

# Wage Markdowns and FDI Liberalization<sup>\*</sup>

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## Abstract

This paper examines how liberalization of inward foreign direct investment (FDI) affects firm's monopsonic power over the wage. We estimate firm-level "wage markdown," the gap between the wage and the marginal revenue of labor (MRL), from plant-level production data of China. Our estimation framework assumes no specific micro-foundation or functional form about labor supply curves to individual firms and simultaneously estimate output markups. We estimate the causal effect of FDI liberalization on wage markdowns, using variations in China's regulation on FDI inflow upon its accession to the WTO in 2001. In contrast to the conventional wisdom, markdowns are narrower at large employers and FDI liberalization widens the average wage markdown by 3.7%. We show these findings are consistent with a modern theory of labor monopsony based on search friction.

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

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# 1 Introduction

The globalization increases competition and thus has the potential to alleviate inefficiencies in imperfectly competitive markets. Trade economists have long investigated whether trade liberalization reduce firm's monopoly power and price markups in imperfectly competitive goods markets. Large theoretical literature have established the cases for the pro-competitive effect of trade liberalization and empirical literature have documented evidence from actual trade liberalization episodes.<sup>1</sup>

In this paper, we examine the competitive effect of foreign direct investment (FDI) liberalization on imperfectly competitive labor markets. Our study is motivated by recent advance in labor economics on labor monopsony: firms exercise monopsony power and set lower wages than the marginal revenue of labor (MRL) (see e.g., Manning (2003; 2011) and Ashenfelter, Farber, and Ransom (2010) for recent surveys). Traditional theories of labor monopsony consider a market with a single large employer such as a corporate town, but modern theories by Burdett and Mortensen (1998) and others emphasize labor monopsony arises in wider circumstances. If workers face search frictions or have non-monetary workplace preferences, every worker does not instantaneously leave jobs in response to wage cuts; thus, labor supply curves to individual firms are upward sloping, which are also confirmed in recent empirical studies. Facing to upward-sloping labor supply curves, firms can set wages lower than MRL.<sup>2</sup> When the labor market exhibits labor monopsony, liberalization of FDI that allows the entry of foreign employers enhance competition among employers and thus may alleviate inefficiencies caused by labor monopsony.

This paper makes three contributions to the analysis of FDI liberalization and wage competition. First, we develop a novel empirical framework to measure firm's monopsony power over the wage from conventional firm-level (more precisely plant-level) production data. Specifically, we estimate firm-level "wage markdowns," the gap between the wage and the MRL, from estimated gross output production functions. Our framework relaxes several important assumptions in previous markdown estimation from production data. First, our framework is general about micro-foundation and functional form of labor supply curves to individual firms. Thus, estimated markdowns can be used to identify a theoretical mechanism behind wage monopsony by investigating how they respond to particular shocks such as FDI liberalization. Second, our framework allows imperfect competition in output markets and simultaneously estimates output markups.

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<sup>1</sup>Listing all papers in this vast literature is beyond the scope of this paper. See Tybout (2003), De Loecker and Goldberg (2014) and Van Biesebroeck and De Loecker (2016) for surveys on this literature.

<sup>2</sup>Furthermore, these modern monopsonic models can explain several empirical regularities including those puzzling to perfectly competitive models such as wage dispersions across firms.

Considering output markups is crucial for wage markdown estimation. Some studies measure wage markdowns as the gap between the wage and the marginal product value of labor, assuming output markets are perfectly competitive. However, this measure overestimates firm's monopsony power since both monopsony and monopoly powers make the wage smaller than the marginal product value of labor. Finally, while previous estimations typically assume Cobb-Douglas production functions, we estimate gross output production functions non-parametrically, following Ghandi, Navarro and Rivers (2017). With the Cobb-Douglas assumption, all variations in markdowns depend solely on variations in labor costs shares in total costs. Free from this strict restriction, our framework can more precisely estimate firm's monopsony power.

We apply our framework to establishment-level production data of Chinese manufacturing from 1998 to 2007 and obtain quite reasonable estimates. First, employers ubiquitously exercise monopsony powers: wage markdowns exist for 92% of firms in our sample. This is consistent with weak worker protection in China during this period.<sup>3</sup> Second, markdowns are narrower for those firms that are known as well-paying jobs, or "good jobs" in China: state owned enterprises (SOEs), foreign-owned firms, and exporters. Finally, narrow markdowns are associated with high productivity and large employment. These patterns contradict with a traditional view that a large firm exercises monopsony power, but it is actually consistent with a modern theory of wage monopsony by Burdett and Mortensen (1998) and others where a high productivity firm offers a high wage to attract more workers.

Our second contribution is to estimate the causal effect of FDI liberalization on wage markdowns. Following Lu, Tao and Zhu (2017), we utilize plausibly exogenous relaxation of China's regulations on FDI inflow upon its World Trade Organization (WTO) accession at the end of 2001. Specifically, upon its WTO accession, China liberalized 112 of its 424 four-digit manufacturing industries, and these industries have indeed experienced a surge of FDI inflows since 2002. We conduct a simple difference-in-difference estimation of FDI liberalization on wage markdowns with firm fixed effects. To address endogenous choices of liberalized industries, we control for a number of determinants of FDI liberalization: trade liberalization on output tariffs, input tariffs, and external tariffs, inter-industry effects through vertical FDI and state owned enterprises reforms (SOE reforms).

The estimation results are contrasting to the conventional wisdom. In our benchmark specification, FDI liberalization increased incumbent firm's MRL by 5.7%, but the wage only by 2.0%, widening the wage

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<sup>3</sup>During this period, workers are not allowed to collectively bargain with employers and had to accept wages unilaterally set by employers. Furthermore, employment without formal written contracts was common. In 2008, after our sample period, China introduced the Labor Contract Law that strengthened worker protection.

markdown by 3.7%. This finding is striking in two senses. First, if the wage markdown is constant as in traditional models of FDI, workers should receive as much as the MRL increases. However, workers received only 35% of the increased MRL by FDI, while 65% of them were taken by employers or other production factors. Second, FDI liberalization induced the new entry of foreign employers and enhanced competition among employers, but wage markdowns by incumbent firms widened. Several studies find that import competition induced by trade liberalization narrows output markups. The contrasting effect of FDI liberalization on wage markdowns suggests that the nature of imperfect competition differs between output markets and labor markets; and thus that the two major modes of the globalization, trade and FDI, have quite different consequences on firm's market power.

The final contribution of the current paper is to explain the counter-intuitive effect of FDI liberalization on wage markdowns. To search for a theoretical explanation, we estimate the heterogeneous impact on wage markdowns. In terms of initial TFP before liberalization, the bottom 90% of firms widened wage markdowns, while top 10% of firms narrowed them. Motivated by this heterogeneous effect, we theoretically analyze FDI in a standard on-the-job-search model of wage monopsony with firm heterogeneity by Burdett and Mortensen (1998). The model predicts that in terms of productivity, the bottom majority of incumbents widen wage markdowns, while only the top few incumbents narrow wage markdowns. Furthermore, this result holds only when foreign firms are on average more productive than domestic firms. As a confirmation of this prediction, we find that the heterogeneous effect only in a subsample of industries where the median productivity of foreign firms is higher than that of domestic firms. In short, our finding of the competitive effect of FDI is contact to the conventional wisdom, but is actually consistent with a modern theory of wage monopsony.

**Related literature** This paper contributes to the empirical literature on the effect of international competition on firm's market power. The empirical literature has typically analyzed the causal impact of trade liberalization on output markups. Empirical studies using micro-data include e.g. Levinsohn (1993), Harrison (1994), Krishna and Mitra (1998), Konings, Van Cayseele, and Warzynski (2001), Chen, Imbs, and Scott (2009), De Loecker, Goldberg, Khandelwal and Pavcnik (2016), and Feenstra and Weinstein (2016). Another strand of the literature conducts general equilibrium analyses: e.g., Holmes, Hsu and Lee (2014), Edmond, Midrigan and Xu (2015), and Arkolakis, Costinot, Donaldson and Rodriguez-Clare (2016). Our study is the first to empirically examine the effect of FDI liberalization on firm's monopsony power in the

labor market and find that the effects of international competition on firm's market power are very different between the good market and the labor market.

Our finding also contributes the literature on globalization and imperfectly competitive labor markets that have developed in the last two decades. For instance, Davidson, Martin, and Matusz (1999) introduces labor market imperfection into a neo-classical trade model; Egger and Kreickemeier (2009), Amiti and Davis (2012), Davis and Harrigan (2011), Helpman, Itskhoki, and Redding (2010), and Felbermayr, Prat, and Schmerer (2011) extended modern trade models with firm heterogeneity. Fajgelbaum (2016) analyzes international trade in a model where workers engage on-the-job search. In contrast to these studies on international trade, theoretical research on FDI with labor market imperfection is limited. As an exception, Egger and Kreickemeier (2013) analyzes FDI in a fair wage model where workers have bargaining powers and receive wage "markups" instead of markdowns.

The current paper is related to recent research in labor economics that estimate firm-level labor supply elasticities and wage markdowns. Dal Bó, Finan, and Rossi (2013), Falch (2010), Matsudaira (2104), Naidu, Nyarko, and Wang (2016), and Staiger, Spetz, and Phibbs (2010) estimate industry-level average markdowns. Brummund (2012) and Isen (2012) estimate firm-level wage markdowns under the assumption that output markets are perfectly competitive. Our approach is inspired by seminal works on output markup estimation by Hall (1998) and De Loecker and Warzynski (2012). Our markdown measure takes into account imperfect competition in output markets by utilizing the Hall-De Loecker-Warzynski output markup estimates. Dobbelaere, Kiyota and Mairesse (2015) derive a wage markdown formula similar to us for the case of Cobb-Douglass production functions and estimate industry-level markdowns. Naidu, Nyarko and Wang (2016) analyze the impact of policy changes on wage markdowns. Naidu, Nyarko and Wang (2016) analyzes the impact of expansion of worker's outside options, while we examine the effect of increased competition among employers.

In the rest of the paper is organized as follows. Section 2 presents our estimation framework of wage markdowns. Section 3 discusses our data and China's FDI liberalization. Section 4 report empirical results. Section 5 presents a theoretical explanation for our findings. Section 6 concludes the paper.

## 2 Framework for Wage Markdown Estimation

### 2.1 Deriving a Formula for Wage Markdowns

A firm  $j$  at time  $t$  produces output using the following gross output production function:

$$Y_{jt} = Y_{jt}(L_{jt}, K_{jt}, M_{jt}, \omega_{jt})$$

where  $L_{jt}$  is labor input,  $K_{jt}$  is capital input,  $M_{jt}$  is intermediate inputs (materials) and  $\omega_{jt}$  is total factor productivity. Firm  $j$  faces a labor supply curve  $L_{jt}(w_{jt})$  with an inverse supply curve  $w_{jt}(L_{jt})$ . We do not specify any micro-foundation for the labor supply curve, which can be derived from the Burdett-Mortensen model or other models of labor monopsony.

The Lagrangian for the cost minimization problem is:

$$\mathcal{L} = w_{jt}(L_{jt})L_{jt} + r_{jt}K_{jt} + P_{jt}^M M_{jt} + \lambda_{jt}[Y_{jt} - Y_{jt}(\dots)],$$

where  $r_{jt}$  is the rental of capital, which might depend on  $K_{jt}$  or other variables, and  $P_{jt}^M$  is the price of intermediate inputs. The first order conditions for labor employment is:

$$w_{jt} \left( 1 + \frac{1}{\varepsilon_{jt}} \right) = \lambda_{jt} \frac{\partial Y_{jt}}{\partial L_{jt}} = MRL_{jt}.$$

The Lagrange multiplier  $\lambda_{jt}$  represents marginal costs of production and  $\varepsilon_{jt} \equiv \frac{L'_{jt}(w_{jt})w_{jt}}{L_{jt}}$  is the elasticity of the labor supply curve that firm  $j$  faces. Since marginal costs equal marginal revenue under profit maximization, the term  $\lambda_{jt} \frac{\partial Y_{jt}}{\partial L_{jt}}$  represents the marginal revenue of labor (MRL)  $\partial R_{jt} / \partial L_{jt}$  where  $R_{jt}$  is firm's revenue. When  $\varepsilon_{jt}$  is infinite under perfect competition, firm's wage equals to MRL. When  $\varepsilon_{jt}$  is finite and the labor supply curve to firm  $j$  is upward sloping, the firm sets its wage lower than MRL. Firm  $j$ 's wage markdown is defined as the gap between them:

$$\eta_{jt} \equiv \frac{w_{jt}}{\lambda_{jt} \frac{\partial Y_{jt}}{\partial L_{jt}}} = \frac{\varepsilon_{jt}}{\varepsilon_{jt} + 1} \leq 1. \quad (1)$$

Under perfect competition with  $\varepsilon_{jt} = \infty$ ,  $\eta_{jt} = 1$  holds.

The definition of markdowns in (1) does not specify any market structure in the output market. Some

prior studies define wage markdowns as  $\zeta_{jt} = \frac{w_{jt}}{P_{jt} \frac{\partial Y_{jt}}{\partial L_{jt}}}$  where  $P_{jt}$  is the output price, assuming perfectly competitive output markets. When a firm charges positive markups  $P_{jt} > \lambda_{jt}$ ,  $\zeta_{jt}$  overestimates firm's monopsony power. Thus, considering imperfect competition in the output market is crucial for the estimation of firm's monopsony power.

A challenge for estimating markdown  $\eta_{jt}$  in (1) is that marginal costs  $\lambda_{jt}$  are rarely observable to researchers. We estimate it from the first order condition for materials  $M_{jt}$  by assuming that materials  $M_{jt}$  are transacted under perfect competition. Combining the first order condition for  $M_{jt}$ ,

$$P_{jt}^M = \lambda_{jt} \frac{\partial Y_{jt}}{\partial M_{jt}},$$

into (1) to eliminate  $\lambda_{jt}$ , the wage markdown is simplified as

$$\eta_{jt} = \frac{\alpha_{jt}^L \theta_{jt}^M}{\alpha_{jt}^M \theta_{jt}^L}, \quad (2)$$

where  $\alpha_{jt}^M \equiv \frac{P_{jt}^M M_{jt}}{P_{jt} Y_{jt}}$  and  $\alpha_{jt}^L \equiv \frac{w_{jt} L_{jt}}{P_{jt} Y_{jt}}$  are the expenditure shares of materials and labor in the total output sales, respectively;  $\theta_{jt}^M \equiv \frac{\partial Y_{jt}}{\partial M_{jt}} \frac{M_{jt}}{Y_{jt}}$  and  $\theta_{jt}^L \equiv \frac{\partial Y_{jt}}{\partial L_{jt}} \frac{L_{jt}}{Y_{jt}}$  are output elasticities on materials and labor, respectively.<sup>4</sup> The expenditure shares  $\alpha_{jt}^M$  and  $\alpha_{jt}^L$  are usually available from production data. We estimate output elasticities  $\theta_{jt}^L$  and  $\theta_{jt}^M$  by estimating the gross output production function non-parametrically.<sup>5</sup>

## 2.2 Output Elasticity Estimation

We estimate firm-level gross output production functions separately for each two-digit industry. 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

<sup>4</sup>Markdown measure  $\eta_{jt}$  in (2) is derived under the assumption of homogenous labor and no-monopsony power for intermediate goods. Even when these assumptions are violated,  $\eta_j$  can be informative about firm's monopsony power in the labor market. First, when a firm exercises a monopsony power over intermediate inputs,  $\eta_j$  in (2) measures firm's monopsony power on labor relative to intermediate goods. Second, suppose labor are heterogeneous in their skills, but still perfectly substitutable when workers are compared in terms of efficiency units, which is the case that wages are linear in skill differences as in the Mincer equation. In Appendix, we show that in this case, a firm sets the same markdown for all types of labor that  $\eta_j$  in (2) measures this common markdown. Finally, when different types of labor are imperfectly substitutable, a firm may set different markdowns for different types of labor. Appendix shows that  $\eta_j$  in (2) measures a weighted average of these different wage markdowns. Therefore,  $\eta_j$  in (2) is still informative about firm's monopsony power to its average employee.

<sup>5</sup>Dobbelaere, Kiyota and Mairesse (2015) derived a similar formula to (2) for the case of Cobb-Douglas production function where output elasticities  $\theta^M$  and  $\theta^L$  are common for all firms and constant overtime. Since in their framework, all variations in markdowns are driven by the expenditure shares of materials and labor, they estimate industry-average markdowns. Our framework allows  $\theta_{jt}^L$  and  $\theta_{jt}^M$  to vary across firms and time to estimate firm-level markdowns more precisely.

Olley and Pakes (1996), Levinsohn and Petrin (2003), Wooldridge (2009) and Akerberg, Caves and Frazer (2015) have developed the so-called proxy approach to use firm's factor usages as a proxy for TFP. Although this proxy approach works fine for the estimation of the value-added function, Gandhi, Navarro, and Rivers (2017) (hereafter, GNR) recently show that when this approach is applied for the non-parametric estimation of the gross output production function, it faces an identification problem.<sup>6</sup> We use an alternative estimation method proposed by GNR that additionally estimates the first order condition for profit maximization on materials. To utilize the first order condition, we have to specify the market structure of output markets. Since output markups potentially affect wage markdowns, we follow the GNR method presented in their Appendix O5-4 that allows firms to charge output markups under monopolistic competition. This method estimates so-called TFPR (Foster, Haltiwanger, and Syverson, 2008) that combine positive shocks to firm revenue such as physical TFP, output quality and output markups. The rest of this section discusses our implementation of the GNR method, so readers can skip it and go to section 2.3.

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  $y_{jt}$ ,  $k_{jt}$ ,  $l_{jt}$ , and  $m_{jt}$  are the logs of output  $Y_{jt}$ , capital, labor and materials. Function  $f \equiv \ln F$  takes a flexible form and will be approximated by polynomials below. Terms  $\omega_{jt}$  and  $\varepsilon_{jt}$  are Hicks neutral productivity shocks:  $\varepsilon_{jt}$  is unanticipated to production and i.i.d shocks with  $E[\varepsilon_{jt}] = 0$  including measurement errors;  $\omega_{jt}$  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.

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

$$Y_{jt} = Y_t \left( \frac{P_{jt}}{\Pi_t \exp(\chi_{jt})} \right)^{\sigma_t} \quad \text{where } \sigma_t < -1, \quad (3)$$

$P_{jt}$  is firm  $j$ 's price,  $\Pi_t$  is the industry-level price index,  $Y_t$  is the industry-level demand-shifter and  $\chi_{jt}$  is

<sup>6</sup>Intuitively, the problem arises because one variable, e.g. materials, is asked to play two roles in production function estimation: to estimate output elasticities of materials non-parametrically on the one hand and to proxy for TFP non-parametrically on the other hand. The estimation of value-added functions does not suffer from this problem because it does not need to estimate output elasticities of materials.

a firm-level demand shifter that known to the firm. Following De Loecker (2011) and GNR, the elasticity of demand  $\sigma_t (< -1)$  is defined negative, is industry-specific, and may vary over time. This implies that an expected output markup is also industry-time specific, though realized markups can vary across firms within industries.

From the demand function (3), firm's revenue  $R_{jt} = P_{jt}Y_{jt}$  becomes

$$R_{jt} = Y_t^{-1/\sigma_t} \Pi_t \exp\left(\tilde{\varepsilon}_{jt} + \omega_{jt}^\mu\right) [F(k_{jt}, l_{jt}, m_{jt})]^{(\sigma_t+1)/\sigma_t}, \quad (4)$$

where  $\omega_{jt}^\mu \equiv \chi_{jt} + \left(\frac{\sigma_t+1}{\sigma_t}\right) \omega_{jt}$  is a combined positive shock to firm revenue known to the firm at time  $t$ , which is often called TFPR (Foster, Haltiwanger, and Syverson, 2008). Following De Loecker (2011; 2013), we assume that TPFR  $\omega_{jt}^\mu$  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,

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

where  $\tilde{\mathcal{E}} \equiv E[\exp(\tilde{\varepsilon}_{jt})]$  and  $\tilde{\varepsilon}_{jt} \equiv \left(\frac{\sigma_t+1}{\sigma_t}\right) \varepsilon_{jt}$ . Using (4), we obtain the first order condition as:

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

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 as:

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

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

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

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.

Then, the first step estimates

$$\begin{aligned} s_{jt} &= \left[ \ln \left( \frac{\sigma_t + 1}{\sigma_t} \right) + \mu + \ln \tilde{\mathcal{E}} \right] + \ln D^\mu(k_{jt}, l_{jt}, m_{jt}; \gamma) - \tilde{\varepsilon}_{jt} \\ &= \delta_t + \ln D^\mu(k_{jt}, l_{jt}, m_{jt}; \gamma) - \tilde{\varepsilon}_{jt} \end{aligned} \quad (5)$$

by the non-linear least square method where  $\delta_t$  is year fixed effects and  $\tilde{\varepsilon}_{jt}$  are treated as error terms. Using the residuals  $\hat{\tilde{\varepsilon}}_{jt}$ , we construct  $\hat{\tilde{\mathcal{E}}}$ , an estimate of  $\tilde{\mathcal{E}}$ , by the sample mean of  $\exp(\hat{\tilde{\varepsilon}}_{jt})$ .

Consider the log of the real revenue function deflated by the price index  $r_{jt} \equiv \ln(R_{jt}/\Pi_t)$  from (4):

$$r_{jt} = \left( \frac{\sigma_t + 1}{\sigma_t} \right) f(k_{jt}, l_{jt}, m_{jt}) - \frac{1}{\sigma_t} \ln Y_t + \omega_{jt}^\mu + \tilde{\varepsilon}_{jt}. \quad (6)$$

Substituting  $\left( \frac{\sigma_t + 1}{\sigma_t} \right) = \exp(\hat{\delta}_t - \ln \hat{\tilde{\mathcal{E}}} - \mu)$ , we obtain

$$r_{jt} = \exp(\hat{\delta}_t - \ln \hat{\tilde{\mathcal{E}}}) \exp(-\mu) f(k_{jt}, l_{jt}, m_{jt}) - \left[ \exp(\hat{\delta}_t - \ln \hat{\tilde{\mathcal{E}}} - \mu) - 1 \right] \ln Y_t + \omega_{jt}^\mu + \tilde{\varepsilon}_{jt}. \quad (7)$$

Following De Loecker (2010) and GNR, we use the market share weighted average of deflated revenues  $\ln \hat{Y}_t \equiv \sum_{j=1}^N (R_{jt} / \sum_{k=1}^N R_{kt}) r_{jt}$  for the industry demand shifter  $\ln Y_t$ . Since  $D^\mu(k_{jt}, l_{jt}, m_{jt}; \gamma) = \exp(-\mu) \frac{\partial f(k_{jt}, l_{jt}, m_{jt})}{\partial m_{jt}}$ , its integration by  $m_{jt}$  leads to

$$\exp(-\mu) f(k_{jt}, l_{jt}, m_{jt}) = \int D^\mu(k_{jt}, l_{jt}, m_{jt}; \gamma) dm_{jt} + \exp(-\mu) \mathcal{C}(k_{jt}, l_{jt}), \quad (8)$$

where  $\mathcal{C}(k_{jt}, l_{jt}) \equiv f(k_{jt}, l_{jt}, m_{jt}) - \int \frac{\partial f(k_{jt}, l_{jt}, m_{jt})}{\partial m_{jt}} dm_{jt}$  is the constant of the integration that is a function of  $k_{jt}$  and  $l_{jt}$ . We approximate  $\mathcal{C}(k_{jt}, l_{jt})$  by the second order polynomials of  $k_{jt}$  and  $l_{jt}$ :<sup>7</sup>

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

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

<sup>7</sup>Note  $\mathcal{C}(k_{jt}, l_{jt})$  should not include a constant term because  $f(k_{jt}, l_{jt}, m_{jt})$  does not contain it.

Using estimated coefficients  $\hat{\gamma}$ ,  $\hat{\delta}_t$ , residuals and  $\hat{\mathcal{E}}$  from (5) and real revenue  $r_{jt}$ , we construct

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

where

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

Substituting  $\mathcal{R}_{jt}$  and (8) into (7), we obtain TFPR  $\omega_{jt}^\mu(\mu, \kappa)$  from (7) as a non-linear function of  $\mu$  and  $\kappa$ :

$$\omega_{jt}^\mu(\mu, \kappa) = \mathcal{R}_{jt} + \exp\left(\hat{\delta}_t - \ln \hat{\mathcal{E}} - \mu\right) \mathcal{C}(k_{jt}, l_{jt}, \kappa) - \left[ \exp\left(\hat{\delta}_t - \ln \hat{\mathcal{E}} - \mu\right) - 1 \right] \ln \hat{Y}_t. \quad (9)$$

The dynamic motion of TFPR is written down as:

$$\omega_{jt}^\mu(\mu, \kappa) = h\left(\omega_{jt-1}^\mu(\mu, \kappa), \mathbf{W}_{jt-1}, \delta_p, \delta_s\right) + \eta_{jt}^\mu.$$

As variables  $\mathbf{W}_{jt}$  that might affect the productivity evolution, we include the following variables on ownerships, trade and FDI: a dummy indicating the state-owned enterprises (SOEs dummy), a dummy indicating the foreign-invested enterprises (FIEs dummy), export status, 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).  $\delta_p$  and  $\delta_s$  are province fixed effects and four-digit industry fixed effects, respectively. We approximate  $h$  by the second order polynomials:

$$h\left(\omega_{jt-1}^\mu, \mathbf{W}_{jt-1}, \delta_p, \delta_s\right) = \delta_p + \delta_s + \zeta_\omega \omega_{jt-1}^\mu + \zeta_{\omega\omega} \left(\omega_{jt-1}^\mu\right)^2 + \mathbf{W}'_{jt-1} \boldsymbol{\zeta}_z \\ + \omega_{jt-1}^h \mathbf{W}'_{jt-1} \boldsymbol{\zeta}_{\omega z} + \left(\omega_{jt-1}^h\right)^2 \mathbf{W}'_{jt-1} \boldsymbol{\zeta}_{\omega\omega z}.$$

We estimate parameters as follows. We first choose a given value of  $(\kappa, \mu)$  and regress  $\omega_{jt}^\mu(\mu, \kappa)$  on  $h\left(\omega_{jt-1}^\mu(\mu, \kappa), \mathbf{W}_{jt-1}, \delta_p, \delta_s\right)$  to obtain  $\eta_{jt}^\mu(\kappa, \mu)$  as a function of  $(\kappa, \mu)$ . Following De Loecker (2011) and De Loecker and Warzynski (2012), we assume  $\mathbf{M}_{jt} \equiv (k_{it}, l_{it-1}, k_{it}^2, l_{it-1}^2, k_{it} l_{it-1}, \ln Y_{t-1})'$  are pre-

determined at time  $t$  and orthogonal to the productivity innovation  $\eta_{jt}^\mu(\kappa, \mu)$ . Then, we construct six moment conditions  $E\left(\eta_{jt}^\mu(\kappa, \mu)\mathbf{M}_{jt}\right) = 0$  and estimate six parameters  $(\kappa, \mu)$  by GMM.<sup>8</sup> We continue these steps until estimate parameters  $(\kappa, \mu)$  converge. Once the production function coefficients have been estimated, we calculate output elasticities  $\hat{\theta}_{jt}^L$  and  $\hat{\theta}_{jt}^M$  and estimate wage markdowns by (2).

### 2.3 Empirical Strategy

We estimate the causal impacts of FDI liberalization on wage markdowns by using variations in FDI regulations upon China’s WTO accession in 2002. Specifically, we conduct difference-in-difference (DD) regressions comparing wage markdowns in our treatment group where regulations on inward FDI are liberalized with that in our control group where regulations did not change before and after FDI regulation changes in 2002. Section 3 below will explain our construction of treatment and control groups.

For wage markdowns  $\eta_{jst}$  of firm  $j$  in four-digit industry (sector)  $s$  in year  $t$ , we estimate the following regression:

$$\ln \eta_{jst} = \alpha_j + \alpha_t + \beta FDI_{st} + \mathbf{X}'_{jst}\psi + \varepsilon_{jst}, \quad (10)$$

where  $\alpha_j$  and  $\alpha_t$  are firm-fixed effects and year fixed effects, respectively; and  $\varepsilon_{jst}$  is the error term. To isolate the effect of FDI regulation changes, we control for a vector of time-varying firm and industry characteristics  $\mathbf{X}_{jst}$  (to be explained later) that may affect the outcome.

The regressor of interest,  $FDI_{st}$ , captures the FDI regulation changes in industry  $s$  and year  $t$ . Specifically,  $FDI_{st} = Treatment_s \times Post02_t$ , where  $Treatment_s$  is a dummy variable indicating whether industry  $s$  belongs to the treatment group;  $Post02_t$  is a dummy variable indicating the post-WTO period, i.e.,  $Post02_t = 1$  if  $t \geq 2002$ , and 0 if  $t \leq 2001$ . To address the potential serial correlation and heteroskedasticity issues, we calculate the standard errors clustered at the four digit industry level (see Bertrand, Duflo, and Mullainathan, 2004). With firm fixed effects, the treatment effect  $\beta$  is identified for the incumbent firms that exist before and after the FDI reform.

The identifying assumption of the DD estimation specification (10) is that conditional on a list of controls

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<sup>8</sup>We picked the initial value of  $(\kappa_0, \mu_0)$  as follows. We regress the OLS regression of  $r_j$  on the second order polynomials of  $(k_{jt}, l_{jt}, m_{jt})$  and  $\ln \hat{Y}_t$  with controls  $\mathbf{W}_{jt-1}$ , province fixed effects, and four-digit industry fixed effects. Following (6), we use estimated coefficients of  $\{k, l, k^2, l^2, kl\}$  and  $\ln \hat{Y}_t$  as  $\kappa_0$  and  $\mu_0$ .

$(\alpha_j, \alpha_t, \mathbf{X}_{jst})$ , our regressor of interest,  $FDI_{st}$ , is uncorrelated with the error term,  $\varepsilon_{jit}$ , i.e.,

$$E[\varepsilon_{jst}|FDI_{st}, \alpha_j, \alpha_t, \mathbf{X}_{jst}] = E[\varepsilon_{jst}|\alpha_j, \alpha_t, \mathbf{X}_{jst}].$$

In other words, the wage markdowns in the treatment group would have followed the same trend as that in the control group if there had been no regulation changes in 2002. To alleviate the concern of this non-comparability of the treatment and control groups *ex ante*, we follow the approach proposed by Gentzkow (2006). First, we carefully characterize the determinants  $\mathbf{Z}_{s1998}$  of the changes in FDI regulations upon the WTO accession. As discussed in Lu, Tao, and Zhu (2017), four determinants are identified at the four-digit industry level: new product intensity, export intensity, number of firms, and industry age. We then add interactions between  $\mathbf{Z}_{s1998}$  and year dummies in  $\mathbf{X}_{jst}$  to control flexibly for post-WTO differences in the time path of the outcomes that are caused by the endogenous selection of industries for changes in FDI regulations. Furthermore, we control for vertical FDI (i.e., backward and forward FDI) that may affect wage markdowns in different industries. Using similar control variables, Lu, Tao, and Zhu (2017) found FDI liberalization significantly increased output shares of FDI firms in liberalized industries.<sup>9</sup>

A second potential concern is that other on-going policy reforms around the time of China's WTO accession might affect wage markdowns, and our DD estimator might confound the effect of these policy reforms. At the time of China's WTO accession, there were substantial tariff reductions by China and its trading partners, which affected the use of imported inputs and access to export markets. To condition out the tariff reduction effects, we include the interactions between year dummies and various tariffs (specifically, China's output and input tariffs, and its export tariffs) in 2001 in  $\mathbf{X}_{jst}$ .<sup>10</sup> Furthermore, one important policy reform in the early 2000s was the restructuring and privatization of SOEs. To control for the possibility that the extent of SOE restructuring and privatization differed across industries and affected our outcomes, we add the interaction between year dummies and industry SOE share in 2001 into  $\mathbf{X}_{jst}$ . China has set up special economic zones to attract foreign direct investments, and to alleviate this concern, we include an additional control, the interaction between year dummies and the share of industry output from the special

<sup>9</sup>While Lu, Tao, and Zhu (2017) conduct two stage least squares to investigate the causality from FDI output share to outcome variables, we employ reduced form regressions (10) to examine a direct causality from FDI liberalization to wage markdowns.

<sup>10</sup>The tariff data for HS-6 products are obtained from the World Integrated Trade Solution (WITS). By mapping HS-6 products to ASIF 4-digit industries through the concordance table from the National Bureau of Statistics of China, we can calculate simple average output tariff at the industry level. The input tariff is constructed as a weighted average of the output tariff, using as the weight share of the inputs in the output value from the 2002 China's Input-Output Table. The export tariff is measured as a weighted average of the destination country's tariffs on China's imports, using China's imports by each destination country as the weight.

economic zones in 2001.

### 3 Data and Background

#### 3.1 Data

**Panel Data on Industrial Firms** The first data used in this study come from the *Annual Survey of Industrial Firms* (ASIF), conducted by the National Bureau of Statistics of China for the 1998–2007 period.<sup>11</sup> These surveys cover all of the state-owned enterprises (SOEs) and non-SOEs with annual sales over 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”, the dataset reports plant-level information.<sup>12</sup> The dataset includes the basic information for each plant, such as its identification number, ownership structure, and industry affiliation, and the financial and operational information extracted from accounting statements, such as sales, employment, intermediate inputs, and total wage bill, from which we construct variables for production function estimation.<sup>13</sup>

**Data on China’s FDI Regulations** We classify each 4 digit industry into the treatment and control groups, following Lu, Tao and Zhu (2017). We use *the Catalogue for the Guidance of Foreign Investment Industries* (hereafter, *Catalogue*) to obtain information on FDI regulations changes of each industry upon China’s WTO accession at the end of 2001. In the *Catalogue*, products were classified into four categories: (i) products where FDI was supported (the supported category), (ii) products (not listed in the *Catalogue*) where FDI

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<sup>11</sup>This is the most comprehensive and representative firm-level dataset in China, and surveyed firms contribute the majority of China’s industrial value-added. The dataset has been widely used by economic researchers in recent years, e.g., Lu, Lu, and Tao (2010), 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 old classification system (GB/T 4754-1994) that had been used from 1995 to 2002. To achieve consistency in the industry codes over our entire sample period (1998–2007), we use the concordance table constructed by Brandt, Van Biesebroeck, and Zhang (2012).

<sup>12</sup>A confusion might arise because a firm and a plant are expressed by the same Chinese character. 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.

<sup>13</sup>To convert the 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 real capital stock is constructed using 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). The total wage bill is measured as the sum of firm’s wage bills and employee supplementary compensation such as bonus and insurance.

was permitted (the permitted category), (iii) products where FDI was restricted (the restricted category), and finally, (iv) products where FDI was prohibited (the prohibited category).

Then, we compare the 1997 and 2002 versions of the *Catalogue*, and identify, for each product in the *Catalogue*, whether there was a change in the FDI regulations upon China's accession to the WTO. We then assign each product to one of three possible outcomes: (i) FDI became more welcome (henceforth, such products are referred to as (FDI) encouraged products), (ii) FDI became less welcome (henceforth, such products are referred to as (FDI) discouraged products), (iii) No change in FDI regulations between 1997 and 2002.<sup>14</sup>

Finally, we aggregate the changes in FDI regulations from the *Catalogue* product level to the ASIF industry level. The aggregation process leads to four possible scenarios:

1. (FDI) Encouraged Industries: For all of the possible *Catalogue* products in a 4-digit CIC industry, there was either an improvement in FDI regulations or no change in FDI regulations.
2. (FDI) Discouraged Industries: For all of the possible *Catalogue* products in a 4-digit CIC industry, there was either a deterioration in FDI regulations or no change in FDI regulations.
3. No-Change Industries: There was no change in FDI regulations for any of the possible *Catalogue* products under a 4-digit CIC industry.
4. Mixed Industries: Some of the possible *Catalogue* products in a 4-digit CIC industry experienced an improvement in FDI regulations, but some had worsening FDI regulations.

Among the 424 4-digit CIC industries, 112 are (FDI) *encouraged industries*, 300 are *no-change industries*, 7 are (FDI) *discouraged industries* and 5 industries are *mixed industries*. We use the encouraged industries as the treatment group and the no-change industries as the control group in our DD regression, excluding the latter two groups from the analysis.<sup>15</sup>

### **3.2 Regulations of FDI in China**

In December 1978, the then leader of China, Deng Xiaoping, initiated an open door policy to promote foreign trade and investment. The policy changed dramatically the situation of China under rigid central

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<sup>14</sup>In the appendix [incomplete], we discuss in details how we make comparison between Catalogue 1997 and 2002 and match Catalogue product level to the ASIF industry level.

<sup>15</sup>The results (available upon request) remain robust when we include the *discouraged industries* in the analysis.

planning before 1978, with almost complete absence of foreign-invested enterprises (FIEs). From the late 1970s to the early 1990s, a series of laws on FDI and implementation measures were further introduced and revised.<sup>16</sup>

- 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.

As a result of these laws and implementation measures, China experienced a rapid growth in FDI inflows from 1979 to 1991 (Figure 1). 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.

[Insert Figure 1 here]

Most significantly, there were policies designating which industries were permitted to accept foreign direct investment. In June 1995, the central government of China promulgated the *Catalogue*, which, together with the modifications made in 1997, became the government unique guideline for regulating the inflows of FDI. Specifically, the *Catalogue* classified products into four categories: (i) FDI was supported, (ii) FDI was permitted, (iii) FDI was restricted, and finally, (iv) FDI was prohibited. Importantly, the guideline was implemented uniformly across regions. The central government prohibited discretionary policies on FDI entry by regional governments.<sup>17</sup>

After China’s entry into the World Trade Organization (WTO) in November 2001, its central government

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<sup>16</sup>FIEs enjoy preferential policies on taxes, land usage, and other matters, often in the form of policies for special economic zones, which were expected to bring advanced technologies and management know-how to China and to promote China’s integration into the world economy.

<sup>17</sup>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 in FDI entry regulations.

substantially revised the Catalogue in March 2002, and made minor revisions in November 2004.<sup>18</sup> In this study, we use the plausibly exogenous relaxation of FDI regulations upon China's WTO accession at the end of 2001 to identify the FDI effect.

## 4 Empirical Results

### 4.1 Wage Markdowns and Firm Status

Table 1 describes summary statistics on output elasticities and returns to scale of estimated gross output production functions. There is substantial heterogeneity on elasticities within industries, which confirms the importance of estimating wage markdowns at the firm level. In overall, estimated elasticities are reasonable. Elasticities are estimated positive in most industries. Though capital elasticities are estimated relatively small, this pattern consistent with previous studies on Chinese firms using different estimation methods (e.g., Lu and Yu, 2015). Thus, it is due to the nature of Chinese data rather than our estimation method. Furthermore, most industries exhibit constant returns to scale. This is consistent with that manufacturing in China mainly engages in traditional and replicable production rather than those requiring large fixed costs and exhibiting increasing returns to scale.

Using estimated output elasticities, we estimate firm-level wage markdowns and implied elasticities of firm-level labor supply curves. First of all, labor monopsony is ubiquitous in Chinese manufacturing industries. In our sample, 92% of firms set wage markdowns smaller than one, which implies these firms exercise monopsony powers over the wages. The first column of Table 2 reports median wage markdowns for each 2 digit industry. In all industries, median markdowns are smaller than one. Second, firm-level wage markdowns are heterogenous both across and within industries. Table 2 orders industries from small markdowns (wide markdowns) to large markdowns (narrow markdowns). Table 2 also report elasticities of labor supply to individual firms, implied by (1). As recent surveys by Manning (2003, 2011) and Ashenfelter, Farber, and Ransom (2010) summarize, previous estimates of labor supply elasticities vary across studies: 0.1 elasticity reported for Veterans Administration hospital nurses by Staiger et al. (2010), 1.3 reported for immigrant workers (mainly engaging in construction) in UAE by Naidu, Nyarko, and Wang (2016) , the range of elasticities of 1–1.9 reported by Falch (2010) for Norwegian teachers, 2 reported by Dal Bó,

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<sup>18</sup>The National Development and Reform Commission and the Ministry of Commerce jointly issued the fifth and sixth revised versions of the Catalogue in October 2007 and December 2011, which are out of our sample period.

Finan, and Rossi (2013) for Mexican public sector positions, and infinite reported by Matsudaira (2014) for low-wage nurse's aides in Californian care homes. While these elasticities are mostly estimated for service sector workers in different countries using different methodologies, our estimates are reasonably close to many of the previous estimates.

Table 3 further examines firm heterogeneity in markdowns, showing correlations of wage, wage markdowns, and employment with firm characteristics. Panel A, B, and C, report regressions where dependent variables are the logs of wage markdowns, wages, and employments, respectively. The dependent variables are regressed on the firm's TFPR in Column (1), on dummy variables indicating state-ownership and foreign ownership in Columns (2) and (3), on a dummy variable indicating whether the firm is located in coastal areas in Columns (4) and (5), and on a dummy variable indicating whether the firm is an exporter in Columns (6) and (7), respectively. The regressions include year fixed effects in all Columns, firm-fixed effects in Column (1), 4 digit industry-fixed effects in Columns (2)–(7), and firm's log TFPR in Column (3), (5) and (7).

In Table 3, wages in Panel B and employment in Panel C confirm patterns that are commonly found in other datasets. High productivity firms, state-owned firms, foreign-owned firms and exporting firms pay higher wages and hire more workers. Panel A shows these high productive firms also set higher markdowns (narrower markdowns). The positive association between wage markdowns, employment, and productivity might look surprising under a traditional view of labor monopsony where large firms exercise greater monopsony powers. However, this association is actually consistent with modern theories of labor monopsony such as the Burdett Mortensen model and other models surveyed in Manning (2003; 2011). As we will discuss in section 5, these modern theories emphasize the role of high wage to recruit more workers. Since high productivity firms demand more workers, they tend to set high wages and narrow wage markdowns.

Wage markdowns in Panel A interestingly confirm conventional images about “good jobs” in manufacturing sectors in China. Stated owned (SOE) firms and foreign firms set 51.2% and 16.1% narrower markdowns, respectively, than domestic private firms. Exporters set 15.8% narrower markdowns than non-exporters. Firms in coastal provinces set 8% lower markdowns than firms in in-land provinces. These markdown patterns are interestingly different from wage patterns in Panel B. First, the average wage difference between SOE firms and domestic private firms in Panel B is moderate 3.4%, which is much smaller than 34.7% of foreign-owned firms and 23.5% of exporters. From these comparisons of wages, one might conclude SOE firms do not really offer “good jobs”. However, in terms of wage markdowns, the 51.2%

premium of SOE firms is much larger than 16.1% of foreign-owned firms and 15.8% of exporting firms. Thus, when SOE firms and domestic private firms with the same MRL are compared, state-owned firms pay 50% higher wages and actually offer “very good jobs”. Another interesting comparison is firms in coastal provinces and in-land provinces. Firms in coastal provinces pay 32% higher wages, but set 8% lower mark-downs and hire 15% fewer workers. Interestingly, these patterns remain the same if we control for firm’s TFP in Column (3), (5) and (7). Thus, these patterns are not fully explained by selection based on firm productivity.

## 4.2 Causal Impacts of FDI Liberalization

The DD estimation results are presented in Table 4. 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 interactions between year dummies and determinants of FDI regulations changes in column 1. Interactions between year dummies and other policy controls are additionally included in column 2. Backward and forward FDI are added in the estimation reported in column 3.

Our regressor of interest,  $FDI_{st}$ , is consistently statistically significant and negative, indicating that the wage markdowns decreased more after the FDI regulation changes in the *encouraged industries* than in the *no-change industries*. Given that there is a surge of FDI inflows after the FDI regulation changes in 2002, the estimate implies that FDI liberalization casts a negative effect on the wage markdowns.

[Insert Table 4 here]

In terms of the economic magnitude, we rely on the estimate in column (3) in Table 4. We find that FDI liberalization decreases wage markdowns by 3.7% on average. As the FDI regulation changes started in 2002 and our sample period is from 1998 to 2007, the DD estimate captures the average treatment effect over six year. Thus, the 3.7% drop of the wage markdowns can be translated into 0.6% drop annually.

Figure 2 plots the time trends of the wage markdowns for the the *encouraged industries* and the *no-change industries*, conditional on a set of controls in (10). It is apparent that in the pre-WTO period, the *encouraged industries* and the *no-change industries* show quite similar trends. This alleviates the concern

that our treatment and control groups are systematically different *ex ante*, lending support to the satisfaction of our DD identifying assumption.

[Insert Figure 2 here]

Meanwhile, in the post-WTO period, the treatment group experienced a significant decline in the wage markdowns compared with the control group, indicating that the FDI regulations changes had a negative effect on wage markdowns.

We decompose the effect of FDI liberalization on wage markdowns into the separate effects on firm wage and MRL. To do so, we estimate the same specification (10), choosing firm wage and MRL as dependent variables, respectively. By construction, the coefficients  $\beta$  from the MRL regression and the wage markdown regression sum up to the coefficient  $\beta$  from the wage regression. Table 6 shows the decomposition result. FDI liberalization increases incumbent firm's MRL by 5.7%, but their wages only by 2.0%. If wage markdowns are constant as in traditional models of FDI, workers should receive as much as the increase in MRL. However, workers received only 35% of the increase in MRL, while 65% of them are captured by employers or other factors through widened wage markdowns.

**Robustness Checks** We conduct a battery of robustness checks on our aforementioned DD estimation. First, we control for firm's ownership structures (indicators for SOEs and FIEs) that may affect wage markdowns to balance firms in different industries. Second, we exclude from the regression sample all foreign firms and examine whether our results are robust using a sub-sample of domestic firms. As shown in columns (1) and (2) in Table 5, our results remain robust, with statistically negative estimate and magnitude barely changes.

In column 3 of Table 3, we conduct a placebo test by adding to the regression an additional control, *Treat*  $\times$  *One Year Before FDI Regulation Changes*, to check whether changes in wage markdowns in anticipation of the FDI regulation changes upon WTO accession. We find that our regressor of interest remains negative and statistically significant, while the coefficient of *Treat*  $\times$  *One Year Before FDI Regulation Changes* is statistically insignificant and with magnitude close to 0. These results indicate that the treatment and control groups are comparable in the pre-treatment periods and there is no expectation effect.

### 4.3 Heterogeneous Change in Wage Markdowns

One hypothesis for the decrease in wage markdowns is stickiness of wages. Though FDI increased MRL, firms did not change their wages because of some menu costs or contract costs. However, this hypothesis is unlikely. First, the nominal wage in China has grown both in liberalized and non-liberalized industries. Second, if this hypothesis is true, the effect should be large in the short run rather than in the long run. However, we saw in Figure 2 that the effect becomes stronger in the long run.

Another hypothesis for the decrease in wage markdowns is a fall in labor quality at incumbent firms. Wages may decrease relative to estimated MRL, if high skilled workers move to new foreign firms and incumbent firms replace them by workers with lower skills and paying them lower wages. We can check this hypothesis by investigating the effect of FDI liberalization on firm's TFP. Since we do not control for labor quality when estimating TFPR, a fall in labor quality should be estimated as a fall in TFPR as the residual in production function estimation. Column (1) in Table 7 reports the effect of FDI liberalization on TFPR in the same specification of the baseline regression. The impact of FDI liberalization on TFPR is estimated insignificant and the sign is positive contrary to the hypothesis. Even with interaction terms with initial productivity, no systematic change in TFPR is observed in the liberalized sectors. Since the effect is small and insignificant, we search for an explanation that does not need any change in factor quality or TFPR.

Firms might respond differently to FDI shocks depending on their productivity. We use the following specification to investigate whether the effect of FDI liberalization on wage markdowns is heterogeneous across firms with different initial productivity:

$$\begin{aligned} \ln \eta_{jst} = & \alpha_t + \alpha_j + \beta FDI_{st} + \phi FDI_{st} \times \ln TFPR_{j,initial} \\ & + \varsigma \ln TFPR_{j,initial} \times Post2002 + \mathbf{X}'_{jst} \psi + \varepsilon_{jst}, \end{aligned} \quad (11)$$

where  $\ln TFPR_{j,initial}$  is the log of firm's initial TFPR in the pre-WTO period (i.e., between 1998–2001). Column (1) in Table 8 report the heterogeneous effect of FDI liberalization on wage markdowns together with the effects on wages and MRLs in Columns (2) and (3), respectively. Column (1) reports that the extent of markdown expansion decreases in firm's initial productivity. Firms whose initial log TFPR exceed the threshold  $4.9 \simeq 0.069/0.014$  actually narrowed wage markdowns. These high productive firms are only top

9.3% of the sample. In sum, a vast majority of low productive firms widened wage markdowns, while a few high productive firms narrowed them. On average, wage markdowns are estimated to expand.

## 5 A Theoretical Explanation

The previous section presents two findings contrasting to the conventional wisdom. First, small firms, not large firms, set wider wage markdowns. Second, in response to FDI liberalization and the induced entry of new employers, only the few most productive firms narrow markdowns, while the rest of them widen them, which results in widening the average markdowns. This section provides a theoretical explanation for these findings. First, Section 5.1 confirms the findings are inconsistent with a traditional monopsony theory. Second, in Section 5.2, we show a modern monopsony theory, the Burdett-Mortensen model, predicts the two findings under . Finally, in section 5.3, we further test the prediction of the Burdett-Mortensen model on the response of markdowns to FDI liberalization.

### 5.1 Traditional Monopsony Theory

Traditional Monopsony theories emphasize employer concentration as a source of firm's monopsony power. We consider Cournot oligopsony as the simplest model. There are  $N$  firms and each firm  $i$  decides employment  $L_i$ , taking other firm's employment as given. Let  $L^A$  be the aggregate employment in the industry and  $w(L^A)$  be an inverse labor supply curve to the industry with elasticity  $\varepsilon^A \equiv \frac{w(L^A)}{w'(L^A)L^A}$ . Let  $R_i(L_i)$ ,  $L_i$  and  $s_i \equiv L_i/L^A$  be firm  $i$ 's revenue, employment and employment share, respectively. Firm  $i$ 's profit maximization problem is written as:

$$\max_{L_i} R_i(L_i) - w\left(\sum_i L_i\right) L_i$$

The first order condition leads to wage markdowns

$$\eta_i = \frac{\varepsilon_i}{\varepsilon_i + 1} = \frac{\varepsilon^A/s_i}{\varepsilon^A/s_i + 1}. \quad (12)$$

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

The markdown formula (12) implies several predictions that can be compared to our findings. First,

equation (12) implies  $\eta_i > \eta_j$  if and only if  $s_i < s_j$ . Thus, those firms with greater employment exercise greater monopsony power and exhibit wider markdowns. Though this prediction conforms with the conventional wisdom, it is the exact opposite to our finding. In Table 3, those firms with greater employment show narrower markdowns. Second, the formula (12) implies a limit theorem for Cournot oligopsony. When the number of firms increases toward infinity and  $\varepsilon^A$  is finite, each firm's employment share approaches to zero and markdowns to one as in a perfectly competitive labor market. This limit theorem contributes to the conventional wisdom that new entry such as FDI liberalization reduces firm's monopsonic power and narrows wage markdowns. Our finding about the effect of FDI on wage markdowns is strikingly different from this conventional wisdom. Instead, facing to new entries of foreign employers, incumbent employers on average exercise stronger monopsonic powers. Of course, if new entry is finite, it is theoretically possible that markdowns expands when  $d\varepsilon^A/dL^A < 0$  and a large fall in  $\varepsilon^A$  offsets a fall in employment shares  $s_i$ . However, even in this case, all firms should equally expand markdowns, which is inconsistent with our finding of heterogeneous responses.

In the next section, we show that this heterogeneous effect is consistent with a standard on-the-job search model of labor monopsony by Burdett and Mortensen (1998). We model FDI liberalization as the entry of high productive firms in the labor market. Then, firm-level labor supply curves respond heterogeneously: labor supply becomes more elastic for few high productive firms, while less elastic for the rest of firms.

## 5.2 Modern Monopsony Theory

Modern monopsony theories consider job search friction for workers as a source of firm's monopsony power. We consider a canonical version of the Burdett and Mortensen (1998) model. Firms produce a homogenous numeraire good under perfect competition by using labor and constant returns to scale technology. Consider a labor market with continuums of workers with mass  $L$  and continuums of firms with mass  $N$ . Workers are homogenous and firms are heterogenous in productivity  $\varphi$ . Denote their productivity distribution function by  $J(\varphi)$  with continuous support  $[b, \varphi_{max}]$ .

Firms and workers search and match randomly. The model repeats infinitely many periods. With a negligible time discount rate, each firm maximizes its per-period profit in a stationary equilibrium. Thus, we do not denote time periods. At the beginning of each period, each firm announces wage  $w$ . Then, both employed and unemployed workers search for jobs. Each of them meets a firm in a Poisson process with rate  $\lambda$ . An unemployed worker accepts any job offer with higher wage  $w$  than unemployment benefit  $b$ ,

while an employed worker accepts only a job offering a higher wage than the current wage. After matching, firms produce goods. At the end of each period, workers leave the job with exogenous rate  $\delta$  and become unemployed. Workers receive unemployment benefits  $b$  if they remain unemployed at the end of each period.

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:

$$\begin{aligned} \delta(1 - u)L &= \lambda uL, \\ \lambda F(w)uL &= [\delta + \lambda(1 - F(w))] N \int_b^w l(t) dF(t) \text{ for all } w \text{ on the support of } F(w), \end{aligned} \quad (13)$$

where  $u$  is unemployment rate,  $N$  is the number of firms in this labor market,  $l(w)$  is the employment by a firm that offers wage  $w$ , and  $F(w)$  is the distribution of wage offers among firms. The first equation is the size of unemployed workers. The inflow into unemployment in the left hand side equals to the outflow from unemployment in the right hand side. The second equation is about a group of employed workers who currently receive lower wages than  $w$ . Unemployed workers join this group with probability  $\lambda F(w)$ . The size of this group is  $N \int_b^w l(t) dF(t)$ , where . The left hand side and the right hand side expresses the inflow and the outflow into this group, respectively. Workers leave this group either because of being unemployed with rate  $\delta$  or moving to better paying jobs 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  $\bar{w} > b$ . Differentiating (13) by  $w$ , we obtain a positive relation between employment and wage in a steady state:

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

where  $k \equiv \lambda/\delta$ . This is the labor supply curve to an individual firm (14). The labor supply curve becomes upward sloping because a high wage firm attracts workers from other firms as well as prevents its own workers from moving to other firms. The tradeoff between wage and employment depends on the chance that employee meet firms offering higher wages,  $1 - F(w)$ .

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

$$\pi(\varphi) \equiv \max_w \pi(w, \varphi) \equiv \varphi l(w) - wl(w) \text{ subject to (14)}. \quad (15)$$

From the second order condition,  $\partial^2 \pi(w, \varphi) / \partial w^2 < 0$  and the supermodularity of  $\pi(w, \varphi)$ ,  $\partial^2 \pi(w, \varphi) / \partial w \partial \varphi >$

0, we obtain the positive wage function  $w'(\varphi) > 0$ . Thus, high productive firms offer higher wages to hire more workers, which is consistent with Table 3. Since the wage distribution  $F$  has a continuous support  $[b, \bar{w}]$ , this positive sorting of wage and productivity means that the wage ranking of firms agrees with the productivity ranking of firms:

$$F(w(\varphi)) = J(\varphi) \text{ for all } \varphi \geq \varphi^*. \quad (16)$$

The lowest wage is equal to the unemployment benefit  $b$ . We assume a firm setting  $w(b) = b$  chooses to exit.

We obtain an equilibrium as follows. Substituting (16) into the labor supply curve, we obtain firm's employment:

$$l(\varphi) = \frac{Lk}{N [1 + k(1 - J(\varphi))]^2}. \quad (17)$$

By applying the envelop theorem for  $\pi(\varphi)$  in (15), we obtain  $\pi'(\varphi) = l(\varphi)$ . Using Integration and  $\pi(b) = 0$  obtains the profit function:

$$\pi(\varphi) = (\varphi - b)\bar{l}(\varphi) = (\varphi - w(\varphi))l(\varphi), \quad (18)$$

where

$$\bar{l}(\varphi) \equiv \left[ \frac{1}{\varphi - b} \int_b^\varphi l(s)^\rho ds \right]^{1/\rho} \quad (19)$$

may be interpreted as an weighted average of employment among firms with lower productivity than  $\varphi$ . From (17) and (18), we obtain the markdown  $\eta(\varphi) = w(\varphi) / \varphi$  as

$$\eta(\varphi) = 1 - \left( \frac{\varphi - b}{\varphi} \right) \frac{\bar{l}(\varphi)}{l(\varphi)} = 1 - \frac{1}{\varphi} \int_b^\varphi \left( \frac{1 + k(1 - J(\varphi))}{1 + k(1 - J(s))} \right)^2 ds. \quad (20)$$

In the current version, we conduct the simplest analysis and will generalize it in future revision. We assume  $J$  is a uniform distribution with support  $[b, \varphi^{max}] = [0, 1]$ , i.e.  $J(\varphi) = \varphi$  for  $\varphi \in [0, 1]$ . Then, the markdown function (20) can be explicitly solved as a linear function in  $\varphi$  for  $\varphi > 0$ :<sup>19</sup>

$$\eta(\varphi) = \frac{k\varphi}{1+k} \text{ for } \varphi > 0.$$

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<sup>19</sup>We assume firms with  $\varphi = 0$  does not hire any worker.

Thus, larger and more productive firms set narrower markdowns. This is the opposite with the prediction by the Cournot oligopsony, but is consistent with our finding in Table 3.

**Inward FDI liberalization** Now we are ready to analyze the liberalization of inward FDI into this labor market. Denote the mass of incumbents by  $M$  and the productivity distribution (uniform) of incumbents by  $J_0(\varphi)$ . We model the opening of FDI as an exogenous entry of foreign firms with mass  $M^*$  and with a uniform productivity distribution  $G^*$  with support  $[a, b]$ . We consider three cases regarding the support  $[a, b]$  of the productivity distribution of foreign firms. The first case is a “high productivity” case ( $a > 0$  and  $b = 1$ ) where foreign firms are more productive than domestic firms on average. This pattern is confirmed in Chinese data as well as in most countries. The second case is an “identical case” ( $a = 0$  and  $b = 1$ ) where foreign entrants have the same productivity distribution as incumbents. The last case is “low productivity” case ( $a = 0$  and  $b < 1$ ) where foreign firms are less productive than domestic firms on average. The latter two cases do not fit with the pattern in the data, but are helpful for understanding the model.

The following proposition shows the response of wage markdowns depends on the productivity distribution of foreign firms. [We will work more on intuition behind the proof.]

**Proposition 1.** (1) *In the high productivity case, there exists a threshold productivity  $\varphi^H \in (a, 1)$  such that  $\eta_1(\varphi) < \eta_0(\varphi)$  if  $\varphi \in (0, \varphi^H)$  and  $\eta_1(\varphi) > \eta_0(\varphi)$  if  $\varphi \in (\varphi^H, 1]$ .* (2) *In the identical case, no firm changes markdowns, i.e.,  $\eta_1(\varphi) = \eta_0(\varphi)$  for all  $\varphi \in [0, 1]$ .* (3) *In the low productivity case, there exists a threshold productivity  $\varphi^L \in (0, b)$  such that  $\eta_1(\varphi) > \eta_0(\varphi)$  if  $\varphi \in (0, \varphi^L)$  and  $\eta_1(\varphi) < \eta_0(\varphi)$  if  $\varphi \in (\varphi^L, 1]$ .*

*Proof.* In the identical case, FDI only changes the mass of firms, but does not change the productivity distribution. Thus, FDI does not affect the wage and the wage markdowns.

In the high productivity case, we first consider the change in employment by the incumbent firms from  $l_0(\varphi)$  to  $l_1(\varphi)$ :

$$\Phi(\varphi) \equiv \frac{l_1(\varphi)}{l_0(\varphi)} = \frac{N_0}{N_1} \left( \frac{1 + k(1 - \varphi)}{1 + kh(\varphi)} \right)^2, \text{ where } h(\varphi) \equiv \begin{cases} 1 - \beta\varphi & \text{for } \varphi \in [0, a] \\ \theta(1 - \varphi) & \text{for } \varphi \in [a, 1] \end{cases}$$

and  $\theta \equiv (1 - a\beta)/(1 - a) < 1$ . Since  $\frac{l_1(0)}{l_0(0)} = \frac{l_1(1)}{l_0(1)} = \frac{N_0}{N_1}$  and

$$\Phi'(\varphi) = \begin{cases} -\frac{2k\Phi(\varphi)(1+k)(1-\beta)}{[1+kh(\varphi)][1+k(1-\varphi)]} < 0 & \text{for } \varphi \in (0, a) \\ \frac{2k\Phi(\varphi)(1-\theta)}{[1+kh(\varphi)][1+k(1-\varphi)]} > 0 & \text{for } \varphi \in (a, 1), \end{cases}$$

the graph of  $l_1(\varphi)/l_0(\varphi)$  is a U-shaped curve and reach its maximum at  $\varphi = 0$  and  $\varphi = 1$ . Thus, there exists a threshold  $\varphi^H \in (a, 1)$  such that<sup>20</sup>

$$\frac{\bar{l}_1(\varphi)}{\bar{l}_0(\varphi)} > \frac{l_1(\varphi)}{l_0(\varphi)} \text{ for } \varphi \in (0, \varphi^H) \text{ and } \frac{\bar{l}_1(\varphi)}{\bar{l}_0(\varphi)} > \frac{l_1(\varphi)}{l_0(\varphi)} \text{ for } \varphi \in (\varphi^H, 1].$$

From (20), we obtain heterogenous changes in the wage markdowns

$$\eta_1(\varphi) < \eta_0(\varphi) \text{ for } \varphi \in (0, \varphi^H) \text{ and } \eta_1(\varphi) > \eta_0(\varphi) \text{ for } \varphi \in (\varphi^H, 1].$$

Notice that the threshold is in a middle of the support of productivity of new foreign entrants. 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 reduces them.

In the low productivity case, the change in employment of incumbent becomes:

$$\Phi(\varphi) \equiv \frac{l_1(\varphi)}{l_0(\varphi)} = \frac{N_0}{N_1} \left( \frac{1+k(1-\varphi)}{1+ki(\varphi)} \right)^2, \text{ where } i(\varphi) = \begin{cases} 1 - \eta\varphi & \text{for } \varphi \in [0, b] \\ \beta(1 - \varphi) & \text{for } \varphi \in [b, 1] \end{cases}$$

and  $\eta \equiv \left( \frac{1-\beta+b\beta}{b} \right) > 1$ . Since  $\frac{l_1(0)}{l_0(0)} = \frac{l_1(1)}{l_0(1)} = \frac{N_0}{N_1}$  and

$$\Phi'(\varphi) = \begin{cases} \frac{2k\Phi(\varphi)(1+k)(\eta-1)}{[1+ki(\varphi)][1+k(1-\varphi)]} > 0 & \text{for } \varphi \in (0, b) \\ -\frac{2k\Phi(\varphi)(1-\beta)}{[1+ki(\varphi)][1+k(1-\varphi)]} < 0 & \text{for } \varphi \in (b, 1), \end{cases}$$

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<sup>20</sup>Consider

$$\begin{aligned} \Psi(\varphi) &\equiv (\varphi - b) [\bar{l}_1(\varphi) - \Phi(\varphi)\bar{l}_0(\varphi)] \\ &= \int_b^\varphi [\Phi(s) - \Phi(\varphi)] l_0(s) ds. \end{aligned}$$

Since  $\Psi'(\varphi) = -\int_b^\varphi \Phi'(s) l_0(s) ds$ ,  $\Psi(\varphi)$  is continuous, increasing for  $\varphi < a$  and decreasing for  $\varphi > a$ . Since  $\Psi(0) = 0$  and  $\Psi(1) = \int_b^1 [\Phi(s) - \Phi(1)] l_0(s) ds < 0$ ,  $\Psi(\varphi) > 0$  for  $\varphi \in (0, \varphi^H)$  and  $\Psi(\varphi) < 0$  for  $\varphi \in (\varphi^H, 1]$ .

we have a threshold  $\varphi^L \in (0, b)$  such that

$$\frac{\bar{l}_1(\varphi)}{\bar{l}_0(\varphi)} < \frac{l_1(\varphi)}{l_0(\varphi)} \text{ for } \varphi \in (0, \varphi^L) \text{ and } \frac{\bar{l}_1(\varphi)}{\bar{l}_0(\varphi)} > \frac{l_1(\varphi)}{l_0(\varphi)} \text{ for } \varphi \in (\varphi^L, 1].$$

Thus, we have heterogenous changes in the wage markdowns that are exactly opposite to our finding:

$$\eta_1(\varphi) > \eta_0(\varphi) \text{ if } \varphi \in (0, \varphi^L) \text{ and } \eta_1(\varphi) < \eta_0(\varphi) \text{ if } \varphi \in (\varphi^L, 1].$$

□

### 5.3 Subsample Analysis (Preliminary)

Proposition 1 predicts the heterogeneous response of wage markdowns to FDI liberalization when foreign firms are more productive than domestic firms. To further test this prediction, we classify each 4 digit industry into two groups based on technology differences between foreign and domestic firms. For each 4 digit industry in the pre-WTO period (1998-2001), we calculate the median TFPR of domestic firms and that of foreign firms. Then, we label an industry by “high foreign TFPR” if the median TFPR of foreign firms is higher than that of domestic firms and by “low foreign TFPR” otherwise. Figure 3 describes the estimated density of the ratio of median foreign firm’s TFPR to domestic firm’s across 4 digit industries. The 25, 50 and 75 percentiles are 1.007, 1.052, and 1.127, respectively. The high foreign TFPR group includes 78% of industries. If Proposition 1 explains the heterogeneous response of wage markdowns, we should observe positive interaction of TFPR and FDI liberalization in (11) only for the high foreign TFPR group. Strictly speaking, we should also observe negative interaction for the low foreign TFPR group. However, as Figure 3 shows, the absolute TFPR gap between foreign and domestic firms in the low foreign TFPR group is not as large as in the high TFPR group.

Columns (2) and (3) in Table 8 estimate (11) for the high foreign TFPR and low foreign TFPR groups. Column (2) for the high foreign TFPR group shows very similar results to Column (1) for the full sample. This is consistent with Proposition 1. In Column (3) for the low foreign TFPR group, both coefficients of FDI liberalization and its interaction with initial TFPR become smaller and insignificant. Strictly speaking, the low productivity case in Proposition 1 predicts that the first two coefficients in Column (3) should have the opposite signs to those in Column (2). However, as Figure 3 shows, the TFPR gap between foreign firms

and domestic firms in the low productivity group is small. Thus, this group could be compared with the identical case in Proposition 1. In this comparison, small and insignificant effects of FDI liberalization in Column (3) is consistent with the model. [We will work more on this sub sample analysis in future revision.]

## 6 Conclusion

To be added.

## References

- Ackerberg, Daniel A., Kevin Caves, and Garth Frazer. 2015. "Identification properties of recent production function estimators." *Econometrica*, 83(6): 2411–51.
- Arkolakis, Costas, Costinot, Arnaud, Donaldson, Dave, and Rodríguez-Clare, Andreas. 2017. "The Elusive Pro-Competitive Effects of Trade."
- Amiti, Mary, and Donald R. Davis. 2012. "Trade, firms, and wages: Theory and evidence." *Review of Economic Studies*, 79(1): 1–36.
- Ashenfelter, Orley C., Henry Farber, and Michael R. Ransom. "Labor market monopsony." *Journal of Labor Economics*, 28.2 (2010): 203–10.
- Brandt, Loren, Johannes Van Biesebroeck, Luhang Wang, and Yifan Zhang. 2012. "WTO Accession and Performance of Chinese Manufacturing Firms." <http://www.ln.edu.hk/econ/staff/yfzhang/pdf/WTO6.pdf>
- Brummund, Peter 2012. "Variation in Monopsonistic Behavior Across Establishments: Evidence From the Indonesian Labor Market."
- Burdett, Kenneth, and Dale T. Mortensen. 1998. "Wage differentials, employer size, and unemployment." *International Economic Review*, 39 (2): 257–273.
- Chen, Natalie, Jean Imbs, and Andrew Scott. 2009. "The Dynamics of Trade and Competition", *Journal of International Economics*, 77, 50–62
- Dal Bó, Ernesto, Frederico Finan, and Martín A. Rossi. 2013. "Strengthening state capabilities: The role of financial incentives in the call to public service." *Quarterly Journal of Economics*, 128(3): 1169–1218.

- Davidson, Carl, Lawrence Martin, and Steven Matusz. 1999. "Trade and search generated unemployment." *Journal of International Economics*, 48(2): 271–299.
- Davis, Donald R., and James Harrigan. 2011. "Good jobs, bad jobs, and trade liberalization." *Journal of International Economics*, 84(1): 26–36.
- Dobbelaere, Sabien, Kozo Kiyota, and Jacques Mairesse. 2015. "Product and labor market imperfections and scale economies: Micro-evidence on France, Japan and the Netherlands." *Journal of Comparative Economics*, 43(2): 290–322.
- De Loeckera, Jan. 2013. "Detecting learning by exporting." *American Economic Journal: Microeconomics*, 5(3): 1–21.
- De Loecker, Jan. 2011. "Product differentiation, multiproduct firms, and estimating the impact of trade liberalization on productivity." *Econometrica* 79(5): 1407–51.
- De Loecker, Jan, and Frederic Warzynski. 2012. "Markups and firm-level export status." *American Economic Review* 102(6): 2437–71.
- De Loecker, Jan, and Pinelopi Koujianou Goldberg. 2014. "Firm Performance in a Global Market." *Annual Review of Economics* 6(1): 201–27.
- De Loecker, Jan, Pinelopi K. Goldberg, Amit K. Khandelwal, and Nina Pavcnik (2016). "Prices, Markups, and Trade Reform." *Econometrica*, 84: 445–510.
- De Loecker, Jan, and Van Biesebroeck, Johannes. 2016. "The Effect of International Competition on Firm Productivity and Market Power."
- Egger, Hartmut, and Udo Kreickemeier. 2009. "Firm heterogeneity and the labor market effects of trade liberalization." *International Economic Review* 50(1): 187–216.
- Fajgelbaum, Pablo D. 2016. "Labor market frictions, firm growth, and international trade."
- Falch, Torberg. 2010. "The Elasticity of Labor Supply at the Establishment Level." *Journal of Labor Economics*, 28(2): 237–266

- Felbermayr, Gabriel, Julien Prat, and Hans-Jörg Schmerer. 2011. "Globalization and labor market outcomes: Wage bargaining, search frictions, and firm heterogeneity." *Journal of Economic Theory*, 146(1): 39–73.
- Foster, Lucia, John Haltiwanger, and Chad Syverson. 2008. "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?." *American Economic Review*, 98(1): 394–425.
- Gandhi, Amit, Salvador Navarro and David Rivers. 2017. "On the Identification of Gross Output Production Functions." mimeo
- Gentzkow, Matthew. 2006. "Television and Voter Turnout", *Quarterly Journal of Economics*, 121, 931–72.
- Harrison, Ann E. 1994. "Productivity, Imperfect Competition and Trade Reform. Theory and Evidence", *Journal of International Economics* 36, 53–73.
- Hall, Robert E. "The Relation between Price and Marginal Cost in US Industry." *Journal of Political Economy* 96(5): 921–47.
- Helpman, Elhanan, Oleg Itskhoki, and Stephen Redding. "Inequality and unemployment in a global economy." *Econometrica* 78.4 (2010): 1239–83.
- Holmes, Thomas J., Wen-Tai Hsu, and Sanghoon Lee. 2014. "Allocative efficiency, mark-ups, and the welfare gains from trade." *Journal of International Economics* 94(2): 195–206.
- Khandelwal, Amit K., Peter K. Schott, and Shang-Jin Wei. 2013. "Trade liberalization and embedded institutional reform: evidence from Chinese exporters." *American Economic Review* 103(6): 2169–95.
- Krishna, Pravin and Devashish Mitra. 1998. "Trade Liberalization, Market Discipline and Productivity Growth: New Evidence from India", *Journal of Development Economics* 56, 447–462
- Konings, Jozef, Patrick Van Cayseele, and Frederic Warzynski. 2001. "The dynamics of industrial mark-ups in two small open economies: does national competition policy matter?" *International Journal of Industrial Organization* 19(5): 841-859.
- Levinsohn, James. 1993. "Testing the Imports-as-Market-Discipline Hypothesis," *Journal of International Economics*, 35: 1–22

- Levinsohn, James, and Amil Petrin. 2003. "Estimating production functions using inputs to control for unobservables." *Review of Economic Studies*, 70(2): 317–41.
- Lu, Yi, and Linhui Yu. 2015. "Trade liberalization and markup dispersion: evidence from China's WTO accession." *American Economic Journal: Applied Economics* 7(4): 221–53.
- Lu, Yi, Zhigang Tao and Lianming Zhu. 2017. "Identifying FDI Spillovers." *Journal of International Economics* 107, 75–90.
- Lu, Jiangyong, Yi Lu, and Zhigang Tao. 2010. "Exporting Behavior of Foreign Affiliates: Theory and Evidence." *Journal of International Economics* 81, 197-205
- Matsudaira, Jordan D. "Monopsony in the low-wage labor market? Evidence from minimum nurse staffing regulations." *Review of Economics and Statistics* 96(1): 92–102.
- Naidu, Suresh, Yaw Nyarko, and Shing-Yi Wang. 2016. "Monopsony Power in Migrant Labor Markets: Evidence from the United Arab Emirates." *Journal of Political Economy*, 124(6): 1735–92.
- Manning, Alan. 2003. *Monopsony in motion: Imperfect competition in labor markets*. Princeton University Press.
- Manning, Alan. 2011. "Imperfect competition in the labor market." David Card and Orley Ashenfelter ed. *Handbook of Labor Economics*, Vol. 4B: 973–1041.
- Mortensen, Dale T. 2003. *Wage Dispersion: Why Are Similar Workers Paid Differently?* Cambridge and London: MIT Press.
- Olley, G. Steven, and Ariel Pakes. 1996. "The Dynamics of Productivity in the Telecommunications Equipment Industry." *Econometrica*, 64(6): 1263-1297.
- Petrin, Amil, and Jagadeesh Sivadasan. 2013. "Estimating lost output from allocative inefficiency, with an application to Chile and firing costs." *Review of Economics and Statistics* 95(1): 286–301.
- Staiger, Douglas O., Joanne Spetz, and Ciaran S. Phibbs. 2010. "Is there monopsony in the labor market? Evidence from a natural experiment." *Journal of Labor Economics*, 28(2): 211–236.
- Wooldridge, Jeffrey M. 2009. "On estimating firm-level production functions using proxy variables to control for unobservables." *Economics Letters* 104(3): 112–14.

# Appendix

## A1. Heterogenous Labor

**Imperfectly substitutable case** Suppose that there are two types of labor, skilled labor  $S$  and unskilled labor  $U$ . Let firm  $j$ 's production function be  $Y_{jt} = Y_{jt}(S_{jt}, U_{jt}, K_{jt}, M_{jt}, \omega_{jt})$ . Firm  $j$  pays a wage for skilled labor  $w_{jt}^S$  and a wage for unskilled labor  $w_{jt}^U$  and face inverse labor supply curves,  $w_{jt}^S(S_{jt})$  and  $w_{jt}^U(U_{jt})$ , respectively.

If we can observe skilled labor employment  $S_{jt}$ , unskilled labor employment  $U_{jt}$ , skilled wage  $w_{jt}^S$  and unskilled wage  $w_{jt}^U$ , then it is possible to measure skilled wage markdown  $\eta_j^S$  and unskilled wage markdown  $\eta_j^U$ , separately, using the formula (2):

$$\eta_{jt}^S = \frac{w_{jt}^S}{\lambda_{jt} \frac{\partial Y_{jt}}{\partial S_{jt}}} = \frac{\alpha_{jt}^S \theta_{jt}^M}{\alpha_{jt}^M \theta_{jt}^S} \text{ and } \eta_{jt}^U = \frac{w_{jt}^U}{\lambda_{jt} \frac{\partial Y_{jt}}{\partial U_{jt}}} = \frac{\alpha_{jt}^U \theta_{jt}^M}{\alpha_{jt}^M \theta_{jt}^U},$$

where  $\alpha_{jt}^S \equiv \frac{w_{jt}^S S_{jt}}{P_{jt} Y_{jt}}$  and  $\alpha_{jt}^U \equiv \frac{w_{jt}^U U_{jt}}{P_{jt} Y_{jt}}$  are the expenditure share of skilled labor and unskilled labor in the total revenue, respectively, and  $\theta_{jt}^S \equiv \frac{\partial Y_{jt}}{\partial S_{jt}} \frac{S_{jt}}{Y_{jt}}$  and  $\theta_{jt}^U \equiv \frac{\partial Y_{jt}}{\partial U_{jt}} \frac{U_{jt}}{Y_{jt}}$  are output elasticities on skilled labor and unskilled labor, respectively.

In our data, we observe only total employment  $L_{jt} = S_{jt} + U_{jt}$  and do not observe skilled labor and unskilled labor separately. The expenditure share of total employment in revenue is the sum of the expenditure shares of skilled labor and unskilled labor:

$$\alpha_j^L = \frac{w_{jt}^S S_{jt} + w_{jt}^U U_{jt}}{P_{jt} Y_{jt}} = \alpha_{jt}^S + \alpha_{jt}^U.$$

To calculate output elasticities of total employment  $\theta_{jt}^L$ , we assume a firm maintains the current skilled/unskilled labor ratio:

$$\frac{dL_{jt}}{L_{jt}} = \frac{dS_{jt}}{S_{jt}} = \frac{dU_{jt}}{U_{jt}}.$$

Since  $dS_{jt}/dL_{jt} = S_{jt}/L_{jt}$  and  $dU_{jt}/dL_{jt} = U_{jt}/L_{jt}$ ,  $\theta_{jt}^L$  becomes

$$\begin{aligned}\theta_{jt}^L &= \frac{dY_{jt}}{dL_{jt}} \frac{L_{jt}}{Y_{jt}} \\ &= \left( \frac{\partial Y_{jt}}{\partial S_{jt}} \frac{dS_{jt}}{dL_{jt}} + \frac{\partial Y_{jt}}{\partial U_{jt}} \frac{dU_{jt}}{dL_{jt}} \right) \frac{L_{jt}}{Y_{jt}} \\ &= \frac{\partial Y_{jt}}{\partial S_{jt}} \frac{S_{jt}}{Y_{jt}} + \frac{\partial Y_{jt}}{\partial U_{jt}} \frac{U_{jt}}{Y_{jt}} \\ &= \theta_{jt}^S + \theta_{jt}^U.\end{aligned}$$

From these relationships, our markdown measure (2) becomes a weighted average of skilled wage markdown and unskilled wage markdown since

$$\begin{aligned}\eta_{jt} &= \frac{\theta_{jt}^M \alpha_{jt}^L}{\alpha_{jt}^M \theta_{jt}^L} \\ &= \frac{\theta_{jt}^M}{\alpha_{jt}^M} \left( \frac{\alpha_{jt}^S + \alpha_{jt}^U}{\theta_{jt}^S + \theta_{jt}^U} \right) \\ &= \left( \frac{\theta_{jt}^S}{\theta_{jt}^S + \theta_{jt}^U} \right) \frac{\theta_{jt}^M}{\alpha_{jt}^M} \frac{\alpha_{jt}^S}{\theta_{jt}^S} + \left( \frac{\theta_{jt}^U}{\theta_{jt}^S + \theta_{jt}^U} \right) \frac{\theta_{jt}^M}{\alpha_{jt}^M} \frac{\alpha_{jt}^U}{\theta_{jt}^U} \\ &= \iota_{jt}^S \eta_{jt}^S + \iota_{jt}^U \eta_{jt}^U,\end{aligned}\tag{21}$$

where  $\iota_{jt}^S \equiv \theta_{jt}^S / (\theta_{jt}^S + \theta_{jt}^U)$  and  $\iota_{jt}^U \equiv \theta_{jt}^U / (\theta_{jt}^S + \theta_{jt}^U) = 1 - \iota_{jt}^S$ .

**Perfectly substitutable case** An interesting special case is when skilled labor and unskilled labor are perfectly substitutable. Suppose there exists scalars  $\kappa^S$  and  $\kappa^U$  such that one unit of skilled labor is equivalent to  $\kappa^S$  efficiency unit of labor  $L^*$  and one unit of unskilled labor is equivalent to  $\kappa^U$  efficiency unit of labor. Firm  $j$  pays a wage  $w_{jt}^*$  for each efficiency unit and hires  $L_{jt}^*$  efficiency unit of labor. The marginal products of skilled labor and unskilled labor are linear in the marginal product of efficiency unit of labor:

$$\frac{\partial Y_{jt}}{\partial S_{jt}} = \kappa^S \frac{\partial Y_{jt}}{\partial L_{jt}^*} \text{ and } \frac{\partial Y_{jt}}{\partial U_{jt}} = \kappa^U \frac{\partial Y_{jt}}{\partial L_{jt}^*}.$$

A skilled wage and an unskilled wage are linear in a wage for an efficiency unit:

$$w_{jt}^S = \kappa^S w_{jt}^* \text{ and } w_{jt}^U = \kappa^U w_{jt}^*.$$

Firm  $j$  sets the same markdown for skilled and unskilled labor:

$$\eta_{jt}^S = \frac{w_{jt}^S}{\lambda_{jt} \frac{\partial Y_{jt}}{\partial S_{jt}}} = \frac{w_{jt}^*}{\lambda_{jt} \frac{\partial Y_{jt}}{\partial L_{jt}^*}} \equiv \eta_{jt}^*$$

$$\eta_{jt}^U = \frac{w_{jt}^U}{\lambda_{jt} \frac{\partial Y_{jt}}{\partial U_{jt}}} = \frac{w_{jt}^*}{\lambda_{jt} \frac{\partial Y_{jt}}{\partial L_{jt}^*}} \equiv \eta_{jt}^*$$

Then, from equation (21), our markdown measure  $\eta_{jt}$  equals to this common markdown  $\eta_{jt}^*$ .

## A2. Calculation of the markdown function

Define

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

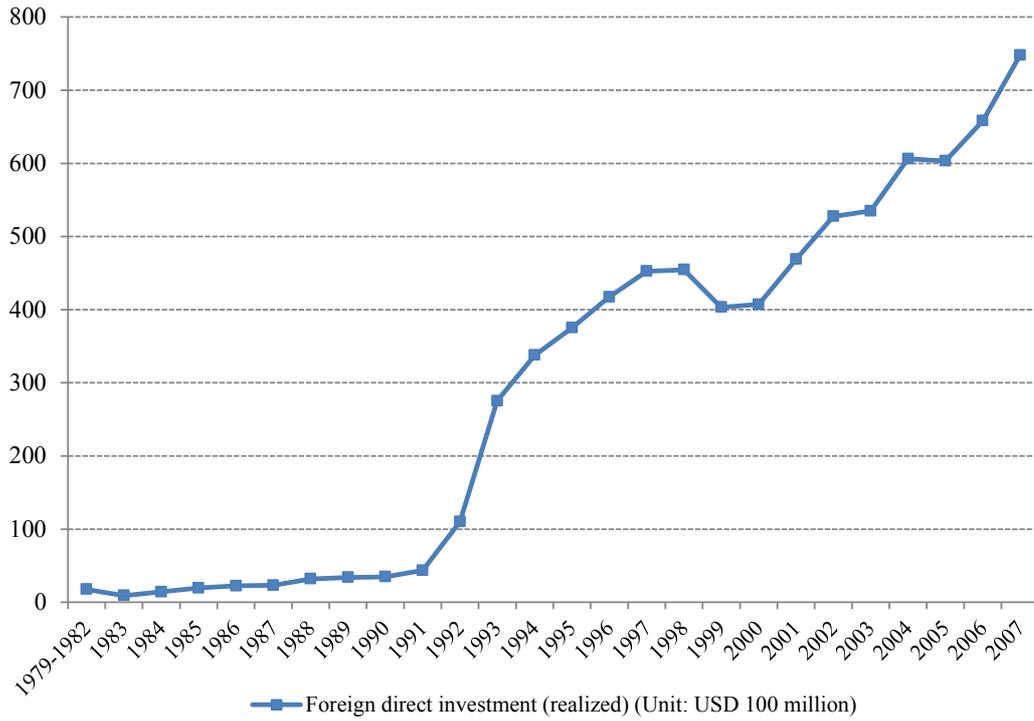
Then, it follows that

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

We obtain the markdown function:

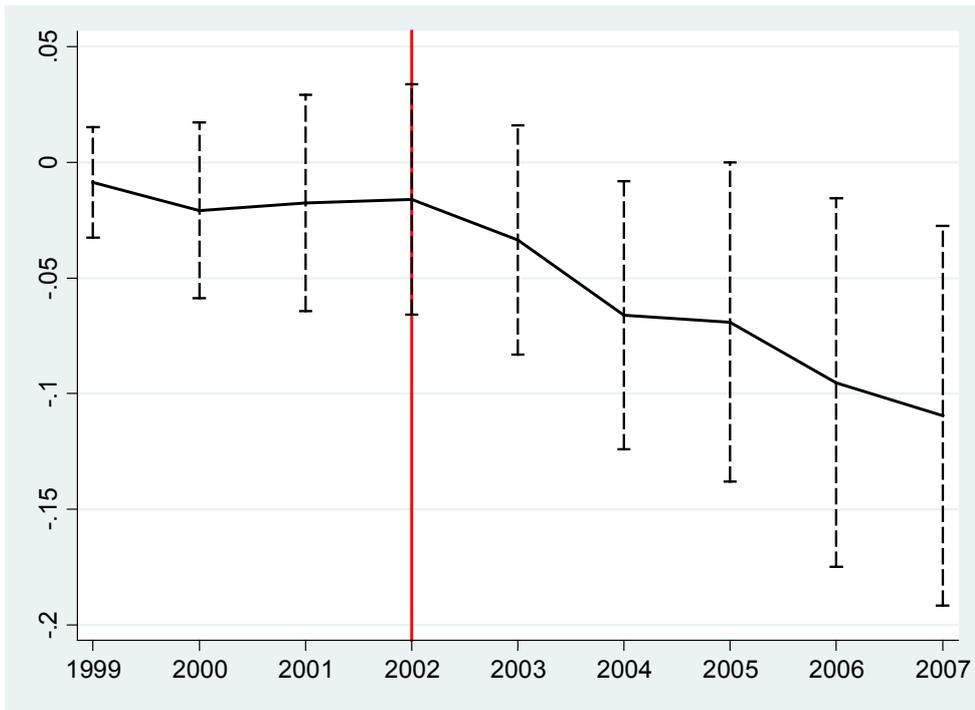
$$\eta(\varphi) = 1 - \vartheta(\varphi) = \frac{\varphi}{v} = \frac{k}{1+k} \varphi.$$

Figure 1: Foreign Direct Investment (Realized) (1979-2007)



Note: The data on foreign direct investment are obtained from China Foreign Economic Statistical Yearbook (various years).

Figure 2: Effect of FDI Regulation Changes on Wage Markdowns



Note: The solid line captures the time course of the wage markdowns difference between industries that were opened up for FDI in 2002 (treatment group) and those that did not (control group). The red vertical line represents the timing of FDI regulation changes. The dashed lines represent the 95% confidence interval of the estimated effect.

Figure 3: TFP gap between foreign and domestic firms

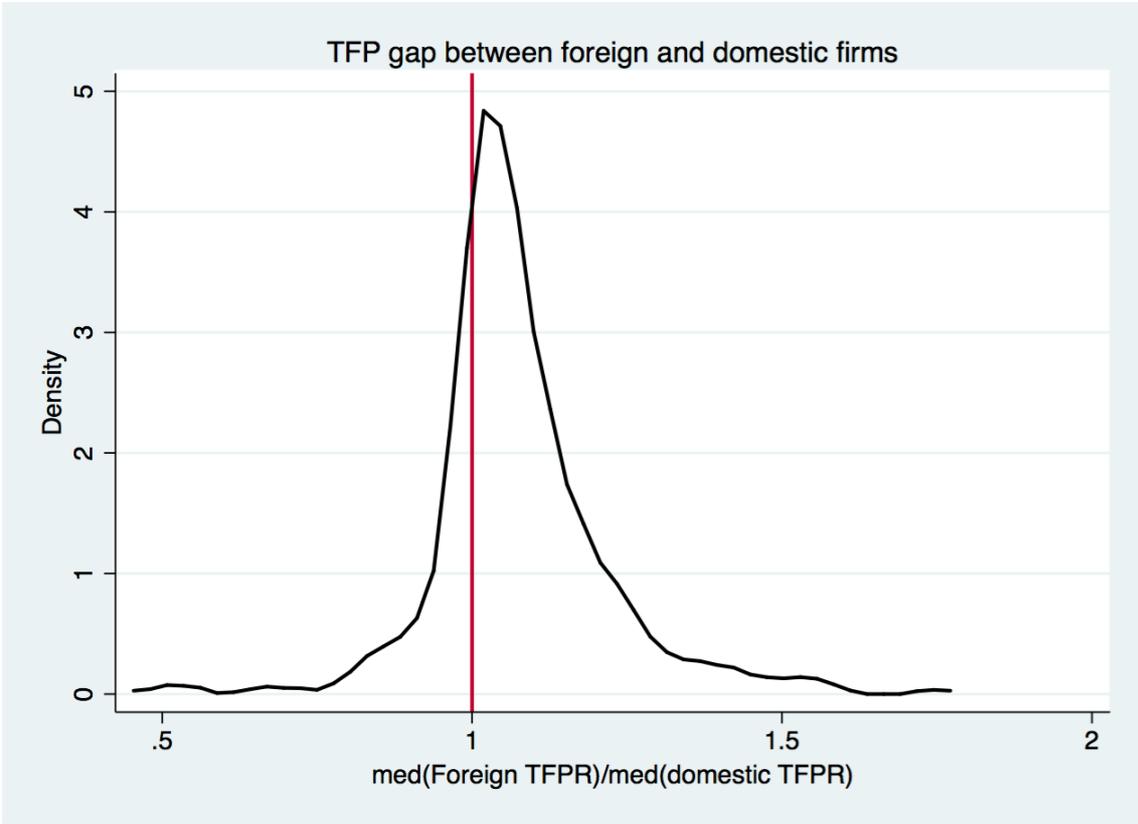


Table 1: Production Function Estimates

Industry	Output Elasticity With Respect to ...									Returns to Scale			Obs.
	Labor			Capital			Materials			median	p25	p75	
	median	p25	p75	median	p25	p75	median	p25	p75				
Food processing	0.28	0.24	0.32	0.09	0.06	0.12	0.60	0.56	0.64	0.96	0.91	1.00	128,089
Food manufacturing	0.34	0.30	0.38	0.09	0.06	0.12	0.62	0.58	0.66	1.03	0.97	1.10	51,231
Beverage manufacturing	0.33	0.29	0.38	0.06	-0.01	0.10	0.69	0.64	0.74	1.05	0.95	1.16	35,271
Textile industry	0.16	0.13	0.19	0.06	0.05	0.08	0.74	0.71	0.78	0.95	0.91	0.99	169,197
Garments & other fiber products	0.42	0.38	0.47	0.08	0.05	0.11	0.59	0.55	0.64	1.08	1.01	1.17	96,643
Leather, furs, down & related products	0.43	0.32	0.53	0.03	-0.03	0.09	0.66	0.62	0.70	1.09	1.00	1.17	48,267
Timber processing, bamboo, cane, palm fiber & straw products	0.37	0.29	0.52	-0.13	-0.18	-0.09	0.81	0.63	1.09	1.09	0.82	1.44	44,086
Furniture manufacturing	0.33	0.27	0.40	0.06	0.03	0.09	0.72	0.62	0.86	1.13	0.95	1.35	23,465
Papermaking & paper products	0.18	0.15	0.22	0.04	0.01	0.06	0.77	0.70	0.84	0.96	0.87	1.06	60,545
Printing industry	0.45	0.38	0.52	0.20	0.12	0.28	0.50	0.44	0.57	1.15	0.97	1.31	43,042
Cultural, educational & sports goods	0.52	0.46	0.58	0.10	0.07	0.13	0.54	0.50	0.60	1.18	1.07	1.29	26,420
Petroleum processing & coking	0.27	0.21	0.33	0.20	0.17	0.22	0.69	0.64	0.74	1.14	1.07	1.20	17,769
Raw chemical materials & chemical products	0.13	0.09	0.17	0.12	0.09	0.14	0.69	0.65	0.73	0.94	0.91	0.97	147,925
Medical & pharmaceutical products	0.19	0.13	0.26	0.01	-0.05	0.05	0.71	0.63	0.80	0.91	0.78	1.04	42,574
Chemical fiber	0.18	0.11	0.26	0.13	0.08	0.17	0.71	0.69	0.74	1.01	0.96	1.05	10,231
Rubber products	0.25	0.23	0.28	0.11	0.09	0.13	0.61	0.58	0.66	0.95	0.92	1.05	24,028
Plastic products	0.34	0.28	0.42	0.10	0.06	0.14	0.57	0.51	0.72	0.98	0.87	1.21	93,753
Nonmetal mineral products	0.36	0.30	0.41	0.15	0.12	0.19	0.54	0.46	0.61	1.06	0.89	1.18	174,174
Smelting & pressing of ferrous metals	0.28	0.25	0.31	0.10	0.08	0.13	0.67	0.63	0.70	1.04	1.02	1.07	48,784
Smelting & pressing of nonferrous metals	0.34	0.32	0.37	0.12	0.10	0.13	0.68	0.64	0.72	1.13	1.10	1.17	35,996
Metal products	0.21	0.17	0.25	0.09	0.05	0.12	0.71	0.68	0.75	0.99	0.94	1.03	109,203
Ordinary machinery	0.20	0.17	0.22	0.06	0.03	0.09	0.72	0.69	0.76	0.97	0.93	1.01	152,245
Special purpose equipment	0.29	0.24	0.35	0.10	0.05	0.13	0.58	0.54	0.63	0.98	0.90	1.07	84,982
Transport equipment	0.24	0.19	0.29	0.14	0.09	0.18	0.63	0.59	0.68	1.00	0.95	1.05	97,730
Electric equipment & machinery	0.28	0.23	0.33	0.10	0.06	0.14	0.68	0.64	0.72	1.05	1.00	1.08	119,239
Electronic & telecommunications equipment	0.72	0.58	0.90	-0.14	-0.22	-0.07	0.80	0.68	0.95	1.33	1.13	1.62	66,842
Instruments, meters, cultural & office equipment	0.44	0.38	0.51	0.10	0.06	0.14	0.52	0.47	0.59	1.06	0.96	1.19	28,708
Other manufacturing	0.31	0.24	0.37	0.07	0.03	0.11	0.65	0.61	0.69	1.01	0.93	1.07	39,345

Table 2: Wage Markdowns and Labor Supply Elasticities

Industry	Wage markdowns			Labor supply elasticities		
	median	p25	p75	median	p25	p75
Smelting & pressing of nonferrous metals	0.10	0.05	0.18	0.11	0.05	0.21
Food processing	0.10	0.06	0.19	0.11	0.06	0.22
Smelting & pressing of ferrous metals	0.13	0.07	0.24	0.15	0.07	0.29
Petroleum processing & coking	0.15	0.07	0.30	0.16	0.07	0.36
Electronic & telecommunications equipment	0.17	0.09	0.29	0.18	0.09	0.37
Cultural, educational & sports goods	0.17	0.10	0.28	0.19	0.10	0.37
Food manufacturing	0.18	0.09	0.34	0.20	0.09	0.44
Chemical fiber	0.20	0.09	0.44	0.18	0.07	0.52
Beverage manufacturing	0.20	0.11	0.36	0.23	0.11	0.49
Printing industry	0.20	0.11	0.37	0.23	0.12	0.50
Plastic products	0.20	0.11	0.38	0.23	0.10	0.50
Instruments, meters, cultural & office equipmer	0.20	0.11	0.36	0.24	0.11	0.50
Nonmetal mineral products	0.21	0.11	0.37	0.24	0.11	0.51
Electric equipment & machinery	0.22	0.11	0.41	0.25	0.10	0.55
Leather, furs, down & related products	0.23	0.10	0.43	0.24	0.09	0.56
Garments & other fiber products	0.24	0.14	0.38	0.29	0.15	0.54
Special purpose equipment	0.28	0.16	0.47	0.33	0.15	0.69
Rubber products	0.30	0.16	0.51	0.36	0.16	0.79
Transport equipment	0.31	0.17	0.52	0.37	0.16	0.78
Timber processing, bamboo, cane, palm fiber & straw products	0.32	0.19	0.54	0.39	0.19	0.83
Furniture manufacturing	0.32	0.17	0.55	0.38	0.16	0.85
Other manufacturing	0.32	0.18	0.55	0.38	0.16	0.85
Metal products	0.35	0.18	0.63	0.36	0.13	0.90
Papermaking & paper products	0.38	0.23	0.64	0.44	0.20	0.96
Raw chemical materials & chemical products	0.41	0.23	0.69	0.45	0.18	1.03
Ordinary machinery	0.43	0.24	0.69	0.51	0.20	1.18
Medical & pharmaceutical products	0.45	0.26	0.74	0.52	0.20	1.19
Textile industry	0.45	0.25	0.78	0.48	0.17	1.16
Average	0.26	0.13	0.49	0.28	0.11	0.67

Note: Median, 25th and 75th percentile of wage markdowns and labor supply elasticities by industries for the sample 1998-2007.

Table 3: Wage Markdowns and Firm Characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. log wage markdowns							
Firm log TFPR	0.038*** (0.001)						
SOEs dummy		0.512*** (0.003)	0.493*** (0.003)				
FIEs dummy		0.161*** (0.003)	0.182*** (0.003)				
Coastal dummy				-0.081*** (0.003)	-0.070*** (0.003)		
Export dummy						0.158*** (0.003)	0.194*** (0.003)
Panel B. log wages							
Firm log TFPR	0.034*** (0.001)						
SOEs dummy		0.038*** (0.003)	0.049*** (0.003)				
FIEs dummy		0.347*** (0.002)	0.314*** (0.002)				
Coastal dummy				0.322*** (0.002)	0.320*** (0.002)		
Export dummy						0.235*** (0.002)	0.194*** (0.002)
Panel C. log employment							
Firm log TFPR	0.069*** (0.001)						
SOEs dummy		0.409*** (0.006)	0.433*** (0.005)				
FIEs dummy		0.412*** (0.004)	0.302*** (0.004)				
Coastal dummy				-0.146*** (0.004)	-0.140*** (0.004)		
Export dummy						0.683*** (0.004)	0.528*** (0.003)
Firm fixed effects	X						
Firm TFPR control			X		X		X
Industry fixed effects		X	X	X	X	X	X
Year fixed effects	X	X	X	X	X	X	X
Observations	1,584,814	1,797,643	1,709,798	1,797,643	1,709,798	1,797,643	1,709,798

Note: Standard errors are clustered at the firm level in parentheses. \*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level respectively.

Table 4: FDI Liberalization and Wage Markdowns

Dependent variable: log wage markdowns	(1)	(2)	(3)
FDI regulation changes	-0.054*** (0.020)	-0.034* (0.018)	-0.037** (0.017)
Determinants of FDI regulation changes	X	X	X
Other policy controls		X	X
Vertical FDI controls			X
Firm fixed effects	X	X	X
Year fixed effects	X	X	X
Observations	1,111,611	1,111,611	1,111,611

Note: Standard errors are clustered at the four-digit industry level in parentheses. Determinants of FDI regulations changes include interactions of year dummies and new product intensity, export intensity, number of firms, and industry age in 1998. Other policy controls include: (1) tariff reductions (output tariff, input tariff, and export tariff), (2) SOE reforms (ratio of state-owned enterprises in the total number of firms), (3) special economic zones (ratio of firms in the SEZs in the total number of firms). Vertical FDI controls include backward and forward FDI. \*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level respectively.

Table 5: Robustness Checks

Dependent variable: log wage markdowns	(1)	(2)	(3)
FDI regulation changes	-0.037** (0.017)	-0.032* (0.018)	-0.039* (0.020)
Treat * One year before FDI regulation changes			-0.006 (0.014)
Determinants of FDI regulation changes	X	X	X
Other policy controls	X	X	X
Vertical FDI controls	X	X	X
Firm ownership controls	X		
FIEs excluded		X	
Firm fixed effects	X	X	X
Year fixed effects	X	X	X
Observations	1,111,611	916,976	1,111,611

Note: Standard errors are clustered at the four-digit industry level in parentheses. Determinants of FDI regulations changes include interactions of year dummies and new product intensity, export intensity, number of firms, and industry age in 1998. Other policy controls include: (1) tariff reductions (output tariff, input tariff, and export tariff), (2) SOE reforms (ratio of state-owned enterprises in the total number of firms), (3) special economic zones (ratio of firms in the SEZs in the total number of firms). Vertical FDI controls include backward and forward FDI. Firm ownership controls include FIEs dummy and SOEs dummy.\*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level respectively.

Table 6: Decompositions

	(1)	(2)
Dependent variable:	Log MRL	Log wages
FDI regulation changes	0.057***	0.020***
	(0.020)	(0.007)
Determinants of FDI regulation changes	X	X
Other policy controls	X	X
Vertical FDI controls	X	X
Firm fixed effects	X	X
Year fixed effects	X	X
Observations	1,111,611	1,111,611

Note: Standard errors are clustered at the four-digit industry level in parentheses. Determinants of FDI regulations changes include interactions of year dummies and new product intensity, export intensity, number of firms, and industry age in 1998. Other policy controls include: (1) tariff reductions (output tariff, input tariff, and export tariff), (2) SOE reforms (ratio of state-owned enterprises in the total number of firms), (3) special economic zones (ratio of firms in the SEZs in the total number of firms). Vertical FDI controls include backward and forward FDI. \*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level respectively.

Table 7: FDI and Firm Productivity

Dependent variable: log TFP	(1)	(2)
FDI regulation changes	0.021 (0.054)	-0.040 (0.068)
FDI regulation changes * TFP in 2001		0.020 (0.021)
Post2002 * TFP in 2001		-0.179*** (0.013)
Determinants of FDI regulation changes	X	X
Other policy controls	X	X
Vertical FDI controls	X	X
Firm fixed effects	X	X
Year fixed effects	X	X
Observations	1,052,510	534,347

Note: Standard errors are clustered at the four-digit industry level in parentheses. Determinants of FDI regulations changes include interactions of year dummies and new product intensity, export intensity, number of firms, and industry age in 1998. Other policy controls include: (1) tariff reductions (output tariff, input tariff, and export tariff), (2) SOE reforms (ratio of state-owned enterprises in the total number of firms), (3) special economic zones (ratio of firms in the SEZs in the total number of firms). Vertical FDI controls include backward and forward FDI. \*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level respectively.

Table 8: FDI, Productivity and Wage Markdowns

	(1)	(2)	(3)
Dependent variable: log wage markdowns	Full sample	High foreign TFPR	Low foreign TFPR
FDI regulation changes	-0.069** (0.028)	-0.062** (0.027)	-0.029 (0.054)
FDI regulation changes * log pre2002 TFPR	0.014** (0.007)	0.015** (0.007)	-0.018 (0.015)
Post2002 * log pre2002 TFPR	-0.002 (0.004)	-0.003 (0.005)	0.005 (0.005)
Determinants of FDI regulation changes	X	X	X
Other policy controls	X	X	X
Vertical FDI controls	X	X	X
Firm fixed effects	X	X	X
Year fixed effects	X	X	X
Observations	553,941	461,951	88,340

Note: Standard errors are clustered at the four-digit industry level in parentheses. Pre2002 TFPR is firm's TFPR in the initial year before 2002. Determinants of FDI regulations changes include interactions of year dummies and new product intensity, export intensity, number of firms, and industry age in 1998. Other policy controls include: (1) tariff reductions (output tariff, input tariff, and export tariff), (2) SOE reforms (ratio of state-owned enterprises in the total number of firms), (3) special economic zones (ratio of firms in the SEZs in the total number of firms). Vertical FDI controls include backward and forward FDI. \*\*\*, \*\* and \* denote significance at the 1, 5 and 10% level respectively.