Optimal Ownership and Firm Performance: Theory and Evidence from China's FDI Liberalization*

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Abstract

Does ownership matter for firm performance? Canonical theories of the firm argue that firms allocate ownership over production facilities to minimize the inefficiencies arising from contractual frictions. But the size of these inefficiencies is unknown. This paper provides a first quantification of the gains from optimal ownership by exploiting a major liberalization of China's policy restrictions on foreign ownership. The reform allowed multinationals to reoptimize their control over Chinese firms. We find that optimal ownership restructuring induced firm-level output gains of up to 34% within only two years. These effects are stronger and accompanied by productivity gains over the medium term. We rationalize our findings by an extended property-rights theory of the multinational firm.

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Keywords: Ownership, firm performance, multinational firms, foreign direct investment, property-rights theory, contracts, China.

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1 Introduction

An old, fundamental, and ubiquitous question in economics is the question of ownership: Should a firm maintain ownership over a particular stage of production, integrating this stage into its firm boundaries, or should the firm instead organize production via the market? This question has been extensively studied since the seminal work of Coase (1937). It is fundamental, as it concerns the very existence of firms. And it is ubiquitous, since each and every firm must decide on how to organize each of its production stages. Over the past decades, the rise of multinational firms, extending their boundaries across international borders, has brought the question of ownership also to the forefront of research in international economics (see Antràs, 2015). Still, one might wonder: Why should we care about these organizational decisions? Does ownership actually matter for efficiency, and eventually for welfare?

Several canonical theories of the firm agree that, indeed, the optimal choice of ownership is crucial, because it can increase efficiency in production. In this literature, contractual frictions are the fundamental reason why firms care about ownership. In particular, since most production processes involve relationship-specific and non-contractible investments, this gives rise to hold-up problems, which result in inefficiencies. Firms then choose the optimal allocation of ownership rights to minimize these inefficiencies. This is the case both in the transaction-cost theory (Williamson, 1971, 1975, 1985) and in the property-rights theory (Grossman and Hart, 1986; Hart and Moore, 1990), as well as in other prominent theories of the firm.[1]

What is missing in the literature to date is direct empirical evidence on the efficiency-enhancing effects of optimal ownership and a quantification of these effects. The major open question is: How much does firm ownership matter in practice? The key challenge for such a quantification exercise lies in identifying exogenous variation in ownership. Ideally, one would like to identify a firm that experiences a change from a non-optimal ownership structure towards the optimum. But such a change is hardly ever observable in a market economy where ownership can freely adjust.

In this paper, we overcome the aforementioned identification challenge by exploiting a unique liberalization of policy restrictions on foreign ownership in China. Historically, foreign direct investment (FDI) into China was severely restricted. In many industries, firms faced explicit upper bounds on foreign ownership shares, and FDI was even entirely prohibited in other industries. These FDI restrictions were abolished to a large extent in 2002, after China's WTO accession. As a consequence of the policy reform, multinational enterprises (MNEs) reoptimized their control over Chinese firms. This variation in the admissible organizational forms can be considered exogenous to the individual firm. It provides us with the unique opportunity to quantify the gains from optimal ownership.

To guide our empirical analysis, we develop a theoretical model of MNEs' ownership decisions. The model extends the property-rights theory (PRT) of the multinational firm by Antràs (2003) and Antràs and Helpman (2004) by allowing for continuous ownership shares. In the model, a foreign MNE and its Chinese supplier both contribute relationship-specific inputs to a joint production process in China. Since contracts are incomplete, both parties face a risk of hold-up and hence underinvest into these inputs. By choosing the optimal ownership share in its supplier, the MNE minimizes the resulting inefficiencies. We introduce the

[1] Gibbons (2005) discusses the theoretical literature on firm boundaries and emphasizes that all established theories of the firm assign a crucial role to contractual frictions.

Chinese FDI restrictions as an upper bound on the foreign ownership share, which aggravates these inefficiencies. FDI liberalization then induces a restructuring process towards higher foreign ownership shares among the previously constrained firm pairs. The model predicts that this optimal ownership restructuring shifts the investment incentives between the two parties and generates efficiency gains, which can boost firm output.

Our empirical analysis uses panel data on more than half a million manufacturing firms in China over the period from 1998 to 2007. We combine these data with information on the FDI policy from official sources. The analysis proceeds in three steps. First, we confirm that general patterns of foreign ownership in unregulated industries are consistent with key predictions of our PRT model. Second, we verify that the Chinese FDI liberalization had the expected direct effect on foreign ownership shares. Third, in our main econometric analysis, we exploit the FDI inflow after the liberalization to estimate the effects of optimal ownership restructuring on firm performance. In a fixed-effects difference-in-differences model for the years 2001 and 2003, we define the 'treated' (or 'foreign-acquired') firms as those increasing their foreign ownership share (across different thresholds) after an FDI restriction in their industry was dropped. To account for selection of acquired firms by foreign investors and selection of liberalized industries by the Chinese government, we choose foreign-owned firms within the same industries as a preferred control group,[2] and we further augment the model with propensity score reweighting based on initial firm characteristics.

We find that the reoptimization of ownership generated substantial gains in firm performance. The Chinese firms that increased their foreign ownership share after the FDI liberalization experienced output gains of up to 34% within two years. These gains were accompanied by a significant shift in the firms' input mix that is fully in line with the PRT model. Furthermore, the output effect tends to increase over time and can be more than twice as large after five years. Over the medium term, ownership restructuring also leads to a significant increase in total factor productivity. In extensive robustness checks, we carefully address remaining concerns – related to selection, spillovers, and benefits of foreign (vs. domestic) ownership – by considering alternative control groups in the difference-in-differences model. Most importantly, we find similar output gains even when comparing the treated firms to other firms that also experienced an increase in foreign ownership at the same time, but that had not faced any FDI restrictions before. These analyses strengthen our main conclusion: Optimal ownership matters substantially for firm performance.

We contribute to the literature investigating the organization of multinational firms. In his pioneering work, Antràs (2003) incorporated the PRT into a model of international trade to explain patterns of intra-firm trade.[3] Subsequent research has enriched this framework and deepened our understanding of MNEs' ownership structures in the presence of firm heterogeneity (Antràs and Helpman, 2004) and multiple suppliers (Acemoglu, Antràs and Helpman, 2007; Du, Lu and Tao, 2009), both in complex production processes (Schwarz and Suedekum, 2014) and along sequential value chains (Antràs and Chor, 2013). We generalize the Antràs (2003) model by allowing for continuous ownership shares in order to account for the existence of partial ownership in international joint ventures (JVs), similar to Bircan (2014) and Eppinger and Kukharskyy (2017). Our treatment of policy restrictions on foreign ownership is new to this literature.

[2] Some firms within the liberalized industries are already foreign-owned before the reform because they produce different products that are not specifically regulated by the FDI policy (see Section 3.2).

[3] Grossman and Helpman (2002, 2003, 2005) developed transaction-cost theories of the MNE.

The predictions of the PRT have been empirically assessed by a growing literature using US data on intra-firm trade at the industry level and, more recently, also using firm-level data from various countries.[4] As summarized in Antràs and Yeaple (2014), these studies have typically examined the relationship between the prevalence of intra-firm trade and proxies for the relative importance of the inputs provided by both parties (the so-called headquarter intensity) and firm productivity (or productivity dispersion), and found patterns consistent with the PRT. Note that the existing firm-level evidence derives almost exclusively from data on firms' headquarters in developed countries.[5] Our paper complements this literature with firm-level evidence on Chinese subsidiaries, which account for a large share of MNEs' global production activities.

As Pol Antràs concludes in his recent book, the key question that has remained open in this literature is: "How do the organizational decisions of multinational firms shape firm-level performance?" (Antràs, 2015, p. 261) He suggests three possible avenues for future research towards closing this gap: (i) making better use of the existing firm-level data, (ii) exploiting exogenous variation due to technological or policy changes, and (iii) moving the empirical analysis closer to the theory. This paper makes progress on all three fronts to provide a first quantification of the performance gains from optimal ownership.

Two recent, innovative papers by Atalay, Hortaçsu, Li and Syverson (2017) and Boehm (2018) pursue objectives related to ours. Atalay et al. (2017) assess the role of firm boundaries for trade volumes and real incomes based on domestic transactions within and across US firms. Their results indicate that ownership links can significantly promote trading and welfare. Boehm (2018) estimates the aggregate implications of contractual frictions in input sourcing by exploiting data on court cases and input-output tables across countries. His analysis suggests that a reduction in contract enforcement costs to the level of the US would bring per-capita income gains of more than 3% to most countries. Both of these papers utilize quantitative trade models, augmented by assumptions from transaction-cost economics and calibrated to cross-sectional data, to quantify effects on aggregate outcomes. The key novelty of our setup is that we observe movements from restricted to optimal ownership that are exogenously triggered by the liberalization of the Chinese FDI policy. This unique scenario allows us to identify the effects of ownership changes within firms over time in the micro data, without relying on the structure of any particular model.

Another related strand of the literature has investigated the effects of foreign acquisitions on various dimensions of firm performance.[6] In this literature, the combination of difference-in-differences estimation with firm fixed effects and propensity score matching or reweighting has become standard practice for estimating average treatment effects.[7] Several studies have identified positive effects of foreign acquisitions on firm performance, though some papers find no significant gains (notably Wang and Wang, 2015, for China). We would like to emphasize that our contribution differs substantially from these studies in terms of its core

[4] Studies using US industry-level data include Antràs (2003), Bernard, Jensen, Redding and Schott (2010), Nunn and Trefler (2008, 2013), and Yeaple (2006). Firm-level studies on the organization of global sourcing include: Tomiura (2007) for Japan, Corcos, Irac, Mion and Verdier (2013) and Defever and Toubal (2013) for France, Federico (2010, 2012) for Italy, Kohler and Smolka (2011, 2014, 2015) for Spain, and Alfaro, Antràs, Chor and Conconi (forthcoming) for the US.

[5] Recent exceptions using data on subsidiaries are Bircan (2014) on foreign-owned firms in Turkey and Kukharskyy (2016) as well as Eppinger and Kukharskyy (2017) examining firm pairs around the globe. Feenstra and Hanson (2005) and Fernandes and Tang (2012) use highly disaggregated customs data from China to investigate the role of ownership and control over input purchases in Chinese processing trade.

[6] Early contributions in this vein include Harris and Ravenscraft (1991) and Swenson (1993).

[7] Examples include Arnold and Javorcik (2009), Girma and Görg (2007a,b), and Guadalupe, Kuzmina and Thomas (2012).

objective, the empirical setup, and the main conclusions. While the existing literature has aimed to identify differences associated with the 'foreignness' of the owner,[8] our goal is to estimate the effects of organizational restructuring towards an *optimal* allocation of ownership rights. We exploit the fact that foreign owners were constrained by the FDI policy, but we are not interested in the effect of their foreignness per se. By contrast, our empirical design explicitly controls for the various other benefits of foreign ownership and allows us to clearly attribute the identified performance gains to optimal ownership restructuring.

Our findings have important policy implications for the regulation of FDI in particular and of firm ownership in general. We directly contribute to evaluating China's major liberalization of its policy restrictions on inward FDI and we identify significant performance gains in the affected firms.[9] This policy is of particular importance since China has become the world's factory (Zhang, 2006) and one of the top destinations for FDI (UNCTAD, 2013) over the past decades. While China continues to maintain one of the most restrictive policies towards FDI, such regulations are also highly relevant beyond China. As data from the OECD reveals, foreign ownership restrictions are still prevailing all around the world in the mid-2010s.[10] The gains from FDI liberalization identified in China are of particular importance for other emerging economies that are potentially attractive destinations for cost-seeking FDI but suffer from imperfect contracting institutions. Since MNEs account for a quarter of world GDP and 80% of world trade in 2010 (UNCTAD, 2011, 2013), liberalizing foreign ownership restrictions may have sizeable effects on global welfare.

More broadly, our analysis points to the costs of distortions caused by the misallocation of ownership rights. These costs matter for any policy that interferes with firm ownership, whether across borders or within countries. Examples of domestic policies include the regulation of mergers and acquisitions or direct involvement of the state in firm ownership, which might deter necessary private investments.[11] While existing restrictions are often motivated by anti-trust or security considerations, our analysis suggests that these arguments should be carefully weighted against the aggravated contractual inefficiencies due to the misallocation of ownership rights. We view our contribution as an important first step towards quantifying the relative importance of different sources of inefficiencies that depress the productivity of developing countries. Our findings suggest that contractual frictions and distorted ownership decisions are likely to play a relevant role in explaining the greater misallocation of resources in China compared to the US that has been identified by Hsieh and Klenow (2009).

[8] Chen (2011) shows explicitly how the performance of acquired US firms depends on the country of the investor, and Wang and Wang (2015) compare foreign to domestic acquisitions in China.

[9] Three studies have previously examined the Chinese FDI policy reform of 2002, though with different objectives than our paper. Sheng and Yang (2016) show that the liberalization increased product variety in Chinese exports. Lu, Tao and Zhu (2017) examine possible spillovers from FDI induced by the liberalization and find some evidence for negative competition and positive agglomeration effects in domestic firms, but they exclude the foreign-acquired firms, which are the main focus of the reform and of this study. Brandt, Van Biesebroeck, Wang and Zhang (2017) control for the FDI liberalization in their analysis focused on tariff reductions.

[10] The 'foreign equity restrictions' component of the OECD's FDI regulatory restrictiveness index provides data for 62 countries over the years 1997 to 2016 (see Kalinova, Palerm and Thomsen, 2010; OECD, 2016). Over this period, we observe a decrease in the index on average, but all countries included in the database maintain some restrictions on foreign ownership in 2016. China's FDI liberalization caused a drop in the index from around 0.38 to 0.22 (where 0 reflects no equity restrictions and 1 represents an economy closed to FDI), but it still ranks third in 2016 after the Philippines and Indonesia.

[11] See Berkowitz, Ma and Nishioka (2017) and Dollar and Wei (2007) for evidence on the inferior performance of China's state-owned enterprises.

The paper is structured as follows. Section 2 presents our property-rights theory of the multinational firm with partial ownership and derives testable predictions for the effects of liberalizing foreign ownership restrictions. Section 3 describes the Chinese FDI policy background and our firm data. The empirical analysis proceeds in three steps: Section 4 shows that general patterns of foreign ownership prevailing in China are in line with the theory. Section 5 verifies the effectiveness of the Chinese FDI policy in terms of its direct impact on foreign ownership. Section 6 presents the core part of the empirical analysis; it introduces the difference-in-differences setup and provides our main estimates of the performance effects from optimal ownership restructuring. Section 7 concludes.

2 Theory

To motivate and guide our empirical analysis, this section presents a theoretical model of the multinational firm based on the seminal property-rights theory (PRT) due to Grossman and Hart (1986) and Hart and Moore (1990). Our approach generalizes the framework developed by Antràs (2003) and Antràs and Helpman (2004) to allow for partial ownership. This setup enables us to incorporate the restrictions on foreign ownership imposed by the Chinese FDI policy explicitly into the model, and to study the consequences of FDI liberalization for ownership and performance.

2.1 Setup

We examine a world of two countries: China and Foreign. For simplicity, we assume that all consumers and firms F producing final goods reside in Foreign, while all intermediate input suppliers (manufacturers) M reside in China. Each firm pair, consisting of one firm F and one supplier M, is indexed by i, and industries are indexed by j. All consumers share identical constant elasticity of substitution (CES) preferences over varieties of the final good. These preferences imply that the monopolistically competitive firms face iso-elastic demand for each variety of the final good:

$$p_j(i) = A_j \, y_j(i)^{\alpha-1}, \tag{1}$$

where $1/(1-\alpha)$ (with $0 < \alpha < 1$) is the elasticity of substitution between varieties and A_j is an industry-specific demand shifter (depending on aggregate expenditure and the industry's share in aggregate expenditure).

Each firm F requires one particular intermediate input $x_j(i)$ that is sourced from a supplier M in China.[12] As in Antràs (2003), we assume that the input is costlessly shipped to Foreign and used there to produce the final good at zero additional cost: $y_j(i) = x_j(i)$.[13] The intermediate input is produced by M

[12] For simplicity, we abstract from the location choice, which Antràs and Helpman (2004) analyze explicitly, by assuming that China has already been selected as the preferable production location, e.g. due to an exogenous cost advantage.

[13] Note that this final production step is absent in Antràs and Helpman (2004). In their model, $x_j(i)$ denotes the final good and production takes place in the foreign firm's country. In our model, joint production takes place in China, which reflects the case that seems to be more relevant in our application, given the high prevalence of processing activities among Chinese manufacturing firms (see Feenstra and Hanson, 2005).

in China using the following Cobb-Douglas technology:

$$x_j(i) = \theta(i) \left(\frac{K_j(i)}{\eta} \right)^{\eta} \left(\frac{L_j(i)}{1-\eta} \right)^{1-\eta}, \tag{2}$$

where the inputs are capital $K_j(i)$, provided by the foreign firm, and labor $L_j(i)$, provided by the Chinese supplier, and the headquarter intensity is denoted by $\eta \in (0,1)$. These assumptions on the joint production process follow Antràs (2003), who cites evidence from several countries that cost sharing with suppliers is much more prevalent in capital compared to labor investments.[14] We further assume that the two parties' investments into the inputs $K_j(i)$ and $L_j(i)$ are fully relationship-specific because they need to be customized to the production process, and the investments are non-contractible because they cannot be verified by a third party.[15] The price of capital r and the wage rate w are determined in competitive factor markets in China and hence exogenous to F and M. The parameter $\theta(i)$ denotes the total factor productivity (TFP) of the firm pair.

Following Antràs and Helpman (2004), we assume that production relationships differ in their productivity $\theta(i)$. To enter the market, potential firms have to incur fixed entry costs in order to draw $\theta(i)$ from a known distribution $G(\theta(i))$, as in Melitz (2003). Upon entry, F obtains knowledge of $\theta(i)$ and decides, in the first stage of the game, whether to exit the market or start producing. Production requires a supplier in China, so if it starts producing, F must simultaneously decide on the organizational form of the production relationship with M, which is summarized by its ownership share $s \in [0,1]$ in M. When choosing s, the firm faces a trade-off involving the underinvestment problems arising from incomplete contracts, which are explained below, and the fixed organizational costs associated with this choice. To obtain a homothetic cost function (as in Antràs, 2003), we assume that in order to start production, the firm has to pay $r^{\eta} w^{1-\eta} f(s)$, where we leave the functional form of the fixed organizational costs $f(s)$ open for now. F then offers a production relationship under the chosen organizational form to potential suppliers, which are assumed to be large in number and competing in a perfect market. The firm concludes with one of the suppliers a contract specifying the ownership share s and a transfer payment. In the second stage, both parties non-cooperatively choose their investment levels into the inputs. Since these investments are non-contractible, both parties bargain over the surplus of the relationship ex post, after their investments are sunk. Bargaining takes place in the last stage of the game, then the final good is produced and sold, and revenues are shared as agreed in bargaining. Using equations (1) and (2) as well as $y_j(i) = x_j(i)$, the implied total revenues are

$$R_j(i) = A_j \theta(i)^{\alpha} \left(\frac{K_j(i)}{\eta} \right)^{\alpha\eta} \left(\frac{L_j(i)}{1-\eta} \right)^{\alpha(1-\eta)}. \tag{3}$$

Due to the relationship-specificity of their investments into $K_j(i)$ and $L_j(i)$, both parties are locked in

[14] In assuming that the foreign firm's capital input is necessary in the joint production process we follow Antràs and Helpman (2004). Even without imposing this assumption, the foreign firm will find it optimal to contribute capital to the joint production process as long as its bargaining power is large enough ($\beta > 0.5$), as shown by Antràs (2003).

[15] These assumptions are crucial to generate a meaningful trade-off between different organizational forms, but they are more restrictive than necessary to derive our main predictions. See Antràs (2015) and Eppinger and Kukharskyy (2017) for more general setups that allow for partial relationship specificity and partial contractibility.

a bilateral monopoly after they have formed a relationship. Also, since courts cannot verify any ex-ante agreements regarding investments (or revenues), the parties bargain over the distribution of the surplus from the relationship after input production has taken place. This setup leads to a two-sided hold-up problem and underinvestment by both F and M relative to the first-best input levels. Importantly, we follow the PRT in assuming that contractual incompleteness and the resulting hold-up problem cannot be eliminated through integration, so ex-post bargaining takes place under any organizational form s. We adopt the standard approach by modeling this process as a generalized Nash bargaining, in which each party obtains their outside option plus a share of the surplus from the relationship, the so-called quasi-rent. We set M's outside option to zero and denote F's bargaining power by $\beta \in (0,1)$, while the supplier's bargaining power is $1-\beta$. The key assumption in this setup is that by choosing a higher ownership share in M ex ante, the firm F increases its outside option in the bargaining process ex post, and thereby increases its own share of the surplus from the relationship. Formally, we assume that if bargaining breaks down, the firm can produce a fraction $\delta(s) \in (0,1)$ of $x_j(i)$, where $\delta'(s) > 0$, $\forall s$. Intuitively, the output loss $1-\delta(s)$ derives from the fact that the firm only has residual property rights over a share s of M's input, and hence cannot produce the same amount of $x_j(i)$ as within the production relationship. The loss decreases in the ownership share, but it is always non-zero, because F can never produce the intermediate good as efficiently on its own as in a joint production process.[16] The resulting revenues $\delta(s)^\alpha R_j(i)$ that the firm can generate if the relationship breaks up constitute F's outside option. This modeling of continuous ownership shares generalizes the approach by Antràs (2003) and Antràs and Helpman (2004), which restricts the firm's decision to a binary choice between full integration and outsourcing. Our approach is motivated by the fact that we observe many JVs empirically, and it will prove useful when we introduce China's FDI regulation policy below.

2.2 Equilibrium

We solve the model by backward induction for the optimal ownership share s^*. In stage two of the game, both parties choose their investments into inputs non-cooperatively, knowing the ownership structure and anticipating the Nash bargaining solution. The firm F chooses $K_j(i)$ to maximize $\pi_F = \beta_F R_j(i) - rK_j(i)$, and the supplier M chooses $L_j(i)$ to maximize $\pi_M = [1-\beta_F] R_j(i) - wL_j(i)$, where

$$\beta_F \equiv \delta(s^*)^\alpha + \beta\left(1-\delta(s^*)^\alpha\right) \tag{4}$$

denotes F's revenue share, which is uniquely determined by the chosen ownership structure s^* (and the parameters α and β).

The first-order conditions of these programs deliver the input choices $K_j(i)$ and $L_j(i)$ as functions of revenues, which can be plugged back into the revenue function (3) to solve for:

$$R_j^*(i) = A_j^{\frac{1}{1-\alpha}} \Theta(i) \alpha^{\frac{\alpha}{1-\alpha}} \left(\frac{\beta_F}{r}\right)^{\frac{\alpha\eta}{1-\alpha}} \left(\frac{1-\beta_F}{w}\right)^{\frac{\alpha(1-\eta)}{1-\alpha}}, \tag{5}$$

[16] Since an alternative modeling approach, which would allow the firm to obtain a share $\delta(s)$ of the supplier's *input* greatly complicates the analysis, we adopt the approach taken by Antràs (2003) and Antràs and Helpman (2004) and model the efficiency loss $\delta(s)$ in terms of *output*.

where we have transformed productivity as $\Theta(i) \equiv \theta(i)^{\alpha/(1-\alpha)}$. Using these results, we can solve for both parties' optimal investments into the inputs in the presence of contractual frictions (and mark-up distortions), which we call second-best input quantities:

$$L_j^*(i) = \Theta(i)(1-\eta)A_j^{\frac{1}{1-\alpha}}\alpha^{\frac{1}{1-\alpha}}\left(\frac{\beta_F}{r}\right)^{\frac{\alpha\eta}{1-\alpha}}\left(\frac{1-\beta_F}{w}\right)^{\frac{1-\alpha\eta}{1-\alpha}}, \tag{6}$$

$$K_j^*(i) = \Theta(i)\eta A_j^{\frac{1}{1-\alpha}}\alpha^{\frac{1}{1-\alpha}}\left(\frac{\beta_F}{r}\right)^{\frac{1-\alpha+\alpha\eta}{1-\alpha}}\left(\frac{1-\beta_F}{w}\right)^{\frac{\alpha(1-\eta)}{1-\alpha}}. \tag{7}$$

These quantities imply the following capital-labor ratio:

$$\frac{K_j^*(i)}{L_j^*(i)} = \frac{\eta}{1-\eta}\frac{w}{r}\frac{\beta_F}{1-\beta_F}. \tag{8}$$

Note that the term $\beta_F/1-\beta_F$ reflects the relative input distortion as in Hsieh and Klenow (2009), which derives from the contracting inefficiency in our framework. For the knife-edge case of $\beta_F = 0.5$, the relative distortion vanishes, but the absolute input quantities remain inefficient. After plugging the input quantities from equations (6) and (7) into the production function (2), we obtain the second-best output level:

$$x_j^*(i) = \theta(i)^{\frac{1}{1-\alpha}}A_j^{\frac{1}{1-\alpha}}\alpha^{\frac{1}{1-\alpha}}\left(\frac{\beta_F}{r}\right)^{\frac{\eta}{1-\alpha}}\left(\frac{1-\beta_F}{w}\right)^{\frac{1-\eta}{1-\alpha}}. \tag{9}$$

As in Antràs and Helpman (2004), the solution of the model is simplified by assuming that the contract between F and M includes a transfer payment. Since there are many potential suppliers with zero outside options, F chooses the size of the transfer that makes M just indifferent between accepting and declining the contract, and thereby, F extracts the entire surplus from the relationship.

In the first stage of the game, the firm therefore chooses the ownership share s^* that maximizes the total operating profits $\Pi_j(i)$ in anticipation of the second-best input quantities from equations (6) and (7) and the resulting revenues from equation (5):

$$\max_{s^*}\Pi_j(i) = \Theta(i)\alpha^{\frac{\alpha}{1-\alpha}}A_j^{\frac{1}{1-\alpha}}\Psi(\beta_F(s^*)) - r^\eta w^{1-\eta} f(s^*), \tag{10}$$

$$\text{where} \quad \Psi(\beta_F(s^*)) \equiv \left(\frac{\beta_F(s^*)}{r}\right)^{\frac{\alpha\eta}{1-\alpha}}\left(\frac{1-\beta_F(s^*)}{w}\right)^{\frac{\alpha(1-\eta)}{1-\alpha}} \times \Big(1-\alpha\eta\beta_F(s^*) - \alpha(1-\eta)\left[1-\beta_F(s^*)\right]\Big), \tag{11}$$

and $\beta_F(s^*)$ is given by equation (4).

The ownership share s^* can generally affect profits via two channels: First, the term $\Psi(\beta_F(s^*))$ reflects the core trade-off created by contractual frictions and the resulting two-sided hold-up problem: One the one hand, a higher ownership share increases the investment incentives and the share of the surplus for F, but on the other hand, it decreases the investment incentives by M, which tends to reduce the overall size of the surplus. Second, the choice of s^* can affect profits via the fixed organizational

costs reflected in the term $f(s^*)$. However, these differences in organizational costs are not at the heart of the model, and any assumption on the fixed cost ranking seems ad hoc, as it is not explained within the theory of the firm. While Antràs and Helpman (2004) assume that the fixed costs of integration exceed those incurred under outsourcing, which is in line with the pattern of firm selection in Spain (Kohler and Smolka, 2011, 2014), the opposite ranking seems to be consistent with firm data for France (Defever and Toubal, 2013). Since none of these alternative ranking assumptions seems preferable *a priori*, and since this assumption is not essential for the core trade-off generated by contractual frictions, we simplify the analysis for the moment by abstracting from differences in fixed organizational costs across ownership forms (as e.g. in Kukharskyy and Pflüger, 2010). Assuming $f(s) = f$ allows us to focus on the core trade-off reflected in $\Psi(\beta_F(s^*))$. We return to a discussion of alternative fixed cost rankings below when considering the role of firm heterogeneity.

Which ownership share maximizes the firm's variable operating profits via $\Psi(\beta_F(s^*))$ in equation (10)?[17] Since the firm's revenue share $\beta_F(s^*)$ is implicitly determined by the choice of s^* and strictly increasing in s^* (via $\partial\beta_F(\cdot)/\partial\delta > 0$ and $\delta'(s^*) > 0$), this problem can be solved in two steps (see Appendix A.1): We first solve $\partial\Psi(\beta_F(s^*))/\partial\beta_F(s^*) = 0$ for $\beta_F(s^*)$ and second compute the ownership share s^* required to implement $\beta_F(s^*)$. Using this result, equation (4), and the invertibility of $\delta(s)$, we can express the optimal ownership share s^* as:

$$s^* = \delta^{-1}\left[\left(\frac{\beta_F^* - \beta}{1-\beta}\right)^{\frac{1}{\alpha}}\right], \tag{12}$$

$$\text{where} \quad \beta_F^* = \frac{\eta(\alpha\eta + 1 - \alpha) - \sqrt{\eta(1-\eta)(1-\alpha\eta)(\alpha\eta + 1 - \alpha)}}{2\eta - 1}. \tag{13}$$

Equation (12) describes a unique mapping of the optimal ownership share into the optimal revenue share (13), which is the same expression as in Antràs and Helpman (2004). In contrast to their analysis, which restricts the ownership choice at this point to a discrete set of two options (outsourcing or full vertical integration), we proceed with the general case and allow the firm to choose any ownership share in the unit interval $s \in [0, 1]$.

The optimal choice is illustrated in Figure 1(a) in terms of the revenue share β_F^*. Since neither one of the two parties receives the full return on its investment, they both underinvest in equilibrium. As a consequence, the firm does not necessarily choose the highest possible ownership share in the optimum, but instead trades off its own share of the surplus and the underinvestment by both parties, which individually decrease the size of the overall surplus. This trade-off varies systematically with the importance of the investments by the two parties, reflected in the headquarter intensity parameter η. As shown graphically in Figure 1(a) and derived formally in Appendix A.1, β_F^* (and hence s^*) is monotonically increasing in η. This result reflects the key intuition of the PRT (Grossman and Hart, 1986): The party undertaking the more important investment should optimally be assigned more ownership rights. Thus, a higher headquarter intensity η in the joint production process optimally requires a higher ownership share s^*. Consequently, firms optimally

[17] Note that the firm treats market conditions reflected in $\alpha^{\alpha/(1-\alpha)} A_j^{1/(1-\alpha)}$, factor prices, and the productivity term $\Theta(i)$ as exogenous when solving this problem.

choose outsourcing ($s^* = 0$) in industries with a very low headquarter intensity, they organize in JVs in the intermediate range of η, where s^* is strictly increasing in η, and full integration ($s^* = 1$) is optimal for very high values of η, as shown in Figure 1(a). This discussion generalizes an important result from Antràs and Helpman (2004) to the case of continuous ownership shares:

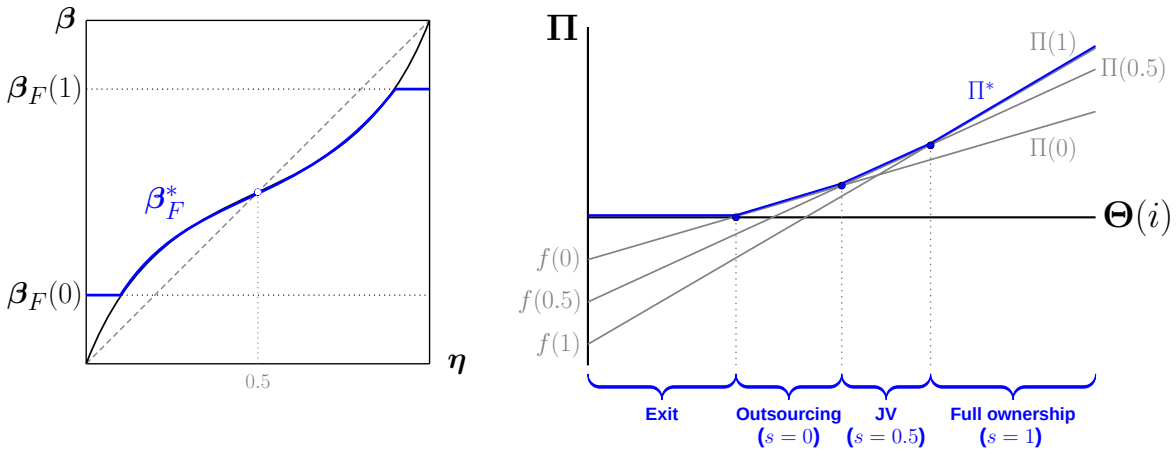
Proposition 1 (Headquarter intensity)**.** *The optimal ownership share s^* increases (weakly) in headquarter intensity η.*

Proof. *See Appendix A.1.*

Figure 1: Optimal revenue share, headquarter intensity, and productivity

(a) Optimal revenue share

(b) Sorting pattern by productivity



Note: Figure 1(a) illustrates the optimal revenue share β_F^* as a function of headquarter intensity η. Figure 1(b) illustrates maximum profits Π as a function of (transformed) productivity $\Theta(i)$ in an industry with a very high η, such that $s^* = 1$, for the example of an increasing fixed cost ranking $f(s)$ and $s = \{0, 0.5, 1\}$. It illustrates how firm pairs sort into organizational forms based on their productivity.

We now turn to a discussion of firm heterogeneity in terms of productivity $\theta(i)$ and alternative fixed cost rankings. Provided that the parameters α, β, and η are shared by all firms in the same industry, the model with constant fixed organizational costs (assumed above) predicts that all firm pairs active in a given industry adopt the same organizational form. However, overwhelming empirical evidence suggests that firms within narrowly defined industries choose different organizational forms (see e.g. Kohler and Smolka, 2011, 2014). To rationalize this fact, we follow Antràs and Helpman (2004) in assuming heterogeneity of firms in terms of their productivity in combination with fixed costs differences across organizational forms. We distinguish two types of rankings of fixed organizational costs, since their ordering is a priori not clear. First, we consider the case in which fixed organizational costs are strictly increasing in the degree of integration $f'(s) > 0 \forall s$, e.g. because the management of both firms' activities creates managerial overload, which dominates the associated managerial economies of scope (as in Antràs and Helpman, 2004). Second, we consider the opposite case in which fixed organizational costs are strictly decreasing $f'(s) < 0 \forall s$ (as in Defever and Toubal, 2013).

This set of assumptions can rationalize self-selection of firms into different organizational forms according to their productivity. The predicted sorting pattern is such that the most productive firms always choose

the ownership share s^* that is optimal in their industry, as described by equations (12) and (13), because they can always cover the fixed costs of any organizational form.[18] Yet, for less productive firms, the optimal choice s^* may yield negative profits if the associated organizational fixed costs are too high. Hence, these firm pairs will either operate under the best feasible organizational form that yields non-negative profits, or they cannot produce at all. This best feasible organizational form depends on the headquarter intensity of the industry and the fixed cost ranking.

Figure 1(b) illustrates the sorting pattern of firms into organizational forms for one exemplary case of an industry characterized by a very high headquarter intensity η and an increasing fixed cost ranking ($f'(s) > 0$). It shows the maximum operating profits $\Pi_j(i)$ from equation (10) as a function of (transformed) productivity $\Theta(i)$ for three possible ownership forms $s = \{0, 0.5, 1\}$. In the industry depicted here, we have $\beta_F^* \geq \beta_F(1)$, so the most productive firm pairs choose full integration ($s^* = 1$). The maximum profit line is flatter for JVs, such as $s = 0.5$, reflecting the less efficient incentive structure. However, given the lower fixed costs, some firms in an intermediate productivity range choose $s = 0.5$. By the same argument, the less productive firms choose outsourcing ($s = 0$), and the least productive ones cannot operate under any organizational form and exit the market. These insights from Figure 1(b) generalize in a straightforward way to the case of continuous ownership shares in the unit interval.

More generally, we can distinguish three types of possible sorting patterns in industries with different degrees of headquarter intensity. First, in industries with a very *high* η, such that $\beta_F^* > \beta_F(1)$, we have that either more productive firm pairs choose *higher* ownership shares (for $f'(s) > 0$, the case in Figure 1(b)), or all operate under full integration (for $f'(s) < 0$) and there is no self-selection based on productivity. Second, in industries with a very *low* η, such that $\beta_F^* < \beta_F(0)$, we find that either all firm pairs conduct outsourcing (for $f'(s) > 0$), or more productive ones choose *lower* ownership shares (for $f'(s) < 0$). Third, in the range of η for which JVs are optimal, i.e., those implying $\beta_F^* \in (\beta_F(0), \beta_F(1))$, we may observe either type of selection pattern, depending on the fixed cost ranking: More productive firm pairs choose higher ownership shares, but never higher than s^* for $f'(s) > 0$, whereas more productive firms choose lower ownership shares, but never less than s^* for $f'(s) < 0$.

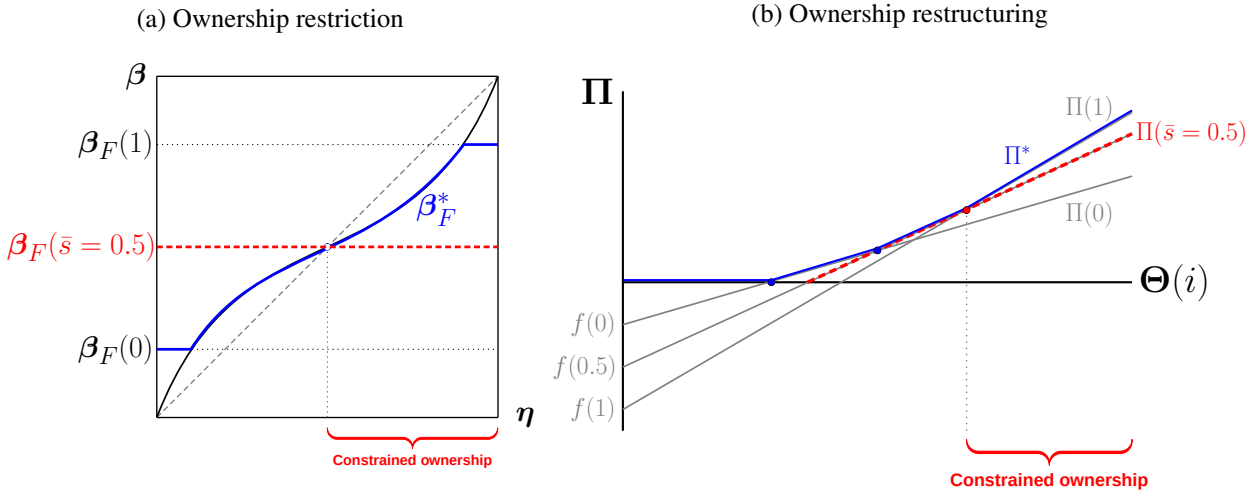
These results are reminiscent of the predictions derived by Kohler and Smolka (2015) for the case of a discrete choice between full integration and outsourcing. Formally, they follow from a modularity property of the maximum operating profit function: β_F^* maximizes $\Psi(\beta_F)$, which is the 'slope parameter' for the productivity term $\Theta(i)$ in equation (10). Intuitively, the incentive effect due to optimal ownership has more leverage for more productive firms. In the words of Kohler and Smolka (2015, p. 2): "the firm's productivity magnifies any per-unit production cost advantage". Hence, whichever degree of integration is preferable in a given industry on the basis of per-unit costs, the most productive firms are (weakly) more likely to choose this optimal degree of integration because they have a higher capacity to cover the fixed costs of the preferred organizational form. Our model extends these results to the case of partial ownership.

[18] This argument assumes that $f(s)$ is not too steep (such that the fixed organizational costs do not increase faster in s than $\beta_F(s)$) and that the upper bound to the productivity distribution is not too low (such that at least one firm can cover the cost $f(s^*)$).

2.3 Modeling foreign ownership restrictions and liberalization

How do restrictions on foreign ownership affect firm performance in this model? As discussed in the introduction, the Chinese FDI policy has maintained various restrictions on foreign ownership across several industries. FDI was entirely prohibited in some industries and severely restricted in other industries, some of which faced explicit limits on foreign equity shares. In terms of the model, these policy restrictions can be understood as introducing an upper bound $\bar{s}$ on the foreign ownership share of the foreign firm F in the Chinese supplier M. This upper bound varies from zero, in case FDI is prohibited entirely, to just below one, in case the foreign investor is required to at least have a Chinese partner holding some shares in a Sino-foreign JV. The foreign ownership restriction $\bar{s}$ implies an upper bound on the firm's revenue share $\beta_F(\bar{s})$, as illustrated by the dashed line in Figure 2(a) for the example of $\bar{s} = 0.5$. To focus on the relevant cases, we consider only industries in which at least one firm pair is constrained by the policy, i.e., $\bar{s} < s^*$. It follows from our analysis in the previous section that in industries with a low headquarter intensity such a policy is less likely to be binding because low ownership shares are preferable on efficiency grounds. Constrained firm pairs will be those active in industries with a high headquarter intensity, as evident in Figure 2(a). Hence, we can restrict our attention to industries with a high headquarter intensity of $\eta > 0.5$. Furthermore, in these industries, more productive firm pairs are more likely to be constrained if the fixed cost ranking is increasing ($f'(s) > 0$). In the constrained production relationships, the policy aggravates existing distortions due to contractual incompleteness, which reduces the output below the second-best level. Therefore, abolishing $\bar{s}$ induces restructuring towards the optimal ownership share, reoptimized input quantities, and higher output as a consequence. We now develop these predictions.

Figure 2: Ownership restriction and restructuring



Note: Figure 2(a) illustrates the optimal revenue share β_F^* as a function of headquarter intensity η in the presence of an ownership restriction $\bar{s} = 0.5$. Figure 2(b) illustrates maximum profits Π as a function of (transformed) productivity $\Theta(i)$ in an industry with a very high η, such that $s^* = 1$, for the example of an increasing fixed cost ranking $f(s)$ and $s = \{0, 0.5, 1\}$. It shows that in such an industry the most productive firm pairs are constrained by the ownership restriction $\bar{s} = 0.5$.

Profit-maximizing firm behavior implies that a policy liberalization, which abolishes the foreign ownership restriction $\bar{s}$, induces the constrained firm pairs to increase s towards the optimal level s^*. The most

productive firm pairs then move to the optimal ownership share s^*, corresponding to β_F^* in Figure 2(a). Some less productive firm pairs may increase the ownership share by less if they are constrained by fixed organizational costs.[19] Figure 2(b) provides an illustration for the same example as in the previous section (an industry with a very high η, such that $s^* = 1$, and three exemplary ownership shares with $f(1) > f(0.5) > f(0)$), where we assume that foreign ownership is restricted initially through $\bar{s} = 0.5$. Abolishing this threshold then induces ownership restructuring among all previously constrained firm pairs to $s^* = 1$. Note that the figure depicts a situation in which all organizational forms coexist in the equilibrium without the policy, though this need not be the case. There may also be industries in which production relationships cannot operate profitably except under foreign ownership, e.g. because the fixed costs $f(0)$ are higher than in the depicted situation (such that the intersection point $\Pi(0) = \Pi(1)$ lies in the loss domain). These firm pairs would be kept out of the market by the policy, but enter the industry with a wholly foreign-owned supplier after liberalization. These predictions are summarized in:

Proposition 2 (Optimal ownership restructuring)**.** *Abolishing foreign ownership restrictions leads to (i) an increase in foreign ownership shares among previously constrained firm pairs and (ii) entry of new (partially) foreign-owned suppliers.*
Proof. *In the text.*

How are both parties' input choices and their joint performance affected by the ownership restructuring caused by the liberalization? The increase in s (and hence $\beta_F(s)$) induces the previously constrained firm pairs to adjust their input quantities towards the second-best levels from equations (6) and (7). From an examination of equation (8), it can be seen that this implies an increase in the capital-labor ratio in previously constrained production relationships (as we formally show in Appendix A.2). This result is intuitive, since allowing the firms to optimally choose a higher ownership share ameliorates F's underinvestment into capital, while it aggravates M's underinvestment into labor. As a result, the capital-labor ratio increases in general for any increase in the ownership share, and in particular for the increase from $\bar{s}$ towards s^* induced by the policy liberalization.

The reoptimized investments lead to an increase in output from the policy-constrained level towards the second-best output level from equation (9) under plausible conditions. We show in Appendix A.2 that output is increasing for an increase in the revenue share $\beta_F(s)$, and for a move from $\bar{s}$ to s^*, if $\eta > \beta_F(s)$. This condition is satisfied for any industry with a high headquarter intensity of $\eta > 0.5$, as is illustrated in Figure 1(a) and can be easily verified using equation (13). Recall that these are precisely the industries in which the policy is most likely to impose a binding constraint initially. The condition is further satisfied also in other industries if the policy restrictions are severe and imply a low $\beta_F(\bar{s})$. Intuitively, the firm pairs move closer to the second-best output level because the aggravated underinvestment by the Chinese supplier is more than compensated by the improved investment incentives of the foreign firm through its increased ownership share. This is how the efficiency gains from an optimal allocation of ownership rights can materialize in terms of higher output:

[19] This discussion focuses on the interesting case of a non-trivial sorting pattern among constrained firms. As noted earlier, there is no sorting if $f'(s) < 0$ in industries with a high η, and firms are unlikely to be affected by the policy at all in industries with a low η.

Proposition 3 (Firm performance)**.** *Optimal ownership restructuring after liberalizing ownership restrictions (i) increases the capital-labor ratio and (ii) results in overall higher output in previously constrained firms.*

Proof. *See Appendix A.2.*

It should be noted that this core prediction is independent of the different rankings of fixed organizational costs discussed in Section 2.2.

At this point, two comments are in order regarding the effects on inputs and alternative measures of firm performance. First, the question arises: How are both input quantities K and L affected by the optimal ownership restructuring after liberalization? In principle, there are two types of effects at work for each input: a direct incentive effect, working in opposite directions for both parties, and an indirect size effect, which may increase the use of both inputs due to the increase in output. The effect on capital is clearly positive, as both the incentive effect for F and the overall efficiency gains lead to increased capital investments. Hence, the use of capital increases both relative to labor and in absolute terms. By contrast, the net effect on the quantity of labor employed is ambiguous in general, since the two effects work in opposite directions. The direct incentive effect on L is negative, since M retains less residual property rights, which aggravates the hold-up problem from the viewpoint of the supplier and reduces its incentives to contribute labor to the joint production process. This negative effect dominates in particular for a marginal increase in s towards the optimal ownership share s^*. However, provided that the optimal ownership restructuring increases output, this tends to raise the demand for labor. For a non-marginal increase from $\bar{s}$ to s^*, this size effect may overcompensate the incentive effect, resulting in a positive employment effect. Appendix A.2 formally derives the marginal effects of an increase in $\beta_F(s)$ on K and L and illustrates by use of a numerical example how the effect of optimal ownership restructuring on L may turn positive.

Second, we have chosen output as our preferred measure of firm performance in anticipation of our empirical analysis. This choice is motivated by the fact that our theory delivers a clear prediction for the output effect of optimal ownership restructuring, and output is observable in the data. One may alternatively consider measuring firm performance in terms of profitability or productivity, but both of these measures have their drawbacks. Profits almost trivially increase for any move to optimal ownership, which makes them a natural candidate to look at. However, the economic profits from the relationship, corresponding to Π in our model, are unobservable in our data on Chinese firms, since (i) accounting profits are generally a poor proxy for economic profits due to tax-optimizing reporting behavior, and (ii) the profits from the relationship are likely to be captured by the foreign firm, whose profits we do not observe. Hence, we do not focus on profitability as a performance measure. Given our focus on efficiency gains, productivity would seem to be another suitable performance measure. Note that TFP θ in our model is exogenous, drawn in an entry lottery à la Melitz (2003), and does not respond to ownership changes. Hence, we would not expect any effect of optimal ownership restructuring on TFP, provided that it can be measured in a theory-consistent manner. Instead, the efficiency gains in the model arise purely through reoptimized input choices. Only to the extent that TFP captures aspects of the production process that can be subject to underinvestment, one may expect an impact of ownership restructuring on TFP, but this would not be an empirical analogue of θ. We will return to this question in the empirical analysis of firm performance in Section 6.

3 Policy Background and Data

To bring the theoretical predictions to the data, we take advantage of China's large-scale FDI liberalization following its WTO accession. In this section, we briefly introduce the institutional background on China's FDI regulation policy, describe the reform liberalizing this policy in many industries, and provide an overview of our firm panel data.

3.1 China's FDI regulation policy

China was historically closed to FDI and started opening its door to foreign capital in 1978, as part of the 'Reforming and Opening' program. The regulations on FDI, however, remained tight until the mid-1990s.[20] In 1995, the National Development and Reform Commission (NDRC) and the Ministry of Commerce (MOFCOM) co-published the first 'Catalogue for the Guidance of Foreign Investment Industries' (henceforth referred to as the Catalogue) as a guideline for regulations on FDI. In the Catalogue, products are sorted into four categories: 'restricted', 'encouraged', 'prohibited', and by implication 'permitted' (the last is the residual category of products not included in the Catalogue).[21] Different rules and restrictions apply to products in different categories. For products in the 'encouraged' category, foreign investors are granted freedom in choosing their ownership structures and often enjoy other privileges, such as preferential tax rates, subsidized land, or duty-free imports of inputs (Sheng and Yang, 2016). By contrast, no FDI is allowed in 'prohibited' products. Foreign firms that intend to invest in the 'restricted' products are subject to intense scrutiny and have to satisfy stringent requirements.

Equity requirements are one particular type of restrictions that directly constrain foreign ownership structures, namely the *Sino-Foreign joint venture* requirement and the *majority Chinese ownership* requirement. Under the *Sino-Foreign joint venture* requirement, a foreign investor has to find a Chinese partner and form a joint venture (JV) to start a business. Hence, this regulation excludes full foreign ownership, corresponding to a foreign equity share of 100%. Under the *majority Chinese ownership* requirement, a foreign investor can only own 50% or less of the firm's equity.[22] Hence, it excludes majority foreign ownership. Other restrictions include local content requirements, technology transfer for market access, or mandatory export requirements, among others.[23]

From the information provided in the Catalogue, we construct two indicator variables for the policy categories 'restricted or prohibited' and 'encouraged'. These are obtained by mapping the product descriptions from the Catalogue to our firm data (described in Section 3.3) via the Chinese Industry Classification (CIC) at the 4-digit level if possible, and at the 3-digit or 2-digit level in some instances. Note that the different policy categories are not mutually exclusive at the 4-digit industry level, so FDI in a given industry

[20] For instance, before 1990, the 'Equity Joint Venture Law' required that the chairman of the board of an equity JV must be appointed by Chinese investors.

[21] To give some examples, based on the 2002 Catalogue, 'wool and cotton textiles' and 'container production' were both restricted categories for foreign investment, while investment in 'automobile and motor cycles' was encouraged.

[22] In some cases, the requirement is that the Chinese parties shall hold a higher equity share than any foreign parties in the joint project, which is known as a 'relative majority Chinese ownership' requirement.

[23] For example, a foreign firm may be required to export the majority of its manufactured products to get approval in a restricted product category.

may for instance be both encouraged (for some products) and restricted (for some other products), or an encouraged product may have explicit equity requirements. Furthermore, some foreign firms that export their manufactured products have also received preferential treatment.[24]

3.2 China's WTO accession and FDI policy liberalization

After its first publication in 1995, the Catalogue was revised in 1997, 2002, 2004, 2007, 2011, 2015, and 2017.[25] Through these revisions, the Catalogue has generally become more liberal and investor-friendly over time. Our main focus is on the 2002 revision of the Catalogue, which manifests a major liberalization of inward FDI as a direct consequence of China's accession to the WTO in 2001.

In accessing the WTO, China made exceptional commitments to liberalize its FDI policy. In compliance with the WTO Agreement on Trade-Related Investment Measures (TRIMs), China had to abolish any restrictions or distortions on foreign investment related to international trade. In particular, China had to abolish its performance requirements (such as local content or technology transfer) in restricted industries upon accession, and it was not granted a transition period to implement these changes.[26] What is more, China accepted several additional obligations that substantially exceed the standard WTO rules. These additional obligations are unique in WTO history (Qin, 2007). They further extended China's commitments to liberalize foreign investment by granting national treatment to foreign-invested enterprises and abolishing equity restrictions in particular industries.[27] To fulfill these obligations, China undertook a major regulatory reform regarding foreign trade and investment in 2002, which involved a substantial liberalization of the Catalogue.

Figure 3 illustrates the major FDI liberalization in 2002 after China's WTO accession. It counts the number of industries in which products are regulated by the Catalogue in each year over the period 1997-2007. Within the manufacturing sector, 45 industries (out of 425) became newly 'encouraged', while 50 industries were removed from the 'restricted' list and in two industries FDI was no longer 'prohibited'. The net changes depicted show a clear liberalization process. Note that the changes in the Catalogue in 2004 were very small in comparison: Within the manufacturing sector, only three industries were liberalized. Hence, we focus on the major reform of 2002.

As briefly discussed in the introduction, our main difference-in-differences analysis in Section 6 compares the performance of firms increasing their foreign ownership share in liberalized industries to other firms in the same 4-digit industries, which were already foreign-owned before the reform. This approach

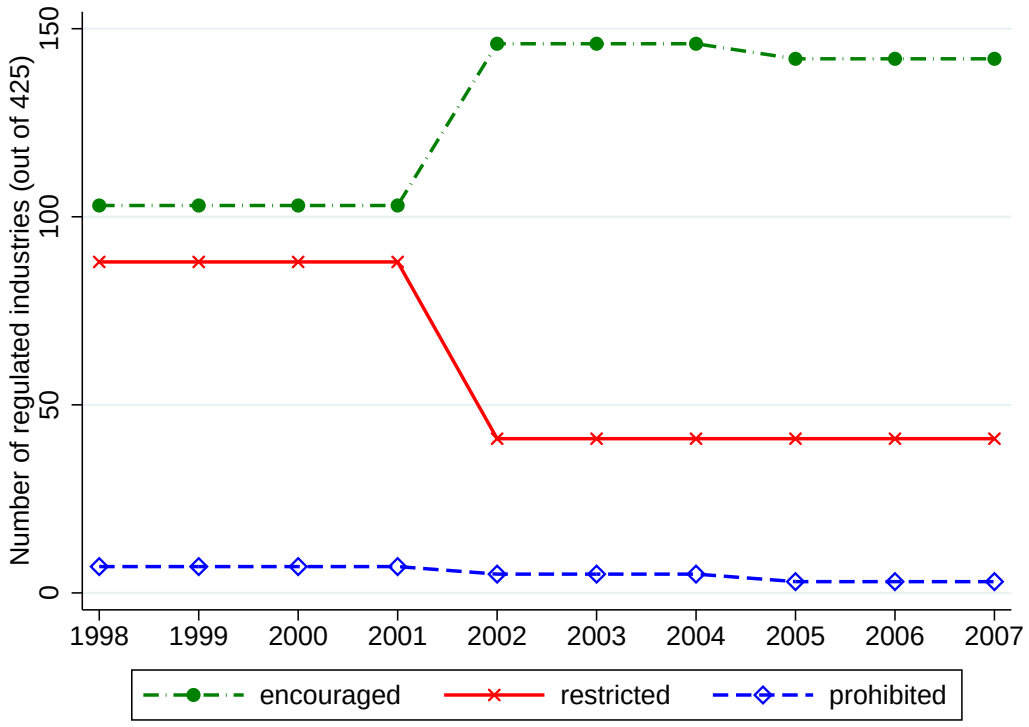
[24] To be concrete, foreign investment in 'permitted' product categories can be treated as 'encouraged' if all products are made for export. And foreign investment in 'restricted' product categories can potentially be treated as 'permitted' if the export share over total sales is above 70%, upon approval.

[25] For our empirical investigation, we code the policy changes by the dates when they were effectively implemented. The 2002 revision became effective on April 1, 2002, so we code the new policy as effective in 2002-2004. The 2004 revision became effective on January 1, 2005, so we code the new policy as effective in 2005-2007, as the 2007 revision became effective only on December 1, 2007.

[26] The Accession Protocol states that "China shall, upon accession, comply with the TRIMs Agreement, without recourse to the provisions of Article 5 of the TRIMs Agreement" (Section I.7.3). Article 5 grants a transition period to developing countries.

[27] Article 207 of the "Report of the Working Party on the Accession of China" states explicitly: "With respect to the manufacture of motor vehicle engines, the representative of China also confirmed that China agreed to remove the 50 per cent foreign equity limit for joint-ventures upon accession." This article was incorporated into the accession protocol pursuant section 1.2 of the same protocol and article 342 of the working party report.

Figure 3: FDI liberalization in Chinese manufacturing, 1997-2007



Note: Authors' calculations based on the 'Catalogues of Industries for Foreign Direct Investment' (NDRC, various issues).

exploits the fact that the products listed in the FDI Catalogue are generally defined at a more disaggregate level than the 4-digit industry codes by which we can map them to the firms. Hence, foreign-owned firms exist in the industries classified as 'liberalized' already before the reform because they produce unregulated products. We have made spot checks using information on firms' specific products from their websites to validate this assumption. Two illustrative examples come from the 4-digit industries 'jewelry' and 'cable and wire' manufacturing. First, the firm ChengDu TianHeYinLou LLC increased its foreign ownership share from 0 to 100% in 2003, after the FDI restriction on its main product 'golden or silver jewelry' was abolished. By contrast, ShangHai TianQi LLC, which was foreign-owned throughout the years 2001-2003, produces 'pearl jewelry', a product that was not listed in the 1997 Catalogue. Second, the main product of Xiamen City HuaLe LLC is a 'cable for high voltage', for which FDI was restricted (with a *Sino-Foreign joint venture* requirement) before the reform, thus it could only be acquired to 100% by a foreign owner in 2003. The comparable firm Beijing LuoBoSenGe Electronic LLC produces other 'electronic cable', which was not listed in the FDI Catalogue, allowing this firm to be wholly foreign-owned already before 2002. This setup allows us to use highly comparable firms that are similarly selected by foreign investors and active in the same narrowly defined industries as a control group in our main empirical analysis of firm performance.

3.3 Firm data

To investigate foreign ownership and firm performance in China, we use data from the Chinese Annual Surveys of Industrial Production (ASIP), conducted by the National Bureau of Statistics of China (NBSC). This dataset is the most comprehensive survey data for industrial firms in China.[28] It forms the basis for major statistics published in China Statistical Yearbooks and has been widely used in economic research (mostly notably by Brandt et al., 2017; Hsieh and Klenow, 2009). The dataset covers all state-owned enterprises (SOEs) and all other firms with total sales exceeding 5 million RMB (around US$ 620,000 at the running exchange rate in 2005) in the industrial sector (including manufacturing, mining, and utilities). It is a panel for the period of 1998-2007, covering several years before and after the major FDI policy reform in 2002. For our purpose, we limit the analysis to manufacturing firms, resulting in a sample of close to half a million firms (on average around 180,000 firms per year). We follow Cai and Liu (2009) in taking necessary steps to clean the data. Brandt et al. (2012) suggest that one sixth of all firms that are observed for more than one year change their official ID over the sample period. Hence, we follow their procedures to track each firm over time using their ID, name, industry, address, and other information.

From the ASIP, we collect detailed firm-level production and balance-sheet information (gross output, value added, employment, wage bill, fixed assets, material input purchases, etc.). Most importantly, the data contain information on the firms' ownership structures. Our measure of foreign ownership is the share of foreign investors, including investors from Hong Kong, Macao, or Taiwan, in the firm's paid-in capital. This variable has the key advantage that it allows us to observe the degree (or depth) of foreign ownership instead of just a binary choice.

We also use the ASIP data to compute proxies for the key determinants of ownership shares according to our PRT model, namely headquarter intensity η and productivity θ. The crucial headquarter intensity parameter has typically been approximated by industry-level capital intensity or skill intensity since the pioneering work by Antràs (2003). This approach is based on the premise that the foreign owner is more likely to contribute to suppliers' relationship-specific investments in capital or human capital compared to investments in labor, as discussed in Section 2. This premise seems plausible also in the Chinese context, as foreign ownership has long played an important role for Chinese firms in gaining access to capital (Huang, 2008). Bache and Laugesen (2013), Corcos et al. (2013), and Defever and Toubal (2013) have taken this approach to the firm level, arguing that factor intensities vary even within narrowly defined industries. We follow the literature and compute capital intensity and skill intensity as proxies for headquarter intensity, alternatively at the industry level and at the firm level. The firm-level capital intensity K/L is obtained by dividing the real capital stock K by the number of workers L in a given year. We compute the real capital stock by applying the perpetual inventory method to our firm panel. The firm-level skill intensity S/L is the share of workers with college education S in the total number of workers, as observed in the Chinese firm census in 2004. Industry-level measures are arithmetic means of these ratios by industry and year.

To obtain a measure for the total factor productivity (TFP) θ of the firm pairs, we estimate production functions at the 2-digit industry level based on the ASIP data. Since TFP is observable to the firm and affects

[28] It accounts for over 90% of industrial output and over 70% of industrial employment in 2004 (Brandt, Van Biesebroeck and Zhang, 2012).

its input choices and output, but it is unobserved by the econometrician, estimation of these production functions suffers from well-known endogeneity issues. We address these issues by adopting the method proposed by Ackerberg, Caves and Frazer (2015), which builds on the seminal insights from Olley and Pakes (1996) and Levinsohn and Petrin (2003). To adopt their control function approach, we assume that gross output is Leontief in material input $M_j(i)$ and the Cobb-Douglas production function $x_j(i)$, combining $K_j(i)$ and $L_j(i)$ as specified in equation (2), which has the interpretation of value added in this context.[29] We further assume that material input monotonically increases in TFP and can hence be inverted to control for TFP. For this procedure, material input M is deflated by the industry-specific input deflator and value added is deflated by the industry-specific output deflator provided by Brandt et al. (2012).[30] From the estimated production functions, we obtain predicted TFP as the time-varying firm-specific residual.

4 Foreign Ownership Patterns in Chinese Manufacturing

4.1 Econometric model of foreign ownership

As a first step in our empirical analysis, we examine how the factors predicted to shape optimal ownership according to our PRT model correlate with foreign ownership shares in Chinese firms in *unrestricted* industries. This exercise serves to validate the model of Section 2, which is used to interpret our main results in Section 6, and it relates our paper to the existing literature on the organization of MNEs. To this end, we specify the following econometric model:

$$FO\ share_{it} = \boldsymbol{\chi} \cdot \mathbf{X}_{it} + \boldsymbol{\zeta} \cdot \mathbf{Z}_{it} + \rho_j + \rho_r + \rho_t + \upsilon_{it}\,, \tag{14}$$

where the dependent variable $FO\ share_{it}$ denotes the share of equity in firm i and year t owned by foreigners. The vector $\mathbf{X}_{it}$ (with associated coefficient vector $\boldsymbol{\chi}$) contains different sets of variables that determine ownership shares according to our PRT model of the MNE. First, to proxy for the key headquarter intensity parameter η, we follow the literature in using the industry-level capital intensity. To allow for the possibility that headquarter intensity varies within industries, we also use as alternative proxies for η the one-year lags of the firm-level capital intensity $\ln K/L$ and the skill intensity $\ln S/L$ (see Section 3.3 for data and measurement). Second, we interact these headquarter intensity proxies with the one-year lag of the firm's estimated TFP. Since the effect of TFP might be non-linear in headquarter intensity (see Section 2.2 and Kohler and Smolka, 2015), we also adopt a more flexible specification that interacts TFP with quintiles ($Q2 - Q5$) of firm-level capital intensity (similar to the industry-level analysis by Nunn and Trefler, 2014).

As additional firm-level control variables $\mathbf{Z}_{it}$ (with coefficient vector $\boldsymbol{\zeta}$), we include: firm age, which may be important for optimal ownership shares in joint ventures (see Bircan, 2014), the lagged export share (*exports/ sales*), since ownership may depend on whether the firm supplies the domestic market, other

[29] This assumption avoids the identification issue raised by Gandhi, Navarro and Rivers (2017). We have also experimented with estimating gross output production functions following their approach. Note that we relax the assumption of constant returns to scale of $x_j(i)$ when estimating production functions, as is customary to obtain a better empirical fit.

[30] For the subsequent empirical analysis, exports are deflated by the same output deflator, where appropriate, and the wage (bill) is deflated by the consumer price index from the World Bank's World Development Indicators.

markets, or its foreign owner, and the lagged log of the value added ratio (*VA/ sales*) as a proxy for the importance of the Chinese firm in the value chain (following Antràs, 2003). We always include fixed effects ρ_j, ρ_r, and ρ_t by 4-digit industry j, province r, and year t, respectively. The error term is denoted by υ_{it}.

We estimate all variants of equation (14) by Ordinary Least Squares (OLS). Standard errors are clustered by firm or by industry, depending on the level at which the regressors are varying.[31] We use all the available years in our panel, but restrict the sample to industry-years in which FDI was not restricted or prohibited, in order to abstract from the effects of the policy for now.

We conduct this exercise to verify whether the patterns of foreign ownership in Chinese firms are generally in line with the PRT model developed in Section 2. More specifically, Proposition 1 predicts that ownership shares are higher in industries and firms with a high headquarter intensity. Furthermore, based on the discussion in Section 2.2, we would expect that ownership shares increase in the productivity of the production process for a high headquarter intensity, while they tend to decrease in productivity for a low headquarter intensity. These theoretical considerations suggest a positive interaction effect of headquarter intensity and productivity. Note, however, that these estimations should not be interpreted as a strict test of Proposition 1 due to an important endogeneity issue suggested by the same theory. Since increased foreign ownership raises the investment incentives of the foreign owner, but decreases those of the Chinese firm, the factor intensities used to proxy for headquarter intensity are endogenous to ownership (see Proposition 3). This concern is ameliorated here by using industry-level and lagged firm-level proxies for headquarter intensity, but it cannot be fully eliminated.

4.2 Empirical evidence on foreign ownership patterns in China

Table 1 summarizes the results of estimating equation (14). It demonstrates that foreign ownership patterns in the Chinese firm data are generally consistent with our PRT model of the MNE. In column 1, as a first proxy for headquarter intensity, we examine the log of the industry-level capital intensity. The estimated correlation is positive and highly statistically significant, as predicted by Proposition 1. Similarly, in column 2, we find that foreign ownership shares are positively correlated with the firm-level capital intensity (lagged by one year) and skill intensity (as observed in 2004).[32] These findings are consistent with the PRT, provided that these variables reflect the fundamental importance of physical and human capital in production and that the foreign owner is more likely to contribute these inputs to production, whereas the local firm is responsible for hiring (low-skilled) labor. The evidence suggests that firms with a higher headquarter intensity are foreign-owned to a larger degree. The coefficient estimates for the control variables in these and all subsequent regressions suggest that younger, more export-oriented firms with lower value added ratios tend to have higher foreign ownership shares.

Second, we allow for a heterogeneous effect of productivity on ownership across different values of headquarter intensity. This is captured by the interaction term between TFP and headquarter intensity in

[31] Since TFP is a generated regressor, we also experiment with cluster-bootstrapped standard errors (based on 500 replications). However, since the bootstrapped standard errors for the main regressors turn out to be smaller for the main regressors in almost all specifications, we prefer the more conservative cluster-robust standard errors.

[32] Since skill intensity can only be measured for firms observed in 2004, the sample is reduced in this regression. For the same reason, we use capital intensity as our preferred firm-level proxy for headquarter intensity in the remaining regressions.

columns 3-5 of Table 1. Again, we start by considering the industry-level capital intensity as a proxy for headquarter intensity in column 3, which shows a direct positive (but insignificant) correlation with the *FO share*. The coefficient of the interaction term is positive and highly statistically significant. It suggests that in capital-intensive industries, more productive firms have higher foreign ownership shares. This pattern is in

Table 1: Foreign ownership patterns

Dependent variable: *FO share*	Headquarter intensity		Productivity × headquarter intensity		
	Industry	Firm	Industry	Firm	Firm quintiles
	(1)	(2)	(3)	(4)	(5)
ln K/L (industry)	0.0222***		0.00398		
	(0.00801)		(0.00841)		
ln K/L (firm, lag)		0.0515***		0.0585***	
		(0.000719)		(0.000943)	
ln S/L (firm, 2004)		0.0204***			
		(0.000838)			
TFP (firm, lag)			-0.0453***	-0.0220***	-0.0000685
			(0.0111)	(0.00221)	(0.00147)
TFP × ln K/L (industry)			0.0135***		
			(0.00256)		
TFP × ln K/L (firm, lag)				0.00890***	
				(0.000567)	
Q2 K/L (firm, lag)					0.0355***
					(0.00229)
Q3 K/L (firm, lag)					0.0594***
					(0.00248)
Q4 K/L (firm, lag)					0.0887***
					(0.00262)
Q5 K/L (firm, lag)					0.180***
					(0.00310)
TFP × Q2 K/L (firm, lag)					0.00152
					(0.00154)
TFP × Q3 K/L (firm, lag)					0.00580***
					(0.00165)
TFP × Q4 K/L (firm, lag)					0.0107***
					(0.00172)
TFP × Q5 K/L (firm, lag)					0.0307***
					(0.00195)
Age (firm)	-0.00285***	-0.00352***	-0.00331***	-0.00342***	-0.00336***
	(0.000198)	(0.0000533)	(0.000245)	(0.0000530)	(0.0000527)
Exports/ sales (firm, lag)	0.340***	0.370***	0.335***	0.342***	0.340***
	(0.0195)	(0.00277)	(0.0221)	(0.00358)	(0.00358)
ln (*VA/ sales*) (firm, lag)	-0.00125	-0.00111	-0.00544***	-0.00427***	-0.00425***
	(0.00155)	(0.000988)	(0.00177)	(0.00110)	(0.00110)
Observations	1,068,379	672,193	500,818	499,163	500,818
R^2	0.289	0.335	0.359	0.387	0.383

The table reports OLS estimates of equation (14) in the sample of unrestricted industries, controlling for 4-digit industry, province, and year fixed effects. TFP (in logs) is the firm-level residual from industry-level production functions, estimated as described in Section 3. K/L is the capital-labor ratio and S/L is the skill intensity of the industry (in columns 1 and 3) or firm (in columns 2, 4, and 5), respectively. $Q2 - Q5$ denote quintile dummies. Standard errors clustered by industry in columns 1 and 3 and clustered by firm in in columns 2, 4, and 5 are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

line with our model for a ranking of fixed organizational costs that is increasing in the degree of integration (as discussed in Section 2.2). Also, the negative coefficient of TFP can be rationalized by our framework for a decreasing fixed cost ranking: In industries with a very low headquarter intensity, lower ownership shares are optimal, and these are more likely to be chosen by more productive firms if outsourcing is associated with relatively high fixed organizational costs. Hence, a higher productivity tends to favor lower ownership shares in industries with a low headquarter intensity. The final column adopts a more flexible specification by considering quintiles of the distribution of capital intensity across all firms. It reveals that the positive association of the *FO share* with our proxy for headquarter intensity is monotonic. Furthermore, the positive correlation of foreign ownership with TFP is concentrated in the highest three quintiles of K/L and increases monotonically in this variable. Again, this findings is in line with our model for an increasing fixed cost ranking. Overall, we find that the patterns of foreign ownership observed in Chinese manufacturing are fully in line with key predictions of our PRT model.

It is interesting to compare our results to the existing literature which has empirically examined ownership patterns in global sourcing. Both industry-level and firm-level studies have so far mainly focused on firms' headquarters and generally found evidence in line with the theory (see e.g. Nunn and Trefler, 2013; Kohler and Smolka, 2015). These papers implicitly assume that factor intensities and productivity of the headquarters are suitable proxies for the parameters characterizing the joint production process. We complement these studies with evidence on the supplier side of the global sourcing relationship and continuous ownership shares. Since we are interested in production processes taking place in China, we derive proxies for headquarter intensity and productivity using data on Chinese firms. Similar to the previous literature, our findings confirm the ownership patterns predicted by the PRT.

5 Direct Effect of the FDI Policy on Foreign Ownership

5.1 Descriptive evidence of the direct policy impact

Figure 4 provides indicative evidence that the FDI policy reform in 2002 had the expected positive effect on foreign ownership. Figure 4(a) focuses on new entrants into the panel. It depicts the share of equity JVs (*FO share* of 25-99.99%) and wholly foreign owned firms (*FO share* of 100%) among all entrants in each year. While there is slightly more entry of wholly foreign-owned firms compared to JVs in the years 1999-2001, both lines seem to evolve in parallel over this pre-reform period. With the 2002 FDI policy reform, there is a clear divergence, with full ownership becoming more prevalent among entrants. This observation is in line with the second part of Proposition 2. In 2002 and every later year, 9-12% of all entrants were wholly foreign owned, compared to only 3-5% JV entrants.

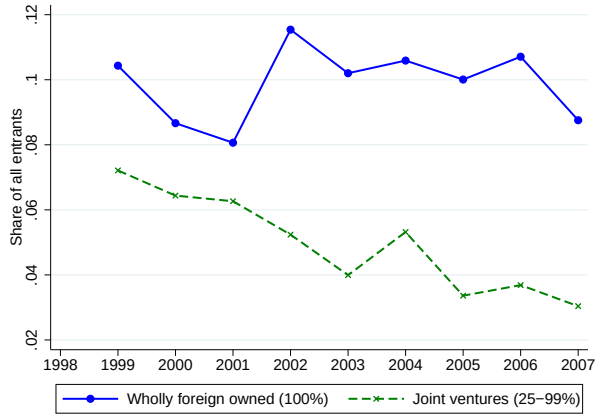
Figure 4(b) moves on to examine the average foreign equity share among incumbent firms, excluding all entrants in a given year. It shows a clear trend towards higher foreign ownership shares throughout the period of 1998-2007, both for non-liberalized and liberalized industries, defined as those for which a 'restricted' or 'permitted' FDI policy was abolished in 2002.[33] It is remarkable that foreign ownership in these two types of

[33]This is also true if we define incumbents more narrowly by considering only firms that are observed throughout the entire period.

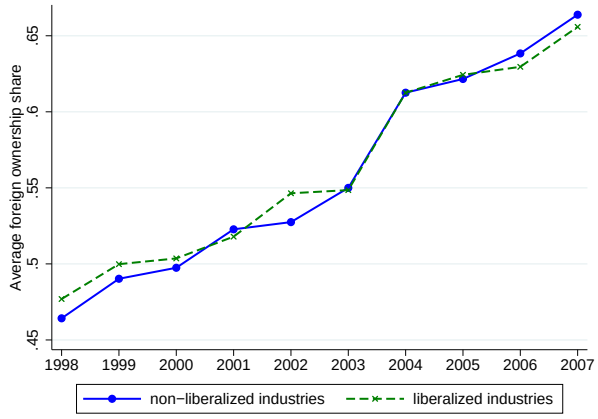
industries seems to follow very closely a common trend both before 2001 and after 2003. The only notable exception is the reform year 2002, in which the trend towards foreign ownership accelerated in liberalized industries (increasing from around 52% to 55% average foreign ownership shares), while it slowed down in the other industries. These observations are in line with the first part of Proposition 2. To sum up, a clear general trend towards higher degrees of foreign ownership is visible both for entrants and incumbents for the period of 1998-2007, as is a temporary acceleration of this trend with the major FDI policy reform in 2002.

Figure 4: Foreign ownership over time

(a) Shares of foreign-owned firms among entrants



(b) Foreign ownership share among incumbents



Note: Figure 4(a) illustrates the share of Sino-foreign equity JVs (*FO share* of 25-99.99%) and wholly foreign owned firms (*FO share* of 100%) among all entrants in a given year. Figure 4(b) illustrates the average *FO share* among all incumbent firms, excluding entrants in a given year. It distinguishes industries by the FDI policy change in 2002. Industries for which a 'restricted' or 'permitted' FDI policy was abolished in 2002 are labeled 'liberalized' industries, all others are non-liberalized.

5.2 Econometric specification

To assess the direct effect of the FDI regulation policy on ownership structures more rigorously, we regress measures of foreign ownership FO_{it} on a set of policy regulation variables $\mathbf{R}_{jt}$, indicating whether FDI in industry j of firm i in year t is 'restricted or prohibited' or 'encouraged':

$$FO_{it} = \boldsymbol{\gamma} \cdot \mathbf{R}_{jt} + \boldsymbol{\psi} \cdot \mathbf{X}_{it-1} + \boldsymbol{\xi} \cdot \mathbf{Z}_{it} + \boldsymbol{\kappa} \cdot \mathbf{T}_{jt} + \delta_j + \delta_r + \delta_t + \nu_{it}\,. \tag{15}$$

As the dependent variable FO_{it}, we consider alternatively the continuous foreign ownership share (*FO share*$_{it}$) or dummy variables indicating either (i) a foreign ownership share at or above the standard legal threshold of 25% (*FO dummy*$_{it}$), or (ii) majority foreign ownership (*MFO dummy*$_{it}$), or (iii) whole foreign ownership (*WFO dummy*$_{it}$).[34] We control for the preferred set of the observed, theory-based determinants of the integration decision contained in $\mathbf{X}_{it}$ (with coefficient vector $\boldsymbol{\psi}$) from column 4 of Table 1 and the same firm-level control variables $\mathbf{Z}_{it}$ (with coefficient vector $\boldsymbol{\xi}$). Since China's WTO accession involved trade policy changes that might affect the attractiveness of different industries for FDI, we also control for

[34] A firm with a *FO share* $\geq$25% is officially classified as a foreign-invested enterprise (FIE) in China.

Chinese import tariffs on the firm's output good and its inputs (inferred from Chinese input-output tables), summarized in $\mathbf{T}_{jt}$ (with coefficient vector $\boldsymbol{\kappa}$).[35] Finally, we include fixed effects by 4-digit industry (δ_j), province (δ_r), and year (δ_t) to account for unobservables. We assume that the error ν_{it} has mean zero and is i.i.d.. Naturally, we expect the estimated parameters $\boldsymbol{\gamma}$ to reflect the policy's intention that foreign ownership is reduced by FDI restrictions and increased by the encouraged policy. In particular, Proposition 2 predicts that liberalizing a 'restricted or prohibited' policy increases the foreign ownership share.

We first estimate equation (15) for the full panel of 1998-2007 by OLS. This approach provides a general picture of the policy impact on foreign ownership within industries over time. Notably, it captures the combined effect of the policy on foreign ownership along three different margins of adjustment: (i) existing firms being acquired (to a higher degree) or divested by foreigners, (ii) firms switching into and out of regulated industries, and (iii) firms entering or exiting the panel. In a second step, we focus on the effect of the major FDI policy reform in 2002 on the first of these margins. To this end, we estimate equation (15) in first differences using only data for one year before and one year after the policy change, i.e., 2001 vs. 2003. We exclude all firms changing their 4-digit industry code over the respective period, and the setup implies that firms entering or exiting the panel between these years are also excluded. Note that first differencing not only controls for heterogeneity specific to industries or regions, but it also accounts for all time-invariant firm characteristics. We continue to include the lagged theory-based variables $\mathbf{X}_{it-1}$ and firm age, and we also add the first-differenced export share and log value added ratio. To account for other contemporaneous changes in policy and market conditions, we further control for the first differences in output and input tariffs as well as 3-digit industry fixed effects in the first-differenced model. Since the policy variables are industry-specific, standard errors are clustered at the 4-digit industry-level in all of these regressions.

5.3 Estimation results for the direct policy impact

Table 2 presents the results of estimating equation (15) and shows that the FDI restrictions had the expected direct effect on foreign ownership. Panel A presents OLS estimation results in the full panel for the alternative dependent variables. All four measures of foreign ownership are negatively affected by the 'restricted or prohibited' FDI policy, as expected, though the effect on the *WFO dummy* is insignificant. The estimate in column 1 suggests that abolishing FDI restrictions has increased the *FO share* on average by 1.2 percentage points (or around 8% relative to the lagged average ownership share). Note that this number reflects only the average treatment effect across all firms, but it involves many large increases in foreign ownership for the subset of treated firms. Similarly, dropping an FDI restriction has increased the probability of being foreign owned above the 25% or 50% thresholds by 1.1-1.5 percentage points or 7-8%.[36] By contrast, the effects of

[35] See Brandt et al. (2017) for evidence on the impact of the tariff cuts due to WTO accession. Data on Chinese import tariffs come from the Worldbank's World Integrated Trade Solutions (WITS) database at the 6-digit level of the harmonized system (HS6) and are matched to Chinese 4-digit industries via a correspondence table. Output tariffs correspond to the firm's industry, and in the case of multiple HS6 codes per industry, the tariffs are weighted by trade volumes, excluding processing trade (which is typically exempt from tariffs). Input tariffs are obtained using input coefficients of the firm's industry according to Chinese input-output tables for 2002, which mandates a higher level of aggregation, and they are similarly weighted by non-processing trade volumes.

[36] These estimates are based on linear probability models with their well-known limitations. Using a fractional logit model for the *FO share* and logit models for the *FO*, *MFO*, and *WFO dummies* yields estimates for the policy's average partial effects of a similar magnitude. These results are available from the authors on request.

the 'encouraged' policy are estimated to be small, negative, and insignificant, suggesting that this policy did not have the intended effect of fostering FDI. This finding may not be too surprising, at least for columns 1, 3, and 4, since exceeding the legal foreign ownership threshold of 25% may in practice be sufficient to obtain the extra benefits associated with the 'encouraged' policy. Therefore, we would not necessarily expect that it provides incentives to increase the foreign ownership share at the margin or to 100%.[37] Note that these estimates reflect ownership changes as well as industry switching, entry, and exit.

Table 2: Effect of the FDI regulation policy on foreign ownership

Panel A. Pooled OLS – Full panel: 1998-2007	(1)	(2)	(3)	(4)
Dependent variable in header:	*FO share*	*FO dummy*	*MFO dummy*	*WFO dummy*
Restricted or prohibited policy	-1.171**	-0.0148***	-0.0111**	-0.00823
	(0.509)	(0.00532)	(0.00514)	(0.00530)
Encouraged policy	-0.367	-0.00279	-0.00482	-0.00254
	(0.432)	(0.00484)	(0.00467)	(0.00475)
Observations	1,192,196	1,192,196	1,192,196	1,192,196
R^2	0.317	0.291	0.281	0.245

Panel B. First Differences (FD) – 2001 vs. 2003

Dependent variable in header:	*FO share*	*FO dummy*	*MFO dummy*	*WFO dummy*
Restricted or prohibited policy	-0.639***	-0.00800**	-0.00443	-0.00843***
	(0.246)	(0.00383)	(0.00288)	(0.00303)
Encouraged policy	0.0613	0.00207	-0.000218	-0.00235
	(0.276)	(0.00364)	(0.00350)	(0.00362)
Observations	79,013	79,013	79,013	79,013
R^2	0.003	0.003	0.002	0.003

The table reports estimates of equation (15). The measure of foreign ownership FO used as a dependent variable is indicated in the header for each column. Panel A reports pooled OLS estimates for the full panel, including all covariates from column 4 of Table 1 and trade-weighted averages of input and output tariffs. Panel B reports FD estimates for the years 2001 and 2003, excluding firms that switch their 4-digit industry code over this period, and controlling for lagged TFP, $\ln K/L$, and TFP $\times \ln K/L$ (as observed in 2001), firm age, the first differences in the remaining covariates from column 4 of Table 1 and input and output tariffs, as well as 3-digit industry fixed effects. Standard errors clustered by 4-digit industry are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Panel B of Table 2 focuses on the major reform of the FDI policy in 2002. In these regressions, the policy effects are identified from within-firm variation in a first-differenced (FD) version of equation (15), using only data for the years 2001 and 2003 and firms that did not switch their 4-digit industry code between these years. We find strong evidence that dropping a 'restricted' or 'prohibited' FDI policy triggered increases in foreign investment and acquisitions. The FD estimates for the effect of this policy category are negative for all measures of foreign ownership and statistically significant at the 5% level in all cases except for the *MFO dummy*. The policy liberalization increased the average foreign ownership share by 0.6 percentage points (or 5%) and the probability of being (wholly) foreign owned by around 4% (11%). Note that, despite our focus on the major policy reform, some of these estimates are smaller than in the full panel. The reason is that they identify only changes in foreign ownership *within* firms after controlling for contemporaneous

[37] The estimated coefficients of the lagged control variables show the same pattern as discussed in the previous section for the unrestricted industries, and they are not reported to save space.

changes at the 3-digit industry level through fixed effects. We cannot reject the hypothesis that encouraging FDI had no impact on foreign ownership.

6 Effects of Ownership Restructuring on Firm Performance

6.1 Difference-in-differences model

We now turn to our empirical analysis of the paper's main question: How does the optimal allocation of ownership rights affect firm performance? To answer this question, we exploit the changes in foreign ownership triggered by the major FDI policy reform in 2002, which can be considered exogenous to Chinese firms. We compare the performance of firms that increased their foreign ownership share after the liberalization to a suitable control group by estimating the following difference-in-differences (DiD) model:

$$\ln \textit{performance}_{it} = \beta \, TX_i \times \textit{after}_t + \boldsymbol{\tau} \, \mathbf{T}_{jt} + \alpha_i + \alpha_t + \varepsilon_{it}. \tag{16}$$

This model examines the time variation in firm i's $\textit{performance}_{it}$ (in logs), most importantly the capital-labor ratio K/L and real output Y; other performance variables examined include the capital-wage bill ratio K/wL as an alternative measure of input intensity, the real capital stock K, employment L, and the real wage per employee w as measures of input quantities and quality, respectively. We restrict the main analysis to the years surrounding the major policy reform $t = \{2001, 2003\}$, and the dummy $\textit{after}_t$ takes a value of one for 2003 (and zero for 2001).[38] We also focus on the liberalized industries in which an FDI restriction (restricted or prohibited policy) is abolished in 2002. We define a firm in these industries as treated and set the alternative treatment group indicators TX_i to one if the firm's foreign ownership share increases across the respective acquisition threshold $X = \{0, 25, 50, 100\}$: (i) above 0%, reflecting the fact that FDI was entirely prohibited in some industries, (ii) to or above 25%, (iii) to or above 50%, reflecting the explicit equity requirement of *majority Chinese ownership*, or (iv) to 100%, reflecting the *Sino-Foreign joint venture* requirement (see Section 3.2). Note that these treatment groups are overlapping because some firms cross several ownership thresholds. In the following, we will refer to the firms for which the foreign ownership share increases across one of these thresholds as 'foreign-acquired' firms.[39] Arguably, the foreign investors increasing their ownership shares in these firms exploited the liberalization in FDI restrictions to reoptimize their ownership decisions. Provided that multinational firms are profit-maximizing, this change reveals a move to optimal ownership. The coefficient of the interaction term $TX_i \times \textit{after}_t$ is the main parameter of interest, denoted by β. Proposition 3 predicts $\beta > 0$ for the performance variables K/L and Y. $\mathbf{T}_{jt}$ is the same vector of input and output tariffs as in Section 5 (with coefficient vector $\boldsymbol{\tau}$), and ε_{it} denotes the error term. Importantly, the firm fixed effect α_i accounts for all time-invariant differences across firms (including initial conditions, industry affiliation, and treatment group status), and the year fixed effect α_t accounts for

[38] Bertrand, Duflo and Mullainathan (2004) point out that serial correlation may invalidate inference in DiD estimations with multiple years of data. To avoid this issue, we follow their suggestion of focusing on a single pre-treatment and a single post-treatment year. The analysis first concentrates on short-term effects after 2 years, and we will subsequently consider also medium-term effects after 3-6 years.

[39] Firms switching their industry code between 2001 and 2003 are excluded from the analysis (as in the FD estimations of Section 5.3) because they may undergo major changes unrelated to ownership.

the first difference (i.e., the performance change in the control group).

What is the appropriate control group to which the treated firms should be compared? To obtain a valid estimate of β, the firms in the control group must be strictly comparable, such that their performance in 2003 provides a valid counterfactual scenario for the treated firms. More specifically, we require that the treatment is random (or strongly ignorable, in the terminology of the treatment effects literature) conditional on observables.[40] This requirement may be violated by two types of selection, at the firm level and at the industry level, respectively. First, it is a well-known fact that foreign investors engage in 'cherry picking' by acquiring the firms with the most favorable growth prospect (see e.g. Blonigen, Fontagné, Sly and Toubal, 2014). Second, there may be selection of liberalized industries by the Chinese government, which had some discretion in selecting the industries to be liberalized within the scope of its commitments related to the WTO accession (see the discussion in Lu et al., 2017). We address these two margins of selection by (i) choosing a narrowly comparable control group, and (ii) applying propensity score reweighting, which will be explained in the next section.

Our preferred control group consists of firms that have already been foreign owned in 2001 and remain foreign-owned in 2003 (by the same ownership threshold as applied to the treated firms) within the liberalized industries. Such firms exist in the liberalized industries because they produce different products that were not specifically regulated by the FDI Catalogue, which classifies products more narrowly than the 4-digit industry codes at which we can map the policy to firms (see Section 3.2). For instance, we are considering firms in the liberalized 'cable and wire' manufacturing industry, where the treated firms producing a 'cable for high voltage' faced foreign ownership restrictions in 2001 and were acquired by foreign investors in 2003, after this restriction was abolished. Some firms producing other 'electronic cable' products were already wholly foreign-owned before 2002, since FDI in this product was not restricted, so they are included in our control group.

This choice of control group addresses both of the aforementioned selection concerns. First, it avoids the cherry-picking critique, since the firms in the control group have similarly been selected by foreign investors. Hence, they are likely to share the same (potentially unobservable) characteristics that also make the treated firms attractive for foreign ownership. Second, choosing the control group from within the liberalized industries avoids potential issues related to the government's selection of liberalized industries, which may not be fully exogenous to (expected) future performance. Furthermore, firms within the same 4-digit industries can be expected to feature similar technological characteristics and produce similar products as the treated firms, so they constitute a suitable choice as a control group. In Section 6.5, we also examine alternative control groups and show that our main conclusions do not hinge on this particular choice.

[40] Formally, strong ignorability of the treatment requires two assumptions, namely (i) ignorability in mean: $E\left[\ln Y_{i2003} - \ln \bar{Y}_i | \mathbf{M}_{i2001}, treated_i\right] = E\left[\ln Y_{i2003} - \ln \bar{Y}_i | \mathbf{M}_{i2001}\right]$, and (ii) overlap: $Pr(treated_i = 1 | \mathbf{M}_{i2001}) < 1 \, \forall \, \mathbf{M}_{i2001} \in \mathcal{M}_{2001}$, where $\mathcal{M}_{2001}$ is the support of the covariates $\mathbf{M}_{i2001}$ (Wooldridge, 2010). The first assumption requires that treatment is random conditional on the initial observable covariates $\mathbf{M}_{i2001}$, which we will define when introducing the propensity score reweighting approach in Section 6.2. The second assumption requires that for each treated firm and each covariate in $\mathbf{M}_{i2001}$, there must exist at least one untreated firm with a similar value. The latter condition is enforced below by excluding the few treated firms off the common support.

6.2 Propensity score reweighting

Note that the firm fixed effects in equation (16) account for all time-invariant differences across the treatment and control groups that affect future performance. However, there may further be selection of the treated firms based on dynamic factors, which might introduce bias into an estimate of the within-transformed DiD model if these dynamic factors are correlated with future firm performance. To account for this type of selection, we implement the inverse propensity score reweighting estimator that accounts for pre-treatment differences in observable characteristics across the treatment and control groups (see e.g. DiNardo, Fortin and Lemieux, 1996; Imbens, 2004). The idea behind this approach is to reweight the firms in the control group such that the distribution of observable pre-treatment characteristics in this group matches that of the treated firms. To the extent that these observable characteristics also account for unobservable differences across the two groups, the reweighting estimator can deliver a consistent estimate of the average treatment effect on the treated. To implement this approach, we estimate the DiD model in equation (16) by weighted least squares, assigning a weight of one to the treated firms and a weight of $\hat{p}/(1-\hat{p})$ to firms in the control group, where $\hat{p}$ is the propensity score (see Nichols, 2007, 2008).

The propensity score $\hat{p}$ is defined as the predicted treatment probability. It is estimated in logit regressions of the treatment indicators (one by one for each acquisition threshold) on the following set of pre-treatment firm characteristics observed in 2001, the covariates $\mathbf{M}_{i2001}$. To account for the key determinants of the ownership decision according to the PRT, we include the log of firm-level capital intensity K/L, log TFP, and the interaction of both variables (as in Sections 4 and 5). The choice of additional covariates follows similar applications in the literature (in particular, Wang and Wang, 2015, for China): We include output, employment, the average wage per employee (all in logs), the firm's age, its export share (exports over total sales), and the equity share owned by the state or collectives (*SOE share*). We further include the pre-treatment trend in log TFP (the change between 2000 and 2001) to account for the fact that foreign investors tend to acquire firms after they experienced a negative productivity shock (Blonigen et al., 2014). Finally, the logit model includes 2-digit industry fixed effects to account for differences in the attractiveness of different industries for FDI. In Section 6.7, we show that our results are robust to variations in this choice of covariates.

Matching and reweighting methods based on the propensity score go back to Rosenbaum and Rubin (1983) and DiNardo et al. (1996) and are well-established in the literature estimating treatment effects in non-experimental settings. Recent applications in the FDI literature include Arnold and Javorcik (2009), Guadalupe et al. (2012), and Wang and Wang (2015). Our approach, which combines the DiD regression with propensity score reweighting, features three advantages over alternative available methods. First, the estimator allows us to control for the contemporaneous changes in tariffs $\mathbf{T}_{jt}$, which might also affect performance, in the multivariate regression framework. Second, it has been shown by Busso, DiNardo and McCrary (2014) that reweighting is typically superior to matching when the overlap in terms of observable covariates between treatment and control groups is good, as in our application. Third, a very attractive feature of the combined approach is its double robustness property, which means that it can deliver consistent estimates as long as either the regression model or the propensity score model is correctly specified (Imbens, 2004).

6.3 Main estimation results

Table 3 presents the main results of our empirical analysis: The reoptimization of ownership shares after China's FDI liberalization caused large and significant increases in the capital-labor ratio and output of the acquired firms. The table shows estimates of β in the DiD model of equation (16) for the different dependent variables indicated in the header. The four rows implement alternative definitions of treatment based on the four different acquisition thresholds ($>0\%$, $\geq 25\%$, $\geq 50\%$, and 100%), so each estimate reported in the table derives from a separate regression. As described in Section 6.1, the estimates compare the performance change of foreign-acquired firms between 2001 and 2003 to our preferred control group of firms that were already foreign-owned in 2001 (and remained so in 2003) within the liberalized industries. Depending on the definition of treatment, there are between 123 and 174 firms in the treatment group. To account for initial observable differences that may affect treatment, the control group observations have been reweighted by the estimated propensity score $\hat{p}$, as described in Section 6.2; the estimates of $\hat{p}$ and covariate balancing tests are discussed below.

We first discuss the effects of foreign acquisitions on input ratios, summarized in columns 1 and 2 of Table 3. As predicted by Proposition 3, the capital-labor ratio K/L increases after foreign acquisitions (column 1). Since this effect is estimated relative to a reweighted control group of comparable, foreign-owned firms, it can be interpreted as the consequence of optimal ownership restructuring after the FDI liberalization. Intuitively, integration increases the firm's capital-labor ratio because the foreign investor's incentives to contribute to the firm's capital stock increase, whereas the Chinese firm's incentives to optimally hire labor diminish. In line with this argument, the increase in K/L is highest for the high acquisition thresholds of 50% and 100%. These effects are statistically significant at the 5% confidence level and they are large in economic terms. The estimated coefficient implies an increase of 27% in K/L for wholly foreign-acquired firms.[41] Note that the effects are smaller and insignificant when we define treatment by the foreign ownership threshold of 25%, which constitutes the legal threshold for receiving official FIE status under Chinese law. This finding might be explained by the fact that this threshold was never legally binding, whereas the other thresholds reflect explicit ownership restrictions that were initially in place for a subset of the liberalized industries. Furthermore, firms with official FIE status receive preferential tax treatment, so firms crossing the 25% threshold might do so for tax reasons rather than considerations about incomplete contracts. The increase in the input ratio is confirmed and the estimated magnitudes are even larger when we measure labor input by the real wage bill (K/wl, column 2).

Columns 3 to 5 provide direct evidence concerning the effects of ownership restructuring on the inputs in line with our PRT model. The estimated positive effect on K/L and K/wL is driven first and foremost by a substantial increase in the real capital stock for foreign-acquired firms, irrespective of how we define the acquisition threshold (column 3). At the same time, the evidence on employment is mixed (column 4). Labor input increased only for firms crossing the low ownership thresholds, but not for those acquired by at least 50% by foreign investors. This ambiguous effect can be rationalized by the countervailing effects discussed in Section 2.3: the negative incentive effect reduces labor provision by the Chinese firm, while the positive size effect increases L. However, the head count of employees L might not adequately measure the

[41] This number is computed as $[\exp(0.239) - 1] \times 100\%$ from the estimate in column 1 of Table 3.

Table 3: Effects of optimal ownership restructuring on firm performance: 2001 vs. 2003

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	K/L	K/wL	K	L	w	Y	N (1-3)/(4-6)
T0 × *after*	0.138**	0.153*	0.268***	0.130**	-0.0149	0.294***	3,512/3,518
	(0.0648)	(0.0827)	(0.0636)	(0.0585)	(0.0621)	(0.0639)	
T25 × *after*	0.0336	0.0742	0.214***	0.181***	-0.0405	0.254***	3,198/3,204
	(0.0635)	(0.0800)	(0.0585)	(0.0577)	(0.0616)	(0.0619)	
T50 × *after*	0.187**	0.296***	0.248***	0.0615	-0.109	0.146*	2,266/2,270
	(0.0742)	(0.103)	(0.0655)	(0.0627)	(0.0812)	(0.0805)	
T100 × *after*	0.239***	0.318***	0.209***	-0.0485	-0.0821	-0.0810	1,416/1,420
	(0.0715)	(0.100)	(0.0642)	(0.0573)	(0.0771)	(0.0796)	

Note: The table reports estimates of β in equation (16) for the years 2001 and 2003, with the dependent variables indicated in the header (all in logs). Each coefficient estimate in the table derives from a separate regression, which controls for weighted input and output tariffs as well as firm and year fixed effects. Treated firms are defined as those increasing their foreign ownership share between 2001 and 2003 to or across different thresholds $X = \{0, 25, 50, 100\}$ in the liberalized industries (where FDI was prohibited or restricted before 2002, but not after). The control group consists of firms that are foreign-owned (by the same thresholds as the treated firms) in both years within the liberalized industries, and they are reweighted by the estimated propensity score as described in Section 6.2. The last column lists the number of observations N for columns 1-3 and 4-6 in each row. Standard errors clustered by firm are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

aggravated underinvestment into labor. Instead of reducing the number of workers, the firm might reduce its effort into hiring and training of workers, as these activities are much more difficult to enforce in a contract. Such underinvestment might be visible in the wage per employee as a proxy for the average quality of the workforce. In line with this argument, we find that the wage weakly decreased in the acquired firms relative to the control group, though these effects are insignificant (column 5). Overall, our findings provide support for our PRT model, which predicts that the foreign multinational's investment incentives into relationship-specific capital should increase, while the Chinese firm's incentives for labor provision may deteriorate after an increase in foreign ownership towards the optimum. As a result of these shifts in input provision, the capital-labor ratio increased.

Note that our results highlight an important identification challenge in testing the PRT. A popular approach in the international economics literature has used the capital-labor ratio as a proxy for the headquarter intensity parameter η from the PRT in order to explain the relative prevalence of vertical integration (or intra-firm trade). However, K/L is endogenous to the ownership decision, as we have demonstrated theoretically in Section 2.2 and empirically in this section: Deeper integration increases K/L because it tilts the investment incentives towards the foreign owner, which typically contributes to the firm's capital stock but is less involved in hiring labor. Regressing measures of integration on the firm-specific capital-labor ratio in an attempt to test the PRT hence suffers from a reverse causality issue that follows from the same theoretical framework.[42]

We quantify the performance gains from optimal ownership restructuring in terms of real output Y in

[42]To ameliorate this concern, we have hence used industry-level and lagged firm-level measures of capital intensity as proxies for η when exploring correlations in Section 4.

column 6 of Table 3. Based on our PRT model, we expect that the increase from the restricted towards the optimal ownership share after FDI liberalization leads to overall efficiency gains and raises output in the acquired firms. Indeed, we find that the optimal allocation of ownership rights can have large positive effects on firm performance. Firms increasing their foreign ownership share across the thresholds of 0%, 25%, or 50% between 2001 and 2003 experienced significant output gains over this period, as predicted by Proposition 3. Somewhat surprisingly, there is no evidence for short-term output gains by 2003 for firms that are fully acquired, an observation that we will return to below. Note that the effects identified for the lower acquisition thresholds are economically sizeable. The move to optimal ownership allowed these firms to increase their production by 16-34% relative to the highly comparable, reweighted control group. These findings show that the optimal choice of ownership matters substantially for firm performance.

Two considerations might rationalize why the effects on firm output are insignificant for firms that moved to 100% foreign ownership. First, it is conceivable that some foreign investors choose too high ownership shares immediately after liberalization, for instance due to information frictions. Within our PRT framework, one would expect that the resulting reduction in investment incentives of the Chinese firm (in line with the estimated effects on L and w) tends to depress output, in particular for higher ownership shares. However, the model predicts that for a move to the optimal ownership share, the increased incentives by the foreign owner should typically outweigh these negative effects and lead to a net increase in production. Hence, the fact that the output effect is non-positive for the 100% threshold might indicate that some of the foreign investors have chosen excessively high ownership shares, thereby exacerbating the production inefficiency. In line with this conjecture, the average foreign ownership share of these firms drops from 100% to 73% in 2004 and remains stable at this level over the subsequent years (among the firms that continue to be observed). This pattern might reflect a correction of the initial ownership decision. Indeed, if we restrict the treatment group for $T100$ to firms that remain wholly foreign owned over the subsequent two years, we find a positive estimate corresponding to output gains of 9.2%, which remains insignificant however. Second, beyond our static model, there may exist short-term adjustment costs from organizational restructuring and adjustment processes within the firm, which delay some of the efficiency gains. This issue may be particularly pronounced in wholly acquired firms, where the ownership change is most radical and hence the adjustment costs are largest. We provide some evidence supporting this idea when considering medium-term effects in Section 6.4.

How well does the propensity score reweighting estimator account for initial differences across firms in the treatment and control groups? The estimates of the logit models used to obtain the propensity scores are summarized in Table B.1 (columns 1-4) in Appendix B. They show that most of the selected covariates are individually significant in several logit regressions, suggesting that the treatment and control groups differ significantly in terms of these pre-treatment characteristics. They jointly explain a relevant part of the acquisition probability, reflected in pseudo R^2 values in the range of 0.082-0.156. Note that, consistent with the PRT, the treated firms are initially less capital intensive than the already foreign-owned firms, which form the control group. These initial observable differences are successfully accounted for by the propensity score reweighting approach. To illustrate this, the second half of Table B.1 (columns 5-8) shows the same logit regressions reweighted by the estimated propensity score. It reveals that none of the covariates remains

individually significant in these weighted regressions. The approach is also successful in finding a similar firm from the control group for each firm in the treatment group. There are very few exceptions of treated firms whose covariates lie off the common support and which have therefore been excluded from the main analysis (one to five firms, depending on the definition of treatment). The pseudo R^2 drops below 0.01 in the reweighted logit regressions, indicating that the initial characteristics have no explanatory power for the treatment after reweighting.

The success of the propensity score reweighting approach is also confirmed by the standard covariate balancing tests, which compare sample averages of the pre-treatment characteristics before and after reweighting (not reported). For all treatment definitions and all but one of the covariates, t-tests cannot reject the null hypothesis of zero differences in the reweighted sample means at any conventional significance level. The sole exception is the *SOE share*, which differs substantially across the two groups by construction, since we have imposed a minimum requirement on the initial foreign ownership share in the control group. This difference cannot be fully eliminated by reweighting, but it is no longer significant conditional on the other covariates, as shown in Table B.1. Most importantly, initial differences in the main performance variables of interest are substantially reduced: The remaining absolute bias ranges between 1.1% and 6.4% for the initial capital-labor ratio, it is never greater than 10.4% for output, and generally insignificant for all outcome variables considered.

6.4 Medium-term effects

In the previous section, we have concentrated on the immediate impact of ownership restructuring in the first year after the FDI liberalization. However, this restructuring process may be costly in the short term, and the subsequent efficiency gains within the firm may take some years to materialize. For these reasons, the short-term effects estimated above might underestimate the gains from the optimal allocation of ownership. To investigate the medium-term effects, we apply the DiD model to performance gains between 2001 and the subsequent years 2004-2007 (for which firm data are available).

In each estimation, we continue to focus on one pre-treatment year (2001) and one post-treatment year (each of the years 2004-2007) to allow for valid inference (see Bertrand et al., 2004). The DiD model is specified as in equation (16), with the $after_t$ dummy equal to one in the post-treatment year, and the treatment dummies TX_i defined by firms increasing their foreign ownership across the different thresholds between the two years. This approach allows for both ownership restructuring and firm performance to respond with some delay to the liberalization. Also, we continue to combine the DiD model with the propensity score reweighting approach to account for initial differences across firms that might affect selection into treatment.

We first examine the medium-term impact on various performance variables before studying the full evolution of the output effects over time. Table 4 summarizes the effects on inputs and output over the five-year period between 2001 and 2006. We find that the estimated effects on the input ratios K/L and K/wL are positive also over the medium term in almost all estimations, but they are much smaller than over the short term and typically insignificant (columns 1-2). Instead, we find statistically significant and economically large positive effects on the quantities of both inputs K and L in the foreign-acquired firms defined by the thresholds of 0%, 25%, and 50% (columns 3-4). The medium-term effect on wages is

Table 4: Medium-term effects of optimal ownership restructuring: 2001 vs. 2006

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	K/L	K/wL	K	L	w	Y	N (1-3)/(4-6)
T0 × *after*	0.110	0.130	0.424***	0.302***	-0.0226	0.511***	2,536/2,550
	(0.0841)	(0.0872)	(0.0920)	(0.0698)	(0.0784)	(0.104)	
T25 × *after*	-0.0231	0.161*	0.288***	0.300***	-0.184**	0.410***	2,344/2,360
	(0.106)	(0.0932)	(0.106)	(0.0735)	(0.0916)	(0.0991)	
T50 × *after*	0.113	0.131	0.429***	0.315***	-0.0179	0.355***	1,726/1,734
	(0.0945)	(0.111)	(0.103)	(0.0841)	(0.0656)	(0.121)	
T100 × *after*	0.0836	0.137	0.0492	-0.0428	-0.0571	0.158	1,112/1,120
	(0.0901)	(0.103)	(0.0843)	(0.0757)	(0.0673)	(0.111)	

Note: The table reports estimates of β in equation (16) for the years 2001 and 2006, with the dependent variables indicated in the header (all in logs). The definitions of the treatment and control groups, the control variables, and the reweighting approach are analogous to the main estimations (see the note to Table 3). The dummy variable $after_t$ is redefined to equal zero in 2001 and one in 2006. Standard errors clustered by firm are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

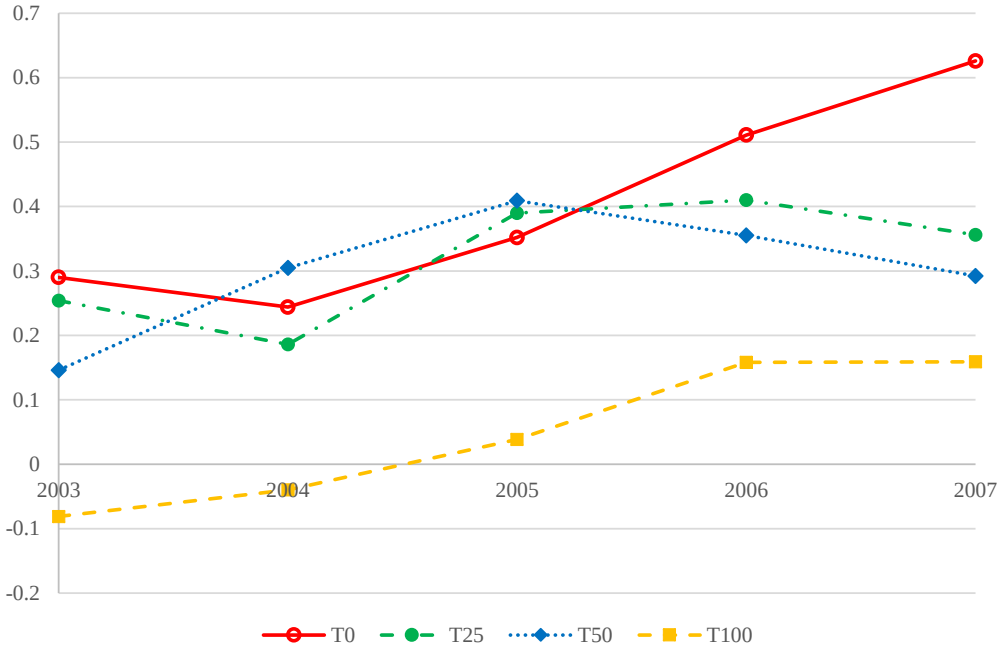
negative, as over the short term, but it remains mostly insignificant (column 5). The medium-term effects on input ratios, quantities, and wages suggest that the positive short-term effect on the factor ratio between 2001 and 2003 identified above is not due to a lasting change in the firm's technology towards more capital intensive production. Instead, the results are in line with the logic of our PRT model: Optimal ownership restructuring triggers immediate adjustments in the investment incentives of both the local firm and the foreign investor, which lead to efficiency gains, an increase in output, and hence more use of both K and L over the medium term. The weakly negative wage effects corroborate our expectation that the quality of labor input provision by the Chinese firms tends to deteriorate after acquisitions. Most importantly, the output gains increase substantially over the medium term (column 6).

Figure 5(a) focuses on the effect of ownership on output, our main performance variable of interest, and illustrates the annual evolution of the estimated output gains over time. Note that each of the point estimates of β in the figure is based on a separate DiD estimation. The output gains show an increasing tendency over time, which is most clearly visible for the highest and the lowest acquisition thresholds. The increase over time is substantial. The average output gains by 2007 are twice as large as the short-term effect in 2003 for acquisitions defined by the 0% and 50% thresholds. Over the medium term of 4-6 years, the point estimate for the output effect is also positive for firms reaching the 100% threshold, though it remains statistically insignificant throughout. For all other acquisition thresholds, the output gains are significantly positive in each of the years 2004-2007. These findings confirm our conjecture that the output gains from ownership reallocation over the medium-term exceed the initial effect identified in the main analysis. The figure further suggests that optimal ownership restructuring might even have favorable dynamic effects on output growth rather than just a one-time level effect.

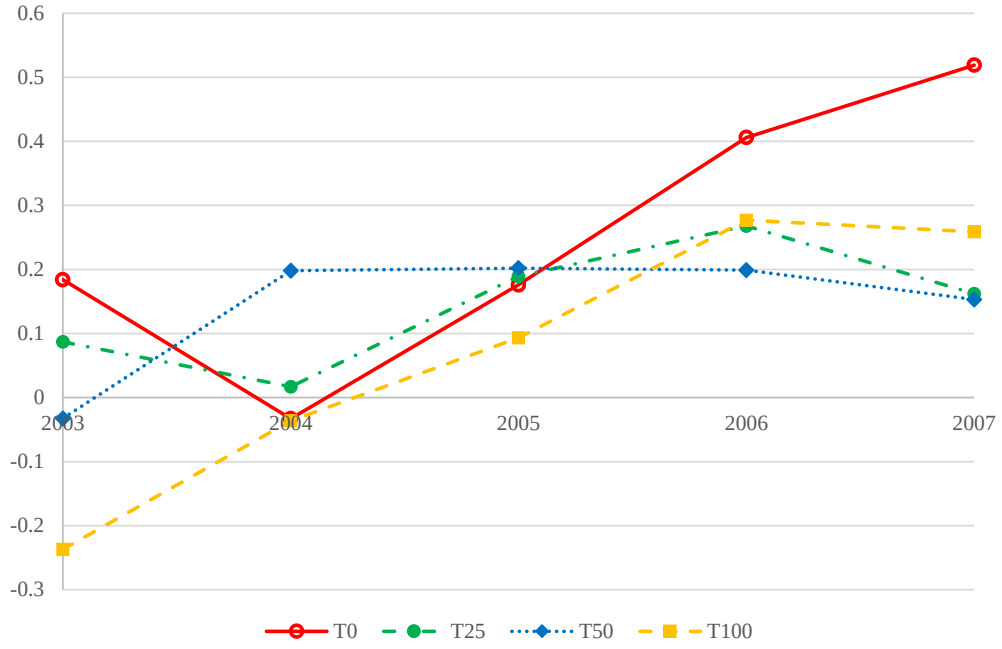
The analysis so far has focused on output as our preferred measure of firm performance. As discussed in Section 2.3, this choice has the two key advantages that our PRT model delivers a clear prediction for

Figure 5: Effects of optimal ownership restructuring over time

(a) Output



(b) Productivity



Note: The figure illustrates estimates of β in equation (16) for the pre-treatment year 2001 and alternative post-treatment years 2003-2007, with log output as the dependent variable in Figure 5 and log TFP as the dependent variable in Figure 5(b). The definitions of the treatment group (indicated by the alternative dummy variables $TX_i, X = \{0, 25, 50, 100\}$), the control group, the control variables, and the reweighting approach are analogous to the main estimations (see the note to Table 3). The dummy variable $after_t$ is redefined to equal zero in 2001 and one in the respective post-treatment year.

the output effect and this measure is easily obtained from the data. An alternative performance measure typically considered in the literature is TFP. Should the optimal ownership restructuring after liberalization also increase firm productivity? The answer to this question depends on the definition of TFP. Note that in our model, TFP is defined as a technology parameter determined in a stochastic innovation process at the entry stage, which is exogenous to subsequent firm decisions and does therefore *not* react to ownership changes. Instead, the efficiency gains in the model materialize purely through reoptimized input choices, conditional on TFP as we have defined it so far. Alternatively, one may adapt a broader definition of TFP encompassing also other features of the production process that allow firms to produce more output using the same quantity of inputs. Such features may include, for instance, the suitability or in-time delivery of inputs. If the decisions on these features are costly, relationship-specific, and non-contractible, they may be subject to underinvestment and hence endogenous to ownership. However, the predicted effect of ownership changes then depends on which party makes these non-contractible decisions. In the next step, we consider the possibility that our empirical measure of TFP reflects also these features of the production process, and we examine the effects of optimal ownership restructuring on TFP. Since these possible adjustments to the production process are likely to take time, we examine the evolution of productivity effects over several years.

Figure 5(b) illustrates that there are productivity gains from optimal ownership restructuring, which materialize after 4-6 years. The effects on TFP are estimated year by year in analogy to the output effects in Figure 5(a). Over the short term of 2-3 years, the effects on TFP are small and vary around zero for the four alternative definitions of treatment. However, the point estimates tend to increase over time, as in the case of output, and they are all positive 4-6 years after the liberalization. These productivity gains are significant at the 5% level in 2006 for all treatment definitions except for the majority threshold ($T50$), and they reach up to 68% in 2007. We obtain similar results when using labor productivity as an alternative dependent variable (not reported). Within our model, these findings can be interpreted as efficiency gains from optimal ownership that improve the production process beyond the reoptimized choice of input quantities. It seems plausible that these additional gains take some years to materialize.

6.5 Alternative control groups

Our baseline choice of the control group, consisting of foreign-owned firms in the liberalized industries, has a number of advantageous features discussed above, but it is only one of several possible choices. This section demonstrates that our main insights are remarkably robust to alternative choices of the control group. These variations further allow us to address possible challenges to identification, relate our findings to the existing literature, and strengthen our main conclusions. To this end, we return to the main DiD analysis for 2001 vs. 2003 and consider as alternative control groups: (i) foreign-owned firms in unregulated industries, (ii) major exporters within liberalized industries, (iii) domestic-acquired firms within liberalized industries, and (iv) foreign-acquired firms in unregulated industries. The fourth exercise constitutes our most stringent and important robustness check.

To consistently estimate the average treatment effect of foreign acquisitions on the treated, firms in the control group should not be affected by the treatment. This requirement is sometimes referred to as the stable

unit treatment value assumption (SUTVA). The SUTVA may be challenged by the existence of spillovers from FDI to other domestic firms. As argued by Lu et al. (2017), domestic firms in China may be indirectly affected by the inflow of foreign capital, e.g. through increased competition in the domestic output market. Note that for our main analysis this concern is ameliorated by the fact that only a small number of firms are acquired between 2001 and 2003, and they produce different products than the control group firms, which were already foreign-owned before the liberalization. Furthermore, the firms in this preferred control group export on average 46-57% of their sales (depending on the applied ownership threshold), so they compete mostly on world markets rather than in the domestic market, which limits the scope for spillovers through competition.

To address remaining concerns related to spillovers, we conduct a cross-industry comparison by choosing firms that are foreign-owned in both years in unregulated industries (that were not regulated by the FDI Catalogue, neither in 2001 nor in 2003) as an alternative control group. These firms certainly produce different products and are hence very unlikely to compete directly with the treated firms. The approach allows us to relax the standard assumption by assuming that the SUTVA holds across industry clusters, but not necessarily within clusters (similar to Girma, Gong, Görg and Lancheros, 2015). In our cross-industry specifications, we modify the logit model for estimating the propensity score used in reweighting to account for the possibility that the Chinese government selected the liberalized industries. Following the considerations in Lu et al. (2017), we augment the logit model used to estimate the propensity scores by the following set of covariates specific to the 4-digit industry: the number of firms, average employment, and average wage per firm (all in logs), the average firm age, and the total exports to sales ratio.[43] From the logit model, we also omit the 2-digit industry fixed effects, which would otherwise fully explain the treatment in some cases. The estimation results reported in columns 1-2 of Table 5 confirm our main findings. The effects of foreign acquisitions on the capital-labor ratio are significantly positive and larger for treatment defined by the higher acquisition thresholds, and positive and significant output gains are identified for the low thresholds.

An alternative way of addressing concerns related to spillovers, while maintaining the focus on narrowly comparable firms within the liberalized industries, is by choosing major exporters as a control group. Since these firms are competing on world markets, spillovers through competition in the domestic product market are likely to be negligible. We define major exporters as firms that export the majority of their sales both in 2001 and 2003, and use them as the control group in DiD regressions restricted to liberalized industries. To maintain a sufficiently large pool of comparable firms in the control group, we do not maintain the additional restriction of foreign ownership, but instead keep all major exporters that are *not* foreign owned in both years. Since we have implemented a strict minimum requirement on the export share in the control group, we exclude this variable from the (otherwise unchanged) set of covariates used to estimate the propensity score, by which observations are reweighted as in the main analysis. The estimation results in columns 3-4 of Table 5 strongly confirm the positive effects of foreign acquisitions after liberalization on K/L and also (for low acquisition thresholds) on output.

[43] This selection of industry-level matching covariates is motivated by possible considerations by the Chinese government in relaxing the FDI restrictions, such as promoting exports, protecting infant industries, and avoiding adverse effects on the labor market. Note that Lu et al. (2017) adopt a broader definition of liberalized industries, which includes for instance also those industries where FDI was newly encouraged. Hence, their preferred set of covariates differs slightly from ours.

Table 5: Alternative control groups

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Control group in header:	Foreign-owned (unregulated)		Major exporters (liberalized)		Domestic-acquired (liberalized)		Foreign-acquired (unregulated)	
	K/L	Y	K/L	Y	K/L	Y	K/L	Y
T0 × after	0.127**	0.336***	0.263***	0.234**	0.156*	0.361***	0.165**	0.312***
	(0.0575)	(0.0756)	(0.0796)	(0.104)	(0.0820)	(0.0725)	(0.0700)	(0.0984)
N	21,594	21,628	808	810	1,606	1,606	1,864	1,870
T25 × *after*	0.0842*	0.283***	0.164**	0.220**	0.109	0.286***	0.0690	0.273***
	(0.0480)	(0.0735)	(0.0743)	(0.0919)	(0.0845)	(0.0707)	(0.0590)	(0.0855)
N	19,314	19,346	898	900	1,650	1,650	2,044	2,050
T50 × *after*	0.237***	0.0919	0.290***	-0.00586	0.197*	0.179**	0.189**	0.156
	(0.0567)	(0.0927)	(0.0719)	(0.0852)	(0.101)	(0.0845)	(0.0822)	(0.104)
N	14,046	14,074	954	956	1,582	1,582	1,608	1,610
T100 × *after*	0.208***	-0.0235	0.224***	-0.0181	0.268	0.109	0.139**	0.164
	(0.0578)	(0.122)	(0.0753)	(0.0854)	(0.193)	(0.0998)	(0.0678)	(0.155)
N	9,226	9,254	1,174	1,178	1,622	1,624	1,642	1,648

Note: The table reports estimates of β in equation (16) for the years 2001 and 2003, with the dependent variables indicated in the header (all in logs). The definitions of the treatment group and the control variables are analogous to the main estimations (see the note to Table 3). The control group consists of foreign-owned firms in unregulated industries (in both years) in columns 1-2, firms exporting the majority of their sales (in both years) in liberalized industries in columns 3-4, domestic-acquired firms (identified by changes in registration types as in Wang and Wang, 2015) in liberalized industries in columns 5-6, and foreign-acquired firms (by the same thresholds as the treated firms) in unregulated industries in columns 7-8. The reweighting approach in columns 1-2 and 7-8 includes industry-level covariates and excludes industry fixed effects relative to the baseline approach, which is used in columns 3-6 and described in Section 6.2. Standard errors clustered by firm are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Wang and Wang (2015) suggest that for identifying the causal effects of foreign ownership, domestic-acquired firms constitute a suitable control group for foreign-acquired firms. They argue that domestic-acquired firms undergo a similar process of ownership restructuring which might involve adjustments within the firm that are unrelated to FDI. Hence, these firms share many important features with the treatment group but not the 'foreignness' of the investor. Note that our intention in this paper is not to identify the distinguishing features of foreign compared to domestic acquisitions; by contrast, our main objective lies in quantifying the gains from an optimal allocation of ownership rights. This question does not hinge on the nationality of the investor per se; our approach merely exploits the fact that foreign investors were previously restricted and hence their ownership share is initially suboptimal and can increase to the optimal level due to FDI liberalization. In light of our predictions derived from the PRT, one might expect qualitative adjustments within domestic-acquired firms that are similar to those triggered by foreign acquisitions, as long as these domestic acquisitions constitute a reallocation of ownership rights towards the optimum. However, since policy (and other) restrictions on domestic ownership did not change between 2001 and 2003, the driving force behind contemporaneous domestic acquisitions remains opaque. By contrast, for firms acquired by foreign investors in the liberalized industries, we clearly expect that initial inefficiencies due to contractual frictions are reduced by the optimal reallocation of ownership rights. Therefore, one might expect the

performance gains induced by foreign acquisitions in these industries to exceed those caused by domestic acquisitions.

We identify domestic acquisitions in the data from changes in firms' registration types following the baseline approach taken by Wang and Wang (2015). We then compare the performance of foreign-acquired firms to domestic-acquired firms within liberalized industries in DiD regressions of equation (16), while reweighting observations by the estimated propensity score (in analogy to the main analysis). The estimation results in columns 5-6 of Table 5 reveal large positive point estimates of β for K/L as the dependent variable, but these are only weakly significant in two cases and insignificant in the other two cases. This finding is not too surprising provided that domestic acquisitions are also likely to involve ownership restructuring towards a more efficient allocation of property rights, and since it seems less clear which stakeholder is involved in the labor and capital input choices. More strikingly, we find strong evidence for positive output effects from foreign acquisitions relative to domestic acquisitions. The estimated output gains are positive throughout, even larger than in the main analysis, and significant at the 5% level for all but the highest acquisition threshold. These results suggest that foreign acquisitions of previously restricted firms are associated with output gains relative to other ownership changes, in line with our expectations based on the PRT model. However, these effects might also be partially attributable to benefits of foreign ownership per se.

As a last exercise, we compare the treated firms, which are foreign-acquired in liberalized industries, to *other foreign-acquired* firms in unregulated industries. Note that this novel approach combines two key advantages of the previous exercises and constitutes an even more ambitious identification strategy. In this setup, the treatment and control group are identical both in terms of the foreignness of the investor and the dynamic adjustment processes that might be triggered by any ownership changes. Since we further account for initial observable differences across firms and industries by the propensity score reweighting approach (implemented as described for the cross-industry specifications in columns 1-2), the only salient difference between the treatment and control group firms in this setup is whether FDI was liberalized in their industry or not. Should we expect to find any performance differences between these two groups of firms? Potentially yes, because the efficiency losses caused by the misallocation of ownership rights prior to liberalization are likely to be larger in liberalized industries. Whatever motivates increased foreign ownership in the control group firms, it is unlikely to be removing a similar distortion as in the liberalized industries, since the foreign ownership share could already be chosen freely in the unregulated industries in 2001.

The results of this important robustness check strongly confirm our theoretical predictions. The estimated effects of foreign acquisitions on K/L and Y in liberalized vs. unregulated industries are summarized in columns 7-8 of Table 5. We find significantly positive effects on the capital-labor ratio of around 15-21% for all definitions of treatment except for the 25% acquisition threshold. The point estimates for output imply large output gains of 17-37%, though these are only statistically significant for the lower acquisition thresholds.[44] These estimates ensure that the observed performance effects are not due to the foreignness

[44] An alternative approach to identifying this effect exploits a triple difference specification, i.e., a variant of equation (16) that includes a triple interaction term $\textit{foreign-acquired}_i \times \textit{liberalized}_j \times \textit{after}_t$ (along with the self-explanatory indicator variables and all two-way interactions as covariates) in the sample of all firms in liberalized and unregulated industries. To account for both selection by investors (within and across industries) and selection by the government (across industries), the observations are reweighted by a propensity score estimated from a logit regression of the triple interaction term on the same pre-treatment industry and firm covariates as before. Such triple difference estimations (not reported) lead to very similar conclusions.

of the investor or due to some dynamic adjustment that might take place in any firm changing ownership. They corroborate our hypothesis that it is indeed the optimal reallocation of ownership rights which caused the shift in input ratios and the ensuing output gains. Hence, these findings lend strong empirical support to Proposition 3 and they confirm that the efficiency gains from an optimal allocation of ownership rights are quantitatively substantial, potentially even exceeding 30% in terms of short-term output gains, as shown in the main analysis.

6.6 Discussion

Our main empirical analysis has identified and quantified the effects of a reallocation of ownership rights towards the optimum on firm performance. Guided by our theoretical model of Section 2, we have interpreted the estimated effects as consequences of a reduction in inefficiencies arising from incomplete contracts. This interpretation of our results seems warranted in light of the fact that both general patterns of foreign ownership in unregulated Chinese industries (see Section 4) as well as the changes in input ratios induced by the acquisitions (see Section 6.3) are in line with the predictions of our property-rights theory of the multinational firm. However, it should be noted that our findings are more general than this specific model setup. For instance, one may envision an alternative theory of the multinational firm based the transaction-cost approach (see e.g. Grossman and Helpman, 2003, 2004, 2005), in which ownership can entirely eliminate underinvestment problems due to contractual frictions and hence increase efficiency and firm output. However, such a model would not necessarily predict the increase in capital-labor ratios consistent with the PRT, for which we have found robust support in the data. More generally, we view our results as quantifying the performance gains from optimal ownership reallocation.

Can alternative mechanisms, unrelated to optimal ownership restructuring explain our findings? One might conjecture that the performance effects of foreign acquisitions identified above derive in part from other benefits of foreign ownership, such as technology transfers, improved financial conditions, or foreign market access. If the foreign investor simply transfers a better and more capital-intensive technology to the Chinese firm, this might explain the increase in output and the capital-labor ratio. Such transfers of intangibles play a prominent role in several analyses of firm boundaries (see Atalay, Hortaçsu and Syverson, 2014; Bolatto, Naghavi, Ottaviano and Kejzar, 2017; Kukharskyy, 2018; Merlevede and Theodorakopoulos, 2018). Also, the literature has shown that MNEs improve the financial conditions in acquired firms, e.g. by providing access to internal capital markets (see Alfaro and Chen, 2012; Desai, Foley and Hines, 2004; Manova, Wei and Zhang, 2015). Guadalupe et al. (2012) further argue that access to foreign markets via the parent company can foster innovation activities within foreign-acquired firms. We have three reasons to believe that the performance effects identified in this paper cannot be explained by these mechanisms alone and are indeed caused by optimal ownership restructuring.

First, our evidence from foreign-acquired firms in China is in line with the view that foreign investors contribute to the capital stock of their subsidiaries – either through direct provision of capital goods or (co-)financing of investments. However, we view the provision of finance not as an alternative explanation, but as a direct consequence of the shift in investment incentives predicted by the PRT. Note that in principle, in the absence of contractual imperfections, the foreign firm should have similar incentives to provide credit

to its Chinese supplier whether or not it acquires any shares in the supplier. Our PRT model provides an explicit rationale for why the foreign investor's incentives to provide relationship-specific investments into the supplier's capital stock improve after an increase in the foreign ownership share. Therefore, we view the provision of capital as one of the channels through which the optimal reallocation of ownership rights can boost firm output, as predicted by our theoretical model.

Second, we find no evidence in our data that foreign acquisitions increased access to export markets, and thereby induced innovative activity in Chinese firms. We test directly for this mechanism by using exports (in logs or normalized by sales) and the share of revenue in new products (in levels or logs, as a measure of product innovation) as alternative dependent variables in the DiD model of equation (16). If market access through foreign ownership and innovation were important for the performance gains, we would expect to find positive effects in these regressions. However, in these estimations (which are not reported to save space), we do not find any significant positive effects of foreign acquisitions on exports or product innovation. Therefore, export market access through foreign acquisitions, which Guadalupe et al. (2012) have found to be important for Spanish firms, cannot explain the firm-level output gains that we have identified in this paper.

Third, and most importantly, we have found similar effects on K/L and Y as in our main analysis even when comparing the treated firms to other foreign-acquired firms in unregulated industries (see columns 7-8 of Table 5). If benefits related to the foreignness of the investor were responsible for the observed capital and output gains, we should not find any significant performance differences across foreign-acquired firms in liberalized and other industries.[45] The reason is that better technology, finance, or market access through foreign ownership should similarly benefit firms irrespective of previous ownership restrictions. The fact that foreign-acquired firms in liberalized industries improved their performance significantly compared to other, contemporaneously foreign-acquired firms cannot be explained by these alternative mechanisms. These findings constitute strong evidence that the performance gains found in this paper are indeed caused by the organizational restructuring from a previously inefficient allocation of property rights (under the policy restrictions) towards optimal ownership.

6.7 Robustness checks concerning propensity scores

Table B.2 in Appendix B demonstrates that our main result are robust to varying the set of covariates in the logit model used to estimate the propensity score. The table reports estimates of the main DiD model for 2001 and 2003 with the baseline configuration of treatment and control groups, while varying the reweighting approach across different columns. Since Manova et al. (2015) argue that foreign investors tend to acquire more financially vulnerable firms, we account for this potential dimension of selection by including the following measures for the firm's initial financial conditions in the logit model in columns 1-2 (following Wang and Wang, 2015): the liquidity ratio $((\textit{current assets} - \textit{current liabilities})/\textit{total assets})$ and the leverage ratio $(\textit{total liabilities}/\textit{total assets})$. To account for observable differences that may describe the

[45] Note that observations in these cross-industry regressions have also been reweighted to account for initial differences in covariates, which include the firm's size, capital intensity, and industry characteristics. Hence, the effects cannot be attributed to higher initial financial vulnerability of the firms in liberalized industries.

varying attractiveness of different liberalized industries for FDI, we include in columns 3-4 the same 4-digit industry-level covariates as in the cross-industry analysis of Section 6.5. Since the evolution of performance variables other than TFP may signal an attractive target for foreign investors, we add pre-treatment trends in the main performance variables Y and K/L (defined as changes between 2000 and 2001 in logs) in columns 5-6. Finally, we account for varying regional attractiveness for FDI through province fixed effects in columns 7-8. In all of the resulting regressions, we find the baseline results to be qualitatively unchanged and also the magnitudes of the estimated effects on K/L and Y are in the same ballpark as in the main analysis.

7 Conclusions

In this paper, we have provided a first quantification of the gains in firm performance that can be achieved by the optimal allocation of ownership rights within multinational firms. We have exploited a unique liberalization of China's policy restrictions on foreign ownership to show that a move to optimal ownership can immediately boost firm output by up to 34% and induces even larger performance gains over the medium term of five years. By comparing foreign-acquired firms to foreign-owned firms (within liberalized industries) and even to other foreign-acquired firms (in unregulated industries), and applying a propensity-score reweighting approach, we have ensured that our results are not driven by selection or other benefits of foreign ownership. We have also demonstrated that foreign ownership patterns in China in general, and the changes in input ratios and output induced by the liberalization in particular, can be rationalized by a property-rights theory of the multinational firm featuring partial ownership.

Our contribution fills an important gap in the literature on firm organization. A large body of research has sought to explain the extent of firm boundaries by the fact that firms optimally allocate ownership rights in order to minimize the inefficiencies arising from incomplete contracts. What has been entirely missing from this literature is a sense of the magnitudes of these inefficiencies and the potential gains from optimal ownership. We provide direct evidence on optimal ownership restructuring and a first quantification of the associated performance gains. These findings demonstrate that the optimal decision on firm boundaries matters substantially for firm performance in practice. The size of these gains underlines the importance of research geared towards understanding firms' organizational decisions.

What are the policy implications of our findings? Should developing countries continue to liberalize foreign ownership restrictions (which remain widespread, see OECD, 2016)? Our analysis of the firms that received FDI after the liberalization suggests a positive evaluation of China's FDI reform in 2002. Abolishing restrictions on FDI and other policies that prevent the optimal allocation of ownership rights may hence lead to substantial efficiency and output gains in the affected firms. However, in order to obtain explicit policy recommendations, a comprehensive assessment of the aggregate implications is needed. The positive effects of the policy reform may well be magnified through the entry and exit of firms and reallocation of resources across firms, though there might also be short-term adjustment costs. Quantifying these aggregate effects of allowing for optimal ownership is an important task for future research.

Our quantification exercise can be seen in a broader context of the literature aiming to explain the

large differences in aggregate productivity between developing countries, such as China, and the US. Hsieh and Klenow (2009) provide evidence that a large part of these differences are due to the misallocation of resources across firms. However, misallocation may be driven by a variety of frictions in output or factor markets, information flows, or contractual relationships, and the relative contribution of these frictions remains an open question. Our findings indicate that the inefficiencies caused by contractual frictions and the misallocation of ownership rights might play an important role in explaining the large cross-country productivity gaps.

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A Theory Appendix

A.1 Derivation of optimal ownership share and proof of Proposition 1

Taking the partial derivative of $\Psi(\cdot)$ in equation (11) with respect to β_F and simplifying yields:

$$\frac{\partial \Psi(\beta_F)}{\partial \beta_F} \times \left[\frac{\alpha}{1-\alpha} \left(\frac{\eta}{\beta_F} - \frac{1-\eta}{1-\beta_F} \right) \Big(1 - \alpha\eta\beta_F - \alpha(1-\eta)\left[1-\beta_F\right] \Big) + \Big(\alpha - 2\alpha\eta \Big) \right] = 0.$$

The first two factors are non-negative for any $\beta_F \in (0,1)$ and $w, r > 0$, so we can concentrate on the term in large brackets, which can be simplified to obtain:

$$(2\eta - 1)\,\beta_F^2 + 2\eta\,(\alpha - \alpha\eta - 1)\,\beta_F - \eta\,(\alpha - \alpha\eta - 1)\,.$$

Setting this term equal to zero and solving the quadratic form delivers the optimal revenue share β_F^* given in equation (13). Finally, s^* in equation (12) is obtained by rearranging equation (4).

The optimal revenue share β_F^* increases weakly in the headquarter intensity η, as

$$\frac{\partial \beta_F^*}{\partial \eta} = \frac{\left[2\alpha\eta(1-\eta) - 1 + 2\sqrt{\eta(1-\eta)(1-\alpha\eta)(\alpha\eta+1-\alpha)} \right] \left[2\alpha\eta(\eta-1) - (1-\alpha) \right]}{2(2\eta-1)^2 \sqrt{\eta(1-\eta)(1-\alpha\eta)(\alpha\eta+1-\alpha)}}$$

is non-negative. This can be seen by noting that for α approaching 1 and $\eta = 0.5$ each of the two terms in square brackets approaches its supremum, which is negative in both cases (and this expression as well as β_F^* are not defined). Hence, both terms are negative for all other admissible parameter values, the denominator is always non-negative, and therefore the entire expression is non-negative. It follows from the strictly monotonic relationship between s^* and β_F^* described in equation (12) that an increase in η, raising β_F^*, implies a higher optimal ownership share s^*. This completes the proof of Proposition 1.

A.2 Proof of Proposition 3

In Section 2.2, we have derived the optimal input choices conditional on the chosen organizational form s, which result in the capital-labor ratio in equation (8). We have further shown in Proposition 2 that abolishing foreign ownership restrictions induces optimal ownership restructuring in previously constrained firm pairs, which increase their ownership share s and hence β_F. Since any increase in β_F raises the capital-labor ratio in equation (8):

$$\frac{\partial \left(K_j^*(i)/L_j^*(i) \right)}{\partial \beta_F(s)} = \frac{\eta}{1-\eta} \frac{w}{r} \frac{1}{[1-\beta_F(s)]^2} > 0,$$

so does the optimal ownership restructuring. This proves part (i) of Proposition 3.

Taking the partial derivative of the second-best output level $x_j^*(i)$ from equation (9) with respect to

$\beta_F(s)$ yields:

$$\frac{\partial x_j^*(i)}{\partial \beta_F(s)} = x_j^*(i)\left[\frac{\eta}{1-\alpha}\beta_F(s)^{-1} - \frac{1-\eta}{1-\alpha}\left[1-\beta_F(s)\right]^{-1}\right],$$

which is positive iff

$$\frac{\eta}{\beta_F(s)} > \frac{1-\eta}{1-\beta_F(s)} \iff \eta - \eta\beta_F(s) > \beta_F(s) - \eta\beta_F(s) \iff \eta > \beta_F(s).$$

Hence, an increase in $\beta_F(s)$ (due to an increase from $\bar{s}$ to s^*) raises output towards the second-best level if $\eta > \beta_F(s)$. This condition holds for any $\eta > 0.5$, as can easily be verified using equation (13) and seen in Figure 1(a). This proves part (ii) of Proposition 3.

To examine input quantities, we continue to focus on the effect of an increase in $\beta_F(s)$ implied by an increase in s towards the optimal level s^*. Taking the partial derivative of $K_j^*(i)$ from equation (7) with respect to $\beta_F(s)$ yields:

$$\frac{\partial K_j^*(i)}{\partial \beta_F(s)} = \Theta(i)\eta A_j^{\frac{1}{1-\alpha}}\alpha^{\frac{1}{1-\alpha}}\left(\beta_F(s)r^{-1}\right)^{\frac{1-\alpha+\alpha\eta}{1-\alpha}}\left(\left[1-\beta_F(s)\right]w^{-1}\right)^{\frac{\alpha(1-\eta)}{1-\alpha}}\frac{1-\beta_F(s)-\alpha(1-\eta)}{(1-\alpha)\beta_F(s)(1-\beta_F(s))}$$

The sign of this derivative is the same as the sign of the fraction. This expression is always positive evaluated at the optimal β_F^* from equation (13), so the impact of optimal ownership restructuring on capital is clearly positive.

Taking the partial derivative of $L_j^*(i)$ from equation (6) with respect to $\beta_F(s)$ yields:

$$\frac{\partial L_j^*(i)}{\partial \beta_F(s)} = \Theta(i)(1-\eta)A_j^{\frac{1}{1-\alpha}}\alpha^{\frac{1}{1-\alpha}}\left(\beta_F(s)r^{-1}\right)^{\frac{\alpha\eta}{1-\alpha}}\left(\left[1-\beta_F(s)\right]w^{-1}\right)^{\frac{1-\alpha\eta}{1-\alpha}}\frac{\alpha\eta-\beta_F(s)}{(1-\alpha)\beta_F(s)(1-\beta_F(s))}$$

The sign of this derivative is the same as the sign of the fraction. This expression is always negative evaluated at the optimal β_F^* from equation (13). Hence, a marginal increase in s towards the optimum s^* discourages labor investments. However, this effect may be overcompensated (for high values of η and α) by increased labor demand through the output increase caused by optimal ownership restructuring (see part (ii) of Proposition 3).

To see how the net effect on employment can be positive, consider the following numerical example, where we specify $\delta(s) = s$ for simplicity and set $A = w = r = 1$, $\beta = 0.5$, $\alpha = 0.9$, and $\eta = 0.95$. Suppose the initial policy is $\bar{s} = 0.5$, which implies $\beta_F(\bar{s}) = 0.77$. Abolishing this policy restriction entails an increase in the ownership share and hence an increase in the revenue share to the optimal value $\beta_F^* = 0.91$. With this parametrization, both the marginal employment effect $\partial L_j(i)/\partial\beta_F(s)$ evaluated at $\bar{s}$ as well as the total change in employment from $L_j(i)|_{\bar{s}}$ to $L_j^*(i)$ is positive.

B Additional Tables and Figures

Table B.1: Logit estimations of the propensity score and reweighted results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Logit regressions				Reweighted logit regressions			
	T0	T25	T50	T100	T0	T25	T50	T100
ln TFP	0.289	0.166	-0.710**	-0.222	-0.0129	-0.0326	-0.00237	0.125
	(0.330)	(0.303)	(0.354)	(0.473)	(0.326)	(0.299)	(0.359)	(0.455)
ln K/L	-0.515***	-0.486***	-0.602***	-0.519***	0.0191	0.0382	0.0429	0.137
	(0.137)	(0.128)	(0.153)	(0.196)	(0.134)	(0.127)	(0.159)	(0.196)
ln TFP × ln K/L	-0.0252	-0.0244	0.0623	-0.117	0.00280	0.0171	0.0155	0.0389
	(0.0614)	(0.0557)	(0.0623)	(0.0769)	(0.0604)	(0.0543)	(0.0627)	(0.0805)
ln L	-0.379*	-0.272	-0.615***	-0.581*	0.0344	0.0653	0.0605	0.229
	(0.208)	(0.196)	(0.225)	(0.304)	(0.202)	(0.194)	(0.229)	(0.308)
ln w	-0.586***	-0.570***	-0.418*	0.0987	0.0506	0.0604	0.0369	-0.0606
	(0.188)	(0.178)	(0.214)	(0.277)	(0.190)	(0.182)	(0.215)	(0.290)
Age	0.0422***	0.0484***	0.0604***	0.0306	-0.00344	-0.00687	0.00340	-0.0278
	(0.0122)	(0.0129)	(0.0212)	(0.0335)	(0.0123)	(0.0134)	(0.0211)	(0.0428)
Exports/ sales	-0.780**	-0.560*	-1.100***	-1.323***	0.0355	0.0575	0.139	0.164
	(0.348)	(0.309)	(0.358)	(0.410)	(0.344)	(0.310)	(0.354)	(0.394)
SOE share	1.531***	1.987***	3.148***		0.122	0.157	0.106	
	(0.346)	(0.337)	(0.542)		(0.338)	(0.331)	(0.554)	
ln Y	0.196	0.157	0.543**	0.741**	-0.0300	-0.0787	-0.0511	-0.322
	(0.225)	(0.211)	(0.243)	(0.322)	(0.221)	(0.212)	(0.255)	(0.344)
Pre-trend *TFP*	-0.147	0.0365	0.0177	0.339*	0.00170	0.0341	0.0329	0.0218
	(0.137)	(0.134)	(0.146)	(0.205)	(0.136)	(0.134)	(0.144)	(0.202)
N	1,707	1,543	1,090	619	1,706	1,541	1,085	615
Pseudo R^2	0.141	0.156	0.176	0.082	0.002	0.005	0.007	0.008
Log-likelihood	-331.7	-349.4	-241.8	-163.9	-139.6	-159.2	-107.6	-68.46
χ^2	109.1	129.6	103.3	29.34	0.847	2.513	2.607	2.156

Note: The table reports coefficient estimates from logit regressions with the dependent variable indicated in the header (treatment dummies, indicating foreign acquisitions between 2001 and 2003 defined by different thresholds). Columns 1-4 report the regressions that predict the propensity score used for reweighting in the main estimations (in Table 3). Columns 1-4 report the same regressions reweighted by the estimated propensity score. All regressions include 2-digit industry fixed effects. Standard errors clustered by firm are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.

Table B.2: Robustness concerning the estimation of the propensity score

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Financial conditions		Industry covariates		Pre-trends Y and K/L		Province fixed effects	
	K/L	Y	K/L	Y	K/L	Y	K/L	Y
T0 × *after*	0.138**	0.295***	0.135**	0.280***	0.139**	0.295***	0.141**	0.294***
	(0.0650)	(0.0639)	(0.0651)	(0.0651)	(0.0648)	(0.0639)	(0.0661)	(0.0668)
N	3,512	3,518	3,512	3,518	3,512	3,518	2,924	2,928
T25 × *after*	0.0336	0.254***	0.0374	0.244***	0.0326	0.256***	0.0589	0.282***
	(0.0636)	(0.0621)	(0.0631)	(0.0624)	(0.0635)	(0.0621)	(0.0639)	(0.0653)
N	3,196	3,202	3,198	3,204	3,198	3,204	3,038	3,044
T50 × *after*	0.183**	0.150*	0.195***	0.137*	0.185**	0.148*	0.172**	0.152*
	(0.0760)	(0.0821)	(0.0746)	(0.0811)	(0.0746)	(0.0812)	(0.0770)	(0.0877)
N	2,258	2,262	2,262	2,266	2,266	2,270	2,112	2,116
T100 × *after*	0.238***	-0.0880	0.237***	-0.0953	0.244***	-0.0820	0.198***	-0.0365
	(0.0718)	(0.0800)	(0.0744)	(0.0795)	(0.0713)	(0.0794)	(0.0720)	(0.0921)
N	1,416	1,420	1,416	1,420	1,416	1,420	1,350	1,354

Note: The table reports estimates of β in equation (16) for the years 2001 and 2003, with the dependent variables indicated in the header (all in logs). The definitions of the treatment and control groups and the control variables are analogous to the main estimations (see the note to Table 3). The propensity scores used in reweighting are estimated as in the main equations (see Table B.1 for the baseline set of covariates) with the following added covariates: liquidity and leverage ratios in columns 1-2; the number of firms, employment, and wage per employee (all in logs), average firm age and the exports to sales ratio at the 4-digit industry level in columns 3-4; the pre-trends in output and the capital-labor ratio (annual differences in logs between 2000 and 2001) in columns 5-6; and province fixed effects in columns 7-8. Standard errors clustered by firm are reported in parentheses. Asterisks indicate significance levels: * p<0.10, ** p<0.05, *** p<0.01.