipment	0.32	(0.18, 0.57)	0.20	(0.1, 0.35)
Instruments, meters, cultural & office equipment	0.79	(0.37, 1.77)	1.91	(0.82, 5.21)
All industries	0.29	(0.12, 0.65)	0.43	(0.20, 0.89)

Note: The table reports median, 25 percentile (p25) and 75 percentile (p75) of wage markdown, those of output price markup, and those statistics weighted by firm employment of wage markdown.

E.2 The Effect of FDI Liberalization on FDI Inflow

Table A.3: The Impact of FDI Liberalization on FDI Inflow

Dependent variables:	Foreign equity share		Share of number of foreign firms	
	(1)	(2)	(3)	(4)
FDI Liberalization	0.082**	0.078*	0.082**	0.086**
	(0.038)	(0.042)	(0.038)	(0.041)
FDI Liberalization ×		-0.011		0.011
Year2001 dummy		(0.023)		(0.019)
Controls:				
FDI determinants	yes	yes	yes	yes
Other policy	yes	yes	yes	yes
Vertical FDI	yes	yes	yes	yes
Prefecture characteristics	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Observations	1,022,448	1,022,448	1,022,448	1,022,448

Note: Standard errors are clustered at the prefecture level in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent. FDI determinants controls include new product intensity, export intensity, number of firms, and age at initial year. Other policy controls include: (1) prefecture's exposures to tariffs (output tariffs, input tariffs, and tariffs by foreign countries); (2) the share of state-owned enterprises among firms in a prefecture, (3) a dummy variable indicating whether a prefecture is a special economic zone or not. Vertical FDI controls include prefecture's exposure to FDI liberalization in backward and forward industries. Prefecture characteristics controls includes interactions between year dummies and the following variables in 2000: agriculture employment share, manufacturing employment share, GDP per capita, share of population with college education or above, manufacturing employment HHI, overall wage markdown and distance to the nearest port. Column (7) reports weighted regression with prefecture employment being the weight.

E.3 Tables for County-Level Analysis

Our main results are robust to the choice of the unit of labor market. The following tables reproduce the main regression tables in the main text by choosing a county, which is a subdivision of a prefecture, as an alternative geographical unit of labor markets. All results mentioned in the main text continue to hold.

Table A.4: FDI Liberalization and Firm-Level Wage Markdowns

Log wage markdown	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FDI Liberalization	-0.131***	-0.202***	-0.162***	-0.112***	-0.113***	-0.125**	-0.119*
	(0.041)	(0.045)	(0.047)	(0.043)	(0.044)	(0.050)	(0.062)
FDI Liberalization ×						-0.033	
Year2001 dummy						(0.041)	
Controls:							
FDI determinants	no	yes	yes	yes	yes	yes	yes
Other policy	no	no	yes	yes	yes	yes	yes
Vertical FDI	no	no	no	yes	yes	yes	yes
County characteristics	no	no	no	no	yes	yes	yes
County emp. weighted	no	no	no	no	no	no	yes
Firm fixed effects	yes	yes	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes	yes	yes
Observations	1,031,432	1,031,432	1,031,432	1,031,432	1,031,432	1,031,432	1,031,432

Note: Standard errors are clustered at the county level in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent. FDI determinants controls include new product intensity, export intensity, number of firms, and age at initial year. Other policy controls include: (1) county's exposures to tariffs (output tariffs, input tariffs, and tariffs by foreign countries); (2) the share of state-owned enterprises among firms in a county, (3) a dummy variable indicating whether a county is a special economic zone or not. Vertical FDI controls include county's exposure to FDI liberalization in backward and forward industries. County characteristics controls includes interactions between year dummies and the following variables in 2000: agriculture employment share, manufacturing employment share, GDP per capita, share of population with college education or above, manufacturing employment HHI, overall wage markdown and distance to the nearest port. Column (7) reports weighted regression with county employment being the weight.

Table A.5: Decomposition and Mechanism

	(1)	(2)	(3)	(4)
Dependent variables:	Log employment	Log MRL	Log wages	Log markdown
FDI Liberalization	-0.064*	0.088**	-0.025	-0.124***
	(0.034)	(0.041)	(0.031)	(0.042)
Log TFPRC				-0.102***
				(0.003)
Controls:				
FDI determinants	yes	yes	yes	yes
Other policy	yes	yes	yes	yes
Vertical FDI	yes	yes	yes	yes
County characteristics	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Observations	1,031,432	1,031,432	1,031,432	1,031,432

Note: Standard errors are clustered at the county level in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent. FDI determinants controls include new product intensity, export intensity, number of firms, and age at initial year. Other policy controls include: (1) county's exposures to tariffs (output tariffs, input tariffs, and tariffs by foreign countries); (2) the share of state-owned enterprises among firms in a county, (3) a dummy variable indicating whether a county is a special economic zone or not. Vertical FDI controls include county's exposure to FDI liberalization in backward and forward industries. County characteristics controls includes interactions between year dummies and the following variables in 2000: agriculture employment share, manufacturing employment share, GDP per capita, share of population with college education or above, manufacturing employment HHI, overall wage markdown and distance to the nearest port.

Table A.6: FDI Liberalization and Firm-Level Labor Income Share

Dependent variables:	Log labor share	Log wage markdown	Log output markup	Log labor elasticity	Log value-added share
	(1)	(2)	(3)	(4)	(5)
FDI Liberalization	-0.171***	-0.122**	0.045**	0.003	0.008
	(0.055)	(0.048)	(0.023)	(0.021)	(0.033)
Controls:					
FDI determinants	yes	yes	yes	yes	yes
Other policy	yes	yes	yes	yes	yes
Vertical FDI	yes	yes	yes	yes	yes
County characteristics	yes	yes	yes	yes	yes
Firm fixed effects	yes	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes	yes
Observations	920,406	920,406	920,406	920,406	920,406

Note: Standard errors are clustered at the county level in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent. FDI determinants controls include new product intensity, export intensity, number of firms, and age at initial year. Other policy controls include: (1) county's exposures to tariffs (output tariffs, input tariffs, and tariffs by foreign countries); (2) the share of state-owned enterprises among firms in a county, (3) a dummy variable indicating whether a county is a special economic zone or not. Vertical FDI controls include county's exposure to FDI liberalization in backward and forward industries. County characteristics controls includes interactions between year dummies and the following variables in 2000: agriculture employment share, manufacturing employment share, GDP per capita, share of population with college education or above, manufacturing employment HHI, overall wage markdown and distance to the nearest port.

Table A.7: Heterogeneous Effects of FDI Liberalization on Firm-Level Wage Markdowns

Log wage markdown	(1)	(2)
FDI Liberalization	-0.238***	-0.373***
	(0.088)	(0.098)
FDI Liberalization $\times$ log initial TFPR	0.038*	0.138***
	(0.023)	(0.045)
FDI Liberalization $\times$ $(\log \text{initial TFPR})^2$		-0.016**
		(0.007)
Controls:		
FDI determinants	yes	yes
Other policy	yes	yes
Vertical FDI	yes	yes
County characteristics	yes	yes
Post2002 $\times$ log initial TFPR	yes	yes
Post2002 $\times$ $(\log \text{initial TFPR})^2$	-	yes
Firm fixed effects	yes	yes
Year fixed effects	yes	yes
Observations	1,031,432	1,031,432

Note: Standard errors are clustered at the county level in parentheses. Significance: * 10 percent, ** 5 percent, *** 1 percent. Initial TFPR is firm's TFPR that the firm first appears in the dataset. FDI determinants controls include new product intensity, export intensity, number of firms, and age at initial year. Other policy controls include: (1) county's exposures to tariffs (output tariffs, input tariffs, and tariffs by foreign countries); (2) the share of state-owned enterprises among firms in a county, (3) a dummy variable indicating whether a county is a special economic zone or not. Vertical FDI controls include county's exposure to FDI liberalization in backward and forward industries. County characteristics controls includes interactions between year dummies and the following variables in 2000: agriculture employment share, manufacturing employment share, GDP per capita, share of population with college education or above, manufacturing employment HHI, overall wage markdown and distance to the nearest port.