The effect of foreign entry regulation on downstream productivity: Microeconomic evidence from China*

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Abstract

We examine the cross-industry influence of foreign entry regulation (based on a novel measure) on the productivity outcomes of downstream firms through the input-output linkages in China. In contrast to the significant liberalization in the manufacturing sector, restrictions on the services sector remained stringent over period of 1997-2007. We find a powerful depressant effect of foreign entry barriers imposed on the upstream manufacturing and services industries on the productivity of downstream manufacturers, and the effect depends on a number of industry- and firm-specific features. Our research calls for further investment liberalization (particularly in the services sector) in China.

JEL Classification: L5; F14; D24; O12

Keywords: foreign entry barrier; competition; investment liberalization; input-output linkages

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1 Introduction

Despite some recent efforts to ease curbs on foreign investment, China has imposed tight regulations on foreign entry since 1990s. For instance, the 'Catalogue for the Guidance of Foreign Investment' (hereafter the 'Catalogue') published by China's National Development and Reform Commission is viewed as a central policy of the Chinese government, which asserts that foreign investment must be made in a manner that is consistent with China's economic policy in order to promote its economic development. Some recent media report indicates that the Chinese government is increasingly under the pressure to reduce restrictions on foreign investment in order to lessen the exposure to reciprocal investment barriers. More importantly, these regulations, by generating entry barriers and impeding competition and technological spillover among upstream industries, may have significant depressant effects on the productivity of other Chinese industries through the input-output linkages.

In contrast to the large body of empirical research on the impact of trade liberalization in China, little is known about the effects of *investment liberalization* which allows greater foreign entry in both services and manufacturing sectors. This paper aims to fill this important gap. The novelty of our paper lies mainly in the following four aspects. First, unlike much of the literature which examines the direct effect of regulation on the performance of regulated sectors, we consider the *indirect* impacts of foreign entry regulation on downstream manufacturing activities in China. Modern economies involve very sophisticated input-output structures. According to Acemoglu et al. (2006), sectoral linkages may act as important channels through which microeconomic shocks generate a 'cascade effect', i.e. in the presence of intersectoral dependence in the production structure, idiosyncratic shocks may propagate throughout the economy and affect the output of other sectors, generating sizable aggregate effects. Using French firm-level data, Di Giovanni et al. (2014) show that the inter-firm linkages are approximately three times as important as the direct effect of firm shocks in driving aggregate fluctuations. Jones (2013) pinpoints the implications of the input-output structure of the economy for economic growth and development, i.e. the effects of resource misallocation can be am-

plified in the presence of input-output linkages. This is particularly relevant for China as the world's largest and the most dynamic developing country where firms and industries are embedded in a complex production network. Thus, regulations that hinder foreign access to domestic markets and unnecessarily constrain competition can be a drag on the productivity of not only firms and industries directly concerned, but also of other firms and industries which use the intermediate inputs from the regulated industries, thereby generating sizable aggregate effects. This important cross-industry influence of foreign entry regulation on productivity outcomes in China has, to the best of our knowledge, been largely ignored in the literature.

Second, we construct a *novel* measure of foreign entry regulation in China, which consists of more than 900 4-digit industries in both services and manufacturing sectors over the period of 1997-2007. The original data is from the official 'Catalogue', which provides the explicit information of Chinese government's attitudes to foreign investment. One challenge is that the listed sectors and product categories in the 'Catalogue' are not aligned with any formal sectoral or industrial classification system. We use a unique matching approach to link the information of foreign entry regulation from the 'Catalogue' with China's Input-Output Tables and the firm-level production data of more than 480,000 manufacturing firms. This novel and comprehensive dataset is superior to the commonly-used OECD indicators of anti-competitive regulations on product market which cover a small number of broadly-defined non-manufacturing industries (Bas and Causa, 2013; Bourlès et al., 2013; Cette et al., 2017).

Third, we investigate the trickle-down effects of foreign entry regulation imposed on both *services* and *manufacturing* sectors on the productivity performance of downstream manufacturing sectors in China. This is because downstream spillovers arising from policy reform and foreign participation in the services sectors are qualitatively different from those arising from foreign direct investment (FDI) in manufacturing industries (Arnold et al., 2016). Despite the important role of services (such as finance, transport, and telecommunications) used as intermediate inputs in manufacturing, there has not been much empirical analysis of the effects of services regulation or liberalization in China. This paper thus provides a more rigorous evidence-based analysis of the role of foreign

entry regulation on the services sector, along with that on the manufacturing sector, in driving the productivity outcome of downstream manufacturing industries which rely on the intermediate inputs from the regulated sectors.

Last, in addition to the overall downstream effects of foreign entry regulation, the focus of this paper is on various *economic mechanisms* that characterize the channels through which upstream regulation on foreign entry affects the performance of firms in downstream industries in China. In particular, we assess to what extent the productivity effects of foreign entry regulation work through some industry-specific channels such as the distance to the world technology frontier, the technology sharing similarity and the labour structure similarity between upstream and downstream industries, or some firm-specific channels such as the R&D investment and the outsourcing intensity. To the best of our knowledge, none of the existing studies explore this important research question in such an in-depth and comprehensive way.

We find that the overall level of foreign entry barriers in China has slightly declined during 1997-2007. Despite vast heterogeneity among different industries, a clear pattern is evident: there exists a significant liberalizing move in the manufacturing sector, whereas the strict restrictions on the services sector remain intact. Regression results show that foreign entry regulation on the upstream manufacturing and services industries curbs downstream firm productivity due to the reduced competition, rent-seeking efficiency incentives and technological spillovers. This cross-industry indirect effect is found to be 2.6 times as big as the direct effect of such regulation on firms' own industries, highlighting the role of input-output structures in amplifying the impact of foreign entry regulation on the entire economy. The downstream effect of lack of upstream competition is more marked for firms in industries close to the world technology frontier and sharing similar technology or labour structure between upstream and downstream industries, and for firms engaging more in R&D and outsourcing activities. The results are robust when various methods are adopted to deal with the potential endogeneity and when alternative measures of key variables are employed.

The structure of the paper is as follows. Section 2 briefly reviews the theoretical and empirical literature on entry regulation. Section 3 provides some background infor-

mation on China's FDI inflows and foreign entry regulation. Section 4 explains our data, variables, model specification and estimation strategy. Section 5 presents some stylized facts and discusses the results of our baseline model. Section 6 explores various economic channels through which foreign entry regulation affects downstream productivity. Section 7 conducts a number of robustness checks, focusing on the endogeneity and alternative measures of key variables. Section 8 concludes the paper.

2 Related literature

Our paper relates to a variety of theoretical and empirical literature on the direct effect that entry regulation has on the performance of regulated sectors, the indirect effect of such regulation on downstream manufacturing industries, and the effect of trade liberalization, FDI and services liberalization.

2.1 Regulation of entry: direct effect

The economic theory of regulation dates from Pigou (1920)'s *public interest theory* which argues that unregulated markets exhibit frequent failures, ranging from monopoly power to externalities, and the government can screen new entrants to make sure that consumers buy high quality products from desirable sellers. It predicts that stricter regulation of entry is associated with socially superior outcomes. By contrast, the *public choice theory* claims that the regulation of entry keeps out the competitors, which leads to greater market power and profits of incumbents rather than benefits to consumers (Stigler, 1971; Peltzman, 1976). Shleifer and Vishny (1993) argue that regulation is pursued for the benefit of politicians and bureaucrats, enabling the regulators to collect bribes from the potential entrants and serves no social purpose. Thus, the public choice theory predicts that stricter regulation is associated with less competition and higher corruption.

There is a growing empirical literature on the effect of entry regulation on the industrial structure. For instance, Djankov et al. (2002) find that heavier regulation of entry is associated with greater corruption and a larger size of the unofficial economy using a

dataset of entry regulation of start-up companies in 85 countries. Alesina et al. (2005) find that liberalization of entry has a positive impact on the industry-level capital accumulation in 21 OECD countries. Klapper et al. (2006) find that costly entry regulation hampers the creation of new firms, discriminates against small new entrants, and reduces the growth rate of incumbent firms in the regulated industries. In brief, most evidence favors the public choice over the public interest theories of regulation, and has been used to justify the simplification of business start-up (Djankov, 2009).

2.2 Regulation of entry: indirect effect

In theory, there are at least three channels through which entry regulation on upstream industries may affect the productivity of downstream firms. First, according to Bourlès et al. (2013), lack of competition in upstream sectors makes the search for intermediate input suppliers time-consuming and costly for new downstream firms. Thus, anticompetitive regulations in upstream sectors can reduce downstream competition if access to downstream markets requires using intermediate inputs produced upstream, which in turn affects downstream productivity.

Second, regulations that increase suppliers' market power can reduce incentives to improve efficiency and curb productivity in downstream sectors even if such regulations do not restrict market access downstream (Bourlès et al., 2013). This is because with imperfect competition in upstream industries, firms in downstream industries have to negotiate terms and conditions of their contracts with suppliers and part of the rents expected downstream from adopting best-practice techniques will be captured by intermediate input providers. Hence, rent-seeking efficiency incentives in downstream sectors are reduced by the search costs implied by imperfect competition in upstream sectors. Cette et al. (2016) confirm that it is the rent-sharing between regulated industries producing intermediate inputs and industries using these inputs that explains the indirect productivity impact of upstream regulations on other industries.

Third, according to Barone and Cingano (2011), anticompetitive upstream regulations may constrain the diffusion of input-intensive technologies and increase the costs

of production in downstream industries. In other words, regulations that generate entry barriers may slow technology transfers through intermediate markets and increase the costs of absorbing new technologies in downstream firms and industries, thus impeding their productivity enhancement.

Empirically, using a panel of cross-country industry-level data, Bourlès et al. (2013) find that anticompetitive upstream regulations significantly curb multifactor productivity growth, and the effect is stronger for observations close to the productivity frontier. Similar results are found by Bas and Causa (2013) which explores the effect of trade and product market policies in upstream sectors on downstream productivity in China, and by Cette et al. (2017) which focuses on the role of R&D investment in driving the relationship between upstream competition and downstream performance. One common feature of these studies is that their regulation variable is based on the OECD indicators of anti-competitive regulations on product market, where 6 non-manufacturing industries are included in Bourlès et al. (2013) and Cette et al. (2017), and only 3 industries are included in Bas and Causa (2013). This leaves scope for further exploration of the impact of upstream regulation on downstream performance by using our more comprehensive and highly-disaggregated dataset on foreign entry regulation in China.

2.3 Foreign entry liberalization: trade, FDI and services

There is an extensive empirical literature showing that trade liberalization increases firm- and industry-level productivity (Pavcnik, 2002; Bernard et al., 2006; Amiti and Konings, 2007; Fernandes, 2007; Aw et al., 2011; Topalova and Khandelwal, 2011; Bustos, 2011; Yu, 2015). The mechanisms are mainly through inter-firm reallocations and the productivity improvement within incumbent firms.

Despite the fact that the economic benefits of liberalization of FDI are well established in the theoretical literature, the empirical evidence on the effect of FDI on technology spillovers and productivity enhancement in host countries is far from conclusive (Aitken and Harrison, 1999; Javorcik, 2004; Blalock and Gertler, 2008; Fu, 2011; Xu and Sheng, 2012). The general message is that the presence of foreign firms does

not always benefit domestic firms in developing countries and the effect depends on the characteristics of domestic firms, industries and the host country, such as the absorptive capacity, financial sector development, and government regulations.

There is a growing literature on the indirect effect of services liberalization on the productivity and growth of downstream manufacturing industries (see, for instance, Arnold et al. (2011) on Czech Republic, Barone and Cingano (2011) on OECD countries, Fernandes and Paunov (2012) on Chile, and Arnold et al. (2016) on India). The main finding is that services liberalization, mainly characterized by the entry of foreign providers, has a positive effect on the performance of domestic downstream manufacturing firms through the reduction of production factor costs, access to higher quality or new varieties of services inputs, and positive foreign spillovers. For instance, the entry of technologically advanced foreign services providers may bring know-how and knowledge about new products and international best practices into the country, which puts pressure on domestic suppliers to make similar improvements, thus permitting downstream manufacturers to introduce productivity enhancing changes.

3 China background

3.1 FDI inflows in China

FDI inflows are regarded as an important factor contributing to China's rapid economic growth. It was Deng Xiaoping's 'Southern Tour' in the spring of 1992 that unleashed a surge of inward FDI to China. Since then foreign firms have been allowed steadily greater freedom to operate in China. FDI was initially attracted by Special Economic Zones (SEZs) for export processing, but the inflows diversified in the 1990s with a large proportion of foreign firms focusing on the domestic Chinese market. In 2013, China's utilized inward FDI ($117.6 Billion in total) surpassed the US as the world's number one destination for FDI.

In addition to its' 'world factory' status by providing manufacturing products, China made a radical commitment to services liberalization through its WTO accession in 2001.

For instance, China has committed to open most services markets to international competition from foreign services providers in the areas of distribution, telecommunications, financial services, professional business services, accounting, law, construction and travel etc. Figure 1 illustrates China's FDI inflows by sectors. China has been quite open to FDI in its manufacturing sectors; however, the services sector has not been fully liberalized until recently. Since 2005, while FDI in the manufacturing sectors remains high and stable, it is the surge of FDI in the services industries that has contributed to the recent rise of FDI inflows to China.

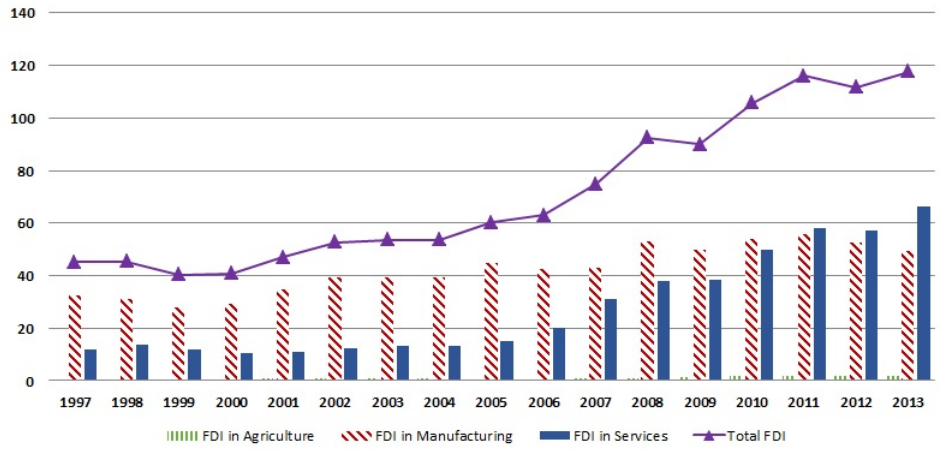

Figure 1: China's utilized inward FDI by sectors: 1997-2013 (Billion US$)

Data source: Statistical Yearbook of China (Various issues)

3.2 Foreign entry regulation in China

In 1995, China's National Development and Reform Commission (NDRC) published the first 'Catalogue' to guide the foreign investment in China. It was revised in 1997, 2002, 2004, 2007, 2011 and 2014, reflecting the evolution and substantial change of the Chinese government's policy objectives towards foreign investment along its economic development over the past 20 years. For instance, China's recent 13th 'Five-Year Economic Plan' identifies that the current challenge for China is to attract the right kind of FDI as it strives to rebalance its economy, improve the environment, and move up the value chain. This goal is clearly reflected in the latest 2014 'Catalogue' which aims to shift the foreign investment away from the low value-added labour-intensive businesses and the industries

with conventional, highly polluted or resource-intensive technology. Thus, China's recent FDI strategies aim to take a more selective approach, attracting the environmentally sustainable, energy efficient, and technologically advanced industries in both manufacturing and services sectors.

Generally speaking, the 'Catalogue' sets out the 'encouraged', 'restricted', and 'prohibited' categories for all foreign investment projects in China. Any foreign investment project that is not included in the 'Catalogue' is deemed to be 'permitted'. The 'encouraged' category indicates where the Chinese government wishes to direct the foreign investment, and such projects would be entitled to certain official preferential treatment in terms of taxation, location choices and various subsidies. The 'prohibited' category indicates the sectors that foreign investors are not allowed to invest in under any circumstances. The 'restricted' category implies that foreign investors are allowed to invest in these sectors, but some conditions (such as the ownership, location choices, and business scope etc) may apply. The 'restricted' projects are subject to more stringent approval requirements in general. Lastly, the 'permitted' category means that foreign investors are allowed to invest in these sectors without any subsidy or condition. A proper understanding of such regulation is crucial for foreign investors to take the opportunities and to overcome potential barriers when investing in China.

Appendix Table A1 shows the number of regulated items listed in various issues of the 'Catalogue', ranging from 318 items in 1997 to 477 items in 2007.[1] Chinese government aims at gradually easing the curbs on foreign investment by expanding the list of 'encouraged' items for foreign investment in all sectors. For instance, the number of 'encouraged' items rose from 176 to 298 in the manufacturing sector and from 3 to 41 in the services sector during the period of 1997 to 2007. On the other hand, despite a small decline of the number of 'restricted' items in the manufacturing sector (from 73 in 1997 to 48 in 2007), the corresponding figure in the services sector rose (from 25 in 1997 to 36 in 2007). The number of 'prohibited' items barely changed in both manufacturing and agriculture sectors during 1997-2007, whereas the list of 'prohibited' items was expanded

[1]We use 'items' rather than 'industries' because the items listed in the 'Catalogue' include product categories, industries and sectors, which do not follow the official industrial classification system in China.

in the services sector (from 14 in 1997 to 21 in 2007). This confirms that the 'Catalogue' as a whole remains a significant restriction on inward FDI in China.

4 Data and empirical methodology

4.1 The datasets

In addition to the 'Catalogue' discussed above, we use a number of comprehensive microeconomic datasets, including the firm-level production data, China's Input-Output Tables, the product-level tariff information published by the World Trade Organization (WTO), and a number of US datasets to construct some industry-specific indicators.

The firm-level dataset is drawn from the Annual Survey of Chinese Industrial Firms conducted by National Bureau of Statistics of China (NBS) over the period of 1998-2007. This dataset includes all State-Owned Enterprises (SOEs) and other types of enterprises with annual sales of five million yuan (about $817,000) or more. These firms operate in the manufacturing sectors and are located in all 30 Chinese provinces or province-equivalent municipal cities. Following the standard cleaning procedures in the literature (Brandt et al., 2012; Yu, 2015; Ding et al., 2016), our final sample includes 485,672 firms and 1,824,089 firm-year observations.

China's Input-Output Tables are employed to measure the inter-sectoral linkages between upstream and downstream industries. The first Input-Output Table was jointly published by NBS, NDRC and Ministry of Finance in 1987. It was subsequently revised in 1992, 1997, 2002, 2007, 2010 and 2012. Corresponding to the sample period of NBS dataset, we adopt the 2002 and 2007 Input-Output Tables, which include 122 3-digit industries in 2002 and 135 3-digit industries in 2007.

We obtain the tariff data from the WTO, which provides product-level tariffs at the 6-digit HS level of all WTO member countries/regions. Following Yu (2015), we use the average ad valorem (AV) duty in our analysis. Lastly, the NBER Manufacturing Productivity Database (June 2013 version), the NBER Patent Database and the 2002

National Industrial-Occupation Employment Matrix (NIOEM) published by the Bureau of Labour Statistics (BLS) are also used to construct some industry-specific indicators.

4.2 Two important measures

4.2.1 Our measure of total factor productivity (TFP)

We calculate the TFP using the System GMM (Blundell and Bond, 1998) method which estimates a Cobb-Douglas log-linear production function including fixed effects. There are at least three justifications for our approach. First, compared with the Olley and Pakes (1996) and Levinsohn and Petrin (2003) approaches, the System GMM estimator allows us to take into account the fixed effects when modelling firm-level productivity. This is important as firms have (unmeasured) productivity advantages that persist over time, which need to be captured (Bartelsman and Dhrymes, 1998). Second, Van Biesebroeck (2007) compares the sensitivity of five widely-used productivity measures using simulated data, and claims that despite the strength and weakness of each method, the System GMM estimator is the most robust technique when measurement errors and technological heterogeneity are present. Third, one key assumption of the Olley and Pakes (1996) approach is that capital is more actively responsive to unobserved productivity. This may not be applicable to China, which is a labour-abundant economy with low labour costs (Yu, 2015). Thus, the System GMM estimator is more appropriate when modelling firm-level TFP in China.

In the light of these considerations, we estimate the following model:

$$y_{it} = \alpha_i + \alpha_L l_{it} + \alpha_M m_{it} + \alpha_K k_{it} + \alpha_T t + \xi_{it} \tag{1}$$

where y, l, m, and k refer to the logarithms of real gross output, employment, intermediate inputs and the capital stock in firm i at time t respectively; we also include a time trend, t, measuring the exogenous gains in TFP over time. We first estimate equation (1) for different industries, and obtain the values of the elasticities of output with respect to inputs (α_L, α_M and α_K). TFP can then be calculated as the level of output that

is not attributable to factor inputs (employment, intermediate inputs and capital), i.e. productivity is due to efficiency levels and technical progress.

Given the absence of firm-specific price deflators, we use different industry-specific price deflators for inputs and outputs, which are directly drawn from Brandt et al. (2012). Our TFP measure is thus a revenue-based productivity measure (TFPR) as introduced by Foster et al. (2008), which may capture both technical efficiency and price-cost markups. Following Pavcnik (2002), we control for firm-specific markups with firm fixed effects in the estimation. We use the perpetual inventory method to compute the capital stock, where the depreciation rate of physical capital is based on firms' reported actual depreciation figure rather than arbitrary assumptions. In the System GMM estimation, gross output, intermediate inputs, labour, and capital are treated as endogenous, where lagged values of these variables are used as instruments in the first-differenced equation, and first-differences of these variables are used as instruments in the levels equation. The Hansen J test of over-identifying restrictions is adopted to evaluate the overall validity of the set of instruments. In assessing whether our models are correctly specified and consistent, we also check for the presence of second-order autocorrelation in the differenced residuals in all estimation. The estimated coefficients of the production function and the associated TFP by industry are reported in the Appendix Table B4.

4.2.2 Our unique measure of foreign entry regulation

There are at least two main challenges when trying to identify the impact of competition on innovation or productivity outcomes, i.e. the endogeneity of competition measure (for instance, entry of new domestic and foreign firms is most likely not exogenous to productivity outcomes) and the lack of direct link to policy of traditional indicators of product market conditions such as markups or industry concentration indices (Bourlès et al., 2013). To address these problems, we construct a unique foreign entry regulation indicator (FER) for more than 900 4-digit industries in both services and manufacturing sectors over the period of 1997-2007 based on the information from the 'Catalogue', and then link this measure with downstream manufacturing industries using China's Input-Output Tables. The main advantage of our FER indicator lies on its largely exogenous

nature and the direct link with underlying policies.

Since the information on the regulated sectors and product categories in the 'Catalogue' is not consistent with any formal sectoral or industrial classification system, we firstly need to establish a link between the 'Catalogue' information and China's official list of sectoral categories, i.e. the 2002 China Standard Industrial Classification of All Economics Activities (GB2002). We manually search the 'key word' of all regulated items in the 'Catalogue' and then match them into the corresponding 4-digit industries under GB2002. Then it is likely that multiple products or sectors in the 'Catalogue' can be merged into one 4-digit industry. Our identification method is that one 4-digit industry is classified as 'prohibited', 'restricted' or 'encouraged' if at least one product or sector in that industry is stated on the government list of prohibition, restriction or encouragement. If there is no matching information from the 'Catalogue', the corresponding industry is classified as 'permitted'. Thus, it is possible for one 4-digit industry to be simultaneously marked as the status of 'prohibited', 'restricted' and 'encouraged'.

We then construct the following two anti-competitive FER indicators. First, we assign the value of 1 to an industry if at least one product or sector in that industry is 'prohibited' on the government list of foreign entry, and 0 otherwise. This measure is referred to as FER_1. Thus, an industry with a unit value of FER_1 is under strict government regulation and has a low level of investment liberalization. Second, since government regulation on foreign entry includes both prohibition and restriction, we assign the value of 1 to an industry if at least one product or sector in that industry is either 'prohibited' or 'restricted' on the government list of foreign entry, and 0 otherwise. This measure is referred to as FER_2, which is broader than FER_1 as it reflects two dimensions of anti-competitive government regulation on foreign entry.

The final step is to measure the foreign entry barriers faced by downstream manufacturing industries. The identifying assumption is that the impact of upstream regulation on downstream firms' performance should be growing with the importance of upstream regulated industries as suppliers of intermediate inputs. Thus, to capture the inter-sectoral linkages between upstream and downstream industries, we weight the degree of foreign entry regulation on each upstream sector by the reliance of downstream manufacturing firms

on each upstream manufacturing and services input. The foreign entry barrier indicator ($Barrier$) for each downstream manufacturing industry is then expressed as

$$Barrier_{jt} = \sum_{s=1}^{n} FER_{st} * w_{sj} \tag{2}$$

where $Barrier_{jt}$ is the upstream foreign entry barrier for downstream manufacturing industry j at time t; FER_{st} refers to the FER indicator (either FER_1 or FER_2) of upstream industry s at time t (where n refers to the total number of upstream industries of manufacturing industry j; and t corresponds to the four waves of the 'Catalogue', i.e. 1997, 2002, 2004, and 2007); and the weight, w_{sj}, is the amount of intermediate inputs sourced from upstream industry s, expressed as a fraction of the overall inputs used by downstream manufacturing industry j. To compute the weight, we obtain the information of the dependence of each manufacturing sector on the different upstream manufacturing and services sectors from the 2002 and 2007 China's Input-Output Tables. In other words, for each downstream manufacturing industry, an industry-specific foreign entry barrier indicator is derived by weighting each upstream industry component of the FER indicator by the downstream industry's reliance on those upstream industries based on the input-output matrices. The use of industry-level information alleviates the concerns about the simultaneity problem between the performance of an individual firm and its input usage. The $Barrier$ indicator takes the form of either $Barrier_1$ or $Barrier_2$ corresponding to the two measures of FER (FER_1 and FER_2) respectively.

More information is provided in the Appendix A to establish the validity of our new foreign entry barrier measures. First, we compare our foreign entry barrier indicator ($Barrier_2$) with the one computed using the information from the 'OECD's FDI Restrictiveness Index' by aggregating our measure to the level of 22 industries used by the OECD Index.[2] Figure A1 shows that these two foreign entry barrier measures are highly and positively correlated. Second, Table A2 shows the proportion of foreign firms in manufacturing industries in various years. We find that the share of foreign firms is

[2]The OECD Index provides the information of FDI restrictiveness of 22 industries in 62 countries (Kalinova et al., 2010). We weight the OECD Index using the 2002 China's Input-Output Table to compute the corresponding foreign entry barrier.

indeed much lower in the restricted sectors than that in the unrestricted sectors in every year, where $Barrier_2$ is used to make the industry classification. Both results indicate the reliability of our new measures of foreign entry barrier.

4.3 Model specification and hypotheses

Our baseline model is specified as follows:

$$Ln(TFP_{ijt}^{GMM}) = \beta_0 + \beta_1 Ln(Barrier_{jt}) + \beta_2 X_{ijt} + \eta_t + \xi_i + \mu_{ijt} \tag{3}$$

where the dependent variable is the natural logarithm of TFP of firm i in industry j at year t based on the System GMM estimation. $Ln(Barrier_{jt})$ is the natural logarithm of upstream foreign entry barrier for downstream manufacturing industry j at time t, where $Barrier_{jt}$ takes the form of either $Barrier_1$ or $Barrier_2$ as defined in Section 4.2.2. We expect a negative trickle-down effect of upstream foreign entry barriers on the productivity performance of downstream manufacturing firms due to the constraints on competition, rent-seeking efficiency incentives and technology spillovers as discussed in Section 2.2.

X_{ijt} consists of a number of industry-specific and firm-specific control variables. First, in order to identify the indirect effect of foreign entry regulation on downstream manufacturing activities, we control for the direct effect of such regulation on the productivity of firms directly concerned. Thus, the foreign entry regulation measure (FER_{jt}) for manufacturing industries is included and we expect a significantly negative impact on firms' productivity due to the public choice argument as discussed in Section 2.1.[3]

Second, the natural logarithm of a weighted measure of input tariffs, $Ln(Tariff_{jt})$, is included to capture the influence of trade liberalization on downstream manufacturing firms in industry j at time t. It is computed as the weighted average of tariffs on the intermediate goods used in the production of final goods in each manufacturing industry, where the product-level tariffs at the 6-digit HS level are obtained from WTO and the weights are taken from the 2002 China's Input-Output Table. We expect a negative effect

[3]We do not take the natural logarithm of FER because the FER indicator consists of lots of zeros without being weighted by the Input-Output Tables.

of input tariffs on downstream firms' productivity, i.e. reducing input tariffs can raise downstream productivity through learning, variety, and quality effects as discussed in the literature (Amiti and Konings, 2007; Topalova and Khandelwal, 2011; Yu, 2015).

Third, we include a market structure measure of upstream industries (HHI_{jt}) to reflect the status of domestic competition among upstream industries faced by downstream industry j at time t. It is computed as a weighted average of the Herfindahl index[4] of all upstream manufacturing industries faced by each downstream industry j, and the weight is taken from the 2002 China's Input-Output Table. The justification is that net entry in the domestic manufacturing sector accounts for over two thirds of total TFP growth in China over the period of 1998-2007 (Brandt et al., 2012). A lower HHI suggests a higher degree of competition in the upstream industries, which may increase downstream firms' productivity through the input-output linkages.

Fourth, we capture ownership heterogeneity by classifying firms into SOEs (SOE), private firms ($PRIV$) and foreign firms (FIE) according to the official definition reported in the China City Statistical Yearbooks. Despite decades of economic reforms, SOEs are commonly found to be the least efficient with an average return on capital well below that in the private sector (Hsieh and Klenow, 2009; Ding et al., 2012; Liu and Siu, 2012). By contrast, foreign ownership is associated with both higher levels of TFP and fewer financial constraints (Manova et al., 2015). We therefore expect a negative effect of SOE and a positive effect of FIE on firms' productivity.

Lastly, firm size and firm age are included to capture the effects of economies of scale and learning-by-doing respectively. Firm size is defined as the natural logarithm of employment, i.e. $Ln(Employment)_{ijt}$. In addition to $Ln(Age_{ijt})$, a quadratic term of firm age, $Ln(Age^2_{ijt})$, is added to reflect the non-linear relationship between firm age and productivity commonly found in the literature (Brouwer et al., 2005).

When examining the economic channels through which upstream foreign entry bar-

[4]The Herfindahl index is computed as the sum of the squared output of the four largest firms in a 4-digit manufacturing industry, normalized by the square of the industrial output.

riers affect downstream productivity, we estimate the following equation:

$$Ln(TFP_{ijt}) = \beta_0 + \beta_1 Ln(Barrier_{jt}) + \beta_2 Ln(Barrier_{jt}) * Channel_{(i),jt} + \beta_3 Channel_{(i),jt} + \beta_4 X_{ijt} + \eta_t + \xi_i + \mu_{ijt} \quad (4)$$

where economic channels ($Channel_{(i),jt}$) take the form of either industry-specific channels ($Channel_{jt}$) or firm-specific channels. All other control variables (X_{ijt}) are the same as those in equation (3).

The error term in equations (3) and (4) comprises three components: (i) the time-specific fixed effect, η_t, accounting for possible business cycles and macroeconomic shocks such as an appreciation of the Chinese yuan; (ii) the firm-specific fixed effect, ξ_i, controlling for any time-invariant unobserved firm-specific features such as markups; and (iii) an idiosyncratic error term, μ_{ijt}, with normal distribution $\mu_{ijt}\overline{N}(0, \sigma_{ij}^2)$ to control for other unspecified factors. Our basic estimation method is the panel data fixed effect with standard errors clustered at the 4-digit industry level. Other estimation methods are adopted as robustness checks to address the potential endogeneity issue.

5 Basic empirical results

5.1 Some stylized facts

Figure 2 illustrates the foreign entry regulation (FER) index in China for 1997, 2002, 2004 and 2007, defined as the 4-digit FER indicator as a fraction of the total number of 4-digit industries in each 2-digit industry. It reflects the proportion of 4-digit industries in each 2-digit industry under strict foreign entry regulation. The overall index merely drops from 21% to 18% over the period of 1997 to 2007, which does not show a significant liberalizing move on foreign investment regulation. An interesting pattern appears when we separate the manufacturing and services sectors: the FER index drops from 17.6% to 11.6% during 1997-2007 for the manufacturing sector, but rises from 24.2% to 28.3% for the services sector. Thus, the foreign entry regulation has been significantly relaxed in the manufacturing sector, especially following China's WTO accession (from 17.6% in 1997

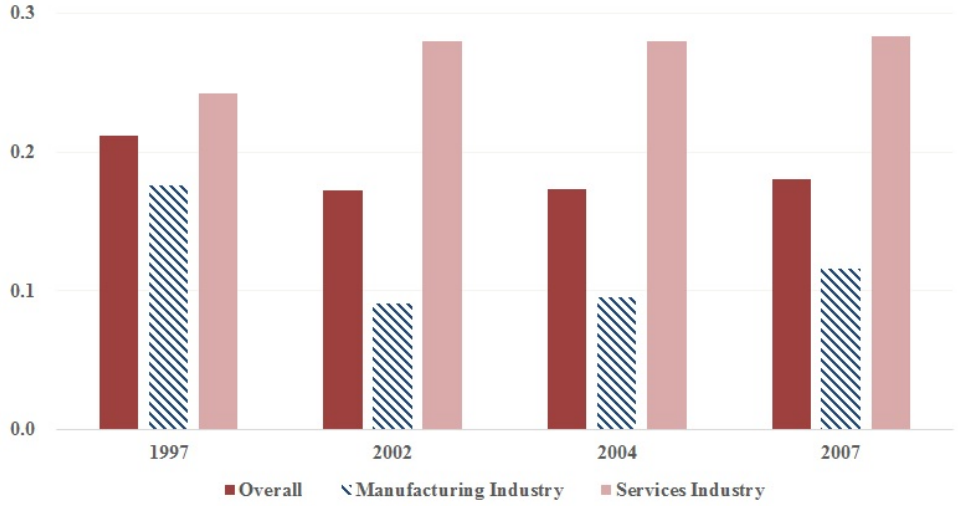

Figure 2: Foreign entry regulation (FER) index in China

Note: This figure is based on the second measure of FER (FER_2).

to 9.1% in 2002), whereas regulation on the services sector has become more stringent, despite its radical commitment to service liberalization in its WTO accession.

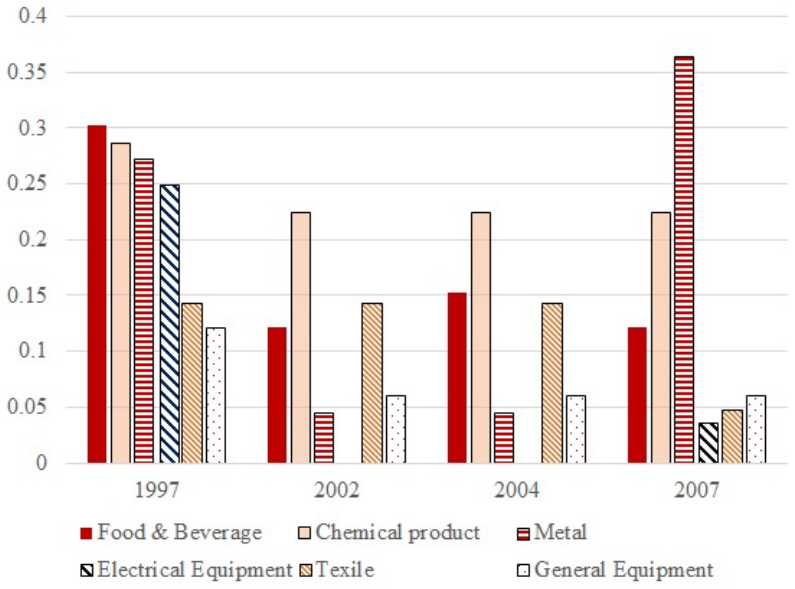

Figure 3: Foreign entry regulation (FER) index of 6 manufacturing sectors

Figure 3 presents the FER index of six manufacturing sectors, including food and beverage, chemical product, metal, electrical equipment, textile, and general equipment sectors over the period of 1997-2007. The declining trend in the FER index is evident for all these industries but with significant heterogeneity, i.e. some industries (such as electrical equipment) exhibit a quicker and more dramatic liberalization process than the

others (such as chemical products). There is a big reversal in 2007 in the metal industry, where the index drops from 27% to 5% during 1997-2004, but climbs to 36% in 2007. This is due to the introduction of new restrictive regulation on foreign investment in the non-ferrous metal manufacturing sector in 2007, reflecting the Chinese government's concern of natural resource conservation.

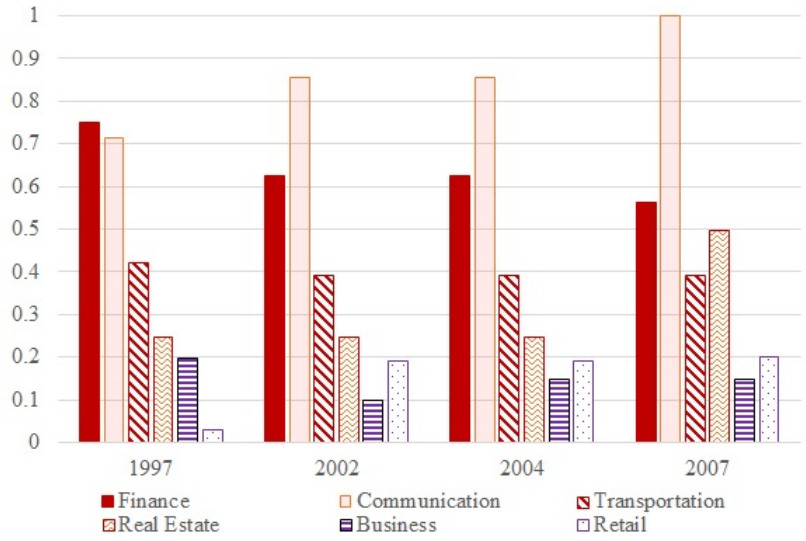

Figure 4: Foreign entry regulation (FER) index of 6 services sectors

Figure 4 illustrates the FER index in six services sectors, including finance, communication, transportation, real estate, business services, and retail sectors. The overall regulation level is much higher in the services sectors. There is some gradual liberalizing trend on foreign investment in three sectors of transportation, business services and finance. By contrast, the regulation becomes stricter in the other three sectors (communication, real estate and retail sectors). The communication sector can be viewed as the most regulated industry in China, with the FER index rising from 70% in 1997 to 100% in 2007, reflecting the new regulation that the Internet services become fully prohibited from foreign investment in 2007. House letting agent services are also added to the restricted list of foreign investment in 2007. It is the new regulation on food, electricity, and gasoline retailing services that turns the originally lightly controlled retail sector to a more regulated one.[5]

[5]The FER index of all 2-digit industries is provided in Appendix Table A3 which further reveals the vast heterogeneity across various industries.

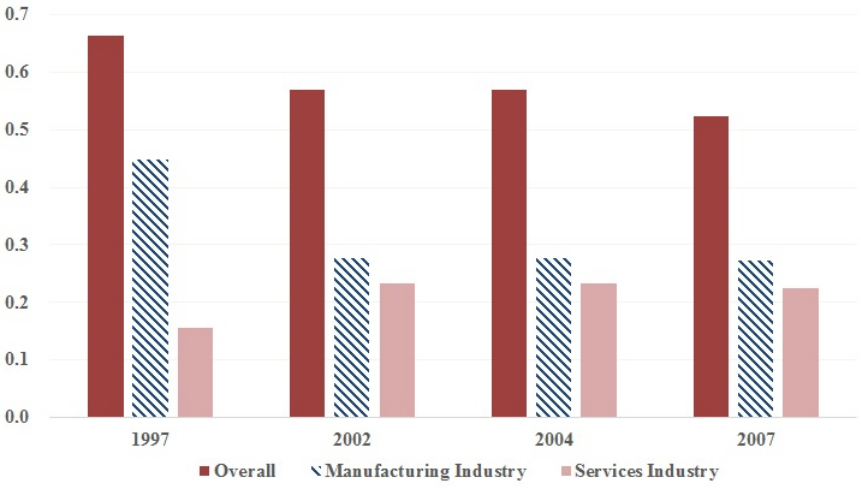

Figure 5: Foreign entry barrier for downstream manufacturing industries

Note: This figure is based on the second measure of *Barrier* ($Barrier_2$).

Figure 5 depicts our foreign entry barrier (*Barrier*) indicator for downstream manufacturing industries, as defined in equation (2). There is a declining trend of the overall foreign entry barrier faced by downstream industries (from 66.3% in 1997 to 52.3% in 2007). The foreign entry barrier associated with the upstream manufacturing sector drops from 45% in 1997 to 27.3% in 2007, whereas the corresponding figure associated with the upstream services sector rises from 15.5% to 22.5%. This confirms that China has been quite open in its manufacturing sector in the process of investment liberalization, but its services sector remains tightly controlled.[6]

5.2 The baseline results

Table 1 reports the results of baseline model of equation (3). We find that the foreign entry barrier (*Barrier*) has a significantly negative effect on the productivity performance of downstream firms, i.e. a 10 percentage point fall in upstream foreign entry barrier is associated with a 0.2% or 0.4% increase in the productivity of downstream manufacturing firms, when $Barrier_1$ and $Barrier_2$ are used respectively. Thus, when regulations restrict the foreign entry and competition in industries that supply intermediate inputs, the incentives to improve efficiency are weaker in downstream industries the more intensively these industries use the regulated products due to the reduced competition, rent-seeking

[6]The summary statistics and detailed definitions of all variables are provided in Appendices C and D.

efficiency incentives and technological spillovers. The direct impact of foreign entry regulation on firms' own (manufacturing) industry (FER) is also found to be negative and significant, consistent with the prediction of public choice theory. When comparing the marginal effects between direct and indirect effects in both columns (3) and (6), the indirect effect appears to be 2.6 times as large as the direct effect, indicating the importance of cross-industry influences of regulations that restrict foreign entry on the productivity outcome of other industries through the input-output linkages.

Table 1: The effect of foreign entry barriers on downstream productivity

	$Barrier_1$			$Barrier_2$		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Barrier)	-0.005**	-0.017***	-0.021***	-0.068***	-0.050***	-0.042***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
FER			-0.009***			-0.017***
			(0.003)			(0.006)
Ln(Tariff)			-0.173***			-0.164***
			(0.005)			(0.006)
HHI			-0.568***			-0.473***
			-0.022			-0.028
SOE		-0.162***	-0.166***		-0.164***	-0.166***
		(0.005)	(0.006)		(0.005)	(0.005)
FIE		0.030***	0.031***		0.033***	0.031***
		(0.005)	(0.005)		(0.005)	(0.006)
Ln(Employment)		0.463***	0.462***		0.462***	0.461***
		(0.002)	(0.002)		(0.002)	(0.002)
Ln(Age)		0.202***	0.201***		0.203***	0.202***
		(0.003)	(0.003)		(0.003)	(0.003)
$Ln(Age^2)$		-0.034***	-0.034***		-0.034***	-0.034***
		(0.001)	(0.001)		(0.001)	(0.001)
R^2	0.876	0.892	0.894	0.875	0.891	0.894
Observation	1824089	1824089	1824089	1824089	1824089	1824089

Notes: the dependent variable is the natural logarithm of TFP based on the System GMM estimation; FER_1 and $Barrier_1$ are used in columns (1)-(3), and FER_2 and $Barrier_2$ are used in columns (4)-(6); all year-specific and firm-specific effects are included; standard errors are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

The effect of input tariffs on downstream firms' productivity is significantly negative, indicating that as importing firms become more productive (due to learning from the foreign technology embedded in the imported inputs, higher input quality, and more input varieties), they can pass on the benefits to other firms through sales of their goods along the vertical production chain. The significant and negative effect of Herfindahl index shows that tougher domestic competition (for instance, through firm entry and exit) in the upstream sectors can stimulate productivity improvements in downstream firms which use the intermediate inputs from their upstream suppliers via cost savings, quality and

variety effects. Compared with the default group of private firms, SOEs have lower levels of productivity whereas foreign firms exhibit higher productivity. Both firm size and age have positive and significant impacts on firms' productivity, and the effect of the latter is found to be non-linear. In brief, all these results are consistent with the hypotheses and predictions discussed in Section 4.3.

Table 2: The effect of foreign entry barriers in the upstream manufacturing and services sectors on downstream productivity

	$Barrier_1$			$Barrier_2$		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Manufacturing-Barrier)	-0.048***		-0.044***	-0.052***		-0.052***
	(0.002)		(0.002)	(0.002)		(0.002)
Ln(Services-Barrier)		-0.045***	-0.036***		-0.031***	-0.032***
		(0.002)	(0.002)		(0.006)	(0.006)
R^2	0.895	0.895	0.895	0.895	0.895	0.895
Observation	1824089	1824089	1824089	1824089	1824089	1824089

Notes: we report only the coefficients of key variables to save space; Ln(Manufacturing-Barrier) and Ln(Services-Barrier) are the natural logarithm of foreign entry barriers imposed on the upstream manufacturing sector and services sector faced by downstream industries respectively; see notes of Table 1 for other information.

Table 2 reports the downstream effect of foreign entry barriers associated with the upstream manufacturing sector and services sector respectively. We find that foreign entry barriers imposed on both sectors have significantly negative effect on the productivity of downstream manufacturers. In column (6), a 10 percentage point decrease in the foreign entry barriers associated with the upstream manufacturing sector results in a 0.5% increase in downstream productivity, and the corresponding figure for barriers associated with the upstream services sector is 0.3%. Downstream spillovers arising from policy reform and foreign participation in the services sectors are qualitatively different from those arising from foreign investment in manufacturing industries (Arnold et al., 2016). According to Arnold et al. (2011), allowing greater foreign entry in services industries can benefit the downstream manufacturing sectors in three ways. First, new services may become available through the entry of more technologically advanced services providers. Second, services liberalization may lead to a wider availability of services that were previously restricted to certain groups of users. Third, the reliability of existing services may improve as a result of competition and the entry of internationally successful players. The entry of foreign providers may play a particularly important role in realizing these benefits.

Our results confirm these arguments and highlight the important but often ignored role of services used as intermediate goods in manufacturing and the potential productivity-enhancing effect of services liberalization through allowing greater foreign competition in the services sector in China.

6 Economic channels and mechanisms

We hypothesize that there are at least five channels through which upstream foreign entry regulation might affect downstream performance. The three industry-specific channels include industry's distance to the world technology frontier, the technology sharing similarity and labour structure similarity between upstream and downstream industries. The two firm-specific channels are firms' R&D investment and their outsourcing intensity.

6.1 Industry's distance to the world technology frontier

The distance-to-frontier theory predicts a non-monotonic nexus between competition and innovation (and therefore productivity) by allowing the relationship to depend on the distance of the product to the world technology frontier (Aghion et al., 2005). For firms far from the technology frontier, an increase in competition may discourage their incentives to innovate because their chances of survival with new competition is limited even if they successfully innovate, i.e. laggard firms are too far from the frontier to be able to compete with the potentially technologically advanced new entrants (the discouragement effect). By contrast, as firms approach the frontier, competition can increase their incentives to innovate because competition may increase the incremental profits from innovating, thereby encouraging firms' R&D investments aiming at escaping competition (the escaping competition effect). This theory is well supported by the empirical evidence.[7]

Since the returns to efficiency improvement are higher for firms that compete neck-to-neck with rivals that are close to the technological frontier (Aghion et al., 2005), we

[7]See the cross-country evidence on economic growth (Acemoglu et al., 2006), the microeconomic evidence on industrial organization and international trade (Aghion et al., 2009; Amiti and Khandelwal, 2013; Ding et al., 2016), and the literature on the effects of anticompetitive upstream regulations on the downstream performance (Bas and Causa, 2013; Bourlès et al., 2013; Cette et al., 2017).

hypothesize that protection from competitive pressure due to upstream foreign entry barriers is likely to reduce downstream incentives to improve efficiency more markedly when industries are close to the world technology frontier. We construct a proxy for the distance to the technology frontier (*Distance*), which relates the labour productivity of 374 4-digit Chinese manufacturing industries to their US industry equivalents, where the US industries are used to represent the world technology frontier. We compute this industry-level distance measure by using the 3-year moving average of US industry labour productivity relative to labour productivity in the respective Chinese industry as follows:

$$Distance_{jpt} = \frac{LP_{jt}^{US}}{LP_{jpt}} \tag{5}$$

where $Distance_{jpt}$ is the distance of industry j in province p in China at time t relative to its technology frontier; LP_{jpt} is the labour productivity (defined as the value added per worker) of industry j in province p in China at time t; and LP_{jt}^{US} is the labour productivity of industry j in the US.

The results are reported in Panel A, Table 3. We find that the coefficient of foreign entry barrier itself is significantly negative whereas the coefficient of the interaction term between the *Distance* measure and the *Barrier* indicator is significantly positive. Taking column (6) as an example, for firms in industries that are far away from the frontier, the average net elasticity with respect to upstream foreign entry barrier is -0.037[8], i.e. a 10 percentage point fall in upstream foreign entry barrier is associated with a 0.37% increase in the productivity of downstream manufacturing firms; whereas for firms in industries close to the frontier, a 10 percentage point decrease in such barrier results in a 0.43% increase in downstream productivity. The negative and significant coefficient of *Distance* itself indicates the presence of convergence effect, i.e. a faster productivity catch-up for firms in industries that are far from the frontier. Thus, consistent with the predictions of neo-Schumpeterian framework, the downstream effect of foreign entry barrier is bigger for those manufacturing firms in industries close to the world technological frontier.

[8]The formula is -0.043+0.002*2.8, where 2.8 is the mean value of Ln(Distance).

6.2 Technology sharing similarity and labour structure similarity among industries

Another two industry-specific features (technology sharing similarity and labour structure similarity) may affect the relationship between foreign entry regulation and downstream performance. Both features relate to the intellectual or technology spillovers, i.e. the technologically-advanced foreign entry in upstream industries may speed the flow of new technology to downstream manufacturing industries through intermediate markets.

Table 3: The industry-specific channels

	$Barrier_1$			$Barrier_2$		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. The industries' distance to the world technology frontier						
Ln(Barrier)	-0.088***	-0.052***	-0.057***	-0.064***	-0.042***	-0.043***
	(0.006)	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)
Ln(Barrier)∗Ln(Distance)	0.035***	0.016***	0.017***	0.006***	0.004***	0.002***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.000)
Ln(Distance)	-0.012**	-0.074***	-0.081***	-0.079***	-0.113***	-0.122***
	(0.006)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)
R^2	0.882	0.895	0.896	0.883	0.895	0.897
Observation	1650634	1650634	1650634	1650634	1650634	1650634
Panel B. The technology sharing similarity among industries						
Ln(Barrier)	-0.078***	-0.075***	-0.076***	-0.070***	-0.068***	-0.069***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Ln(Barrier)∗TS	-0.499***	-0.483***	-0.486***	-0.073***	-0.069***	-0.070***
	(0.014)	(0.014)	(0.015)	(0.003)	(0.003)	(0.003)
TS	2.311***	2.298***	0.301***	0.583***	0.579***	0.580***
	(0.049)	(0.046)	(0.048)	(0.017)	(0.017)	(0.018)
R^2	0.875	0.892	0.894	0.876	0.893	0.894
Observation	1754107	1754107	1754107	1754107	1754107	1754107
Panel C. The labour structure similarity among industries						
Ln(Barrier)	-0.095***	-0.114***	-0.117***	-0.113***	-0.135***	-0.159***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)
Ln(Barrier)∗LS	-0.072***	-0.103***	-0.093***	-0.029***	-0.075***	-0.120***
	(0.009)	(0.009)	(0.010	(0.008	(0.007	(0.008)
LS	0.388***	0.485***	0.770***	0.339***	0.388***	0.762***
	(0.032)	(0.035)	(0.036)	(0.018)	(0.015)	(0.004)
R^2	0.896	0.911	0.913	0.896	0.911	0.912
Observation	1714971	1714971	1714971	1714971	1714971	1714971

Notes: we report only the coefficients of key variables to save space; the table structure is the same as Table 1 where columns (1) and (4) do not include any control variables, columns (2) and (5) include only firm-specific control variables, and columns (3) and (6) includes all firm-specific and industry-specific control variables; see notes of Table 1 for other information.

First, we hypothesize that such benefits may be better reaped by firms in the industries sharing similar technology, i.e. firms in industries using similar technology have better opportunity to exploit the intermediate inputs with superior quality or advanced

technology from their foreign providers. Following Ellison et al. (2010), we construct a technology sharing similarity (TS) indicator which measures the extent to which technologies associated with industry j cite technologies associated with industry s, and vice versa. The patent citation information is drawn from the 1988-1997 NBER Patent Database, which is then matched with China's 2002 Input-Output Table. Thus, the technology sharing similarity between upstream industry s and downstream industry j (TS_{sj}) is

$$TS_{sj} = \sum_{s=1}^{n} Patent_{sj} * w_{sj} \tag{6}$$

where $Patent_{sj}$ is the patent citation number between upstream industry s and downstream industry j; and w_{sj} is the weight measured by the amount of intermediate inputs sourced from upstream industry s, expressed as a fraction of the overall inputs used by downstream manufacturing industry j. This technology sharing similarity variable is introduced to shed light on the importance of exchanging technology and intellectual spillovers between upstream and downstream industries.

Second, technology spillover from upstream to downstream industries may be facilitated by the fact that industries use similar type of workers, i.e. efficient transfer or use of advanced technology from foreign providers in upstream industries requires downstream workers with similar capacity or skills to master its tacit elements. Following Ellison et al. (2010), we measure the extent to which industries use similar types of labour through the occupational employment patterns across industries catalogued in the 2002 National Industrial-Occupation Employment Matrix (NIOEM) published by the Bureau of Labour Statistics (BLS). We first compute the fraction of industry j's employment in occupation o ($Share_{jo}$). The similarity of employments in industry s and industry j ($Labour_{sj}$) is measured by the correlation of $share_{so}$ and $share_{jo}$ across occupations. Thus, the labour structure similarity between upstream industry s and downstream industry j (LS_{sj}) is

$$LS_{sj} = \sum_{s=1}^{n} Labour_{sj} * w_{sj} \tag{7}$$

where w_{sj} is obtained from the 2002 China's Input-Output Table, capturing downstream industry j's dependence on intermediate inputs from upstream industry s.

The results of these two channels are presented in Panels B and C, Table 3. Both the coefficients of foreign entry barrier and the interaction terms between the TS (or LS) and the *Barrier* indicator are significantly negative, indicating that the productivity effect of foreign entry barrier is larger for downstream firms in industries using similar technology or labour structure with their upstream industries. Thus, liberalization of foreign investment in upstream industries (a reduction of *Barrier*) can provide more benefits to firms in downstream industries sharing similar technology or labour structure, as they have better chances to exploit the superior foreign intermediate inputs.

6.3 Two firm-specific channels: R&D investment and outsourcing intensity

Firms' R&D investment can be a vital channel through which upstream foreign entry barriers affect downstream productivity. Investment liberalization in upstream industries offers an opportunity for downstream firms to exploit the superior intermediates which allow firms to increase their efficiency and competitiveness. Since some knowledge/technology is tacit and difficult to acquire unless the firm is directly involved in R&D in this area, we hypothesize that firms which actively engage in R&D investment may better reap these benefits due to *absorptive capacity*. We test this hypothesis by interacting a R&D dummy ($R\&D$) with the upstream foreign entry barrier indicator.[9]

The results are presented in Panel A, Table 4. We find that R&D itself has a significantly positive impact on firm productivity. This might be due to the development of absorptive capacity, as it permits the identification, assimilation and exploitation of innovations made by other firms. Another explanation is that R&D investment may generate process innovations that allow existing products to be produced with greater efficiency (through lower costs). The interaction term between R&D and foreign entry barrier indicator is negative and significant, indicating that firms engaging in R&D investment can better reap the benefits of an easing of the foreign entry barriers in upstream industries.

Firms' outsourcing behavior can also affect the link between foreign entry barri-

[9]We define a R&D dummy which is equal to 1 if the value of R&D is great than 0, and 0 otherwise.

ers and downstream productivity. Outsourcing refers to the process of transferring some manufacturing and related services tasks to other companies. The 'make-or-buy' decision is fundamental to industrial organization, i.e. a producer must decide whether to undertake the activity in-house or to rely on market forces and purchase the input or services from the outside (Grossman and Helpman, 2002). There is a trade-off between internalizing and outsourcing. On the one hand, the TFP of manufacturing firms which outsource their production and service tasks to more productive contract manufacturer or service providers can be accelerated through the specialization effect. For instance, the local suppliers might be highly specialized with particular expertise in the activity, which reduces the overall production costs of manufacturing firms seeking out the lowest cost suppliers. On the other hand, too much outsourcing may involve significant transaction costs, imperfect information and contractual incompleteness, which leads to market failures affecting the contractual relationship with the supplier.

Table 4: The firm-specific channels

	Barrier_1			Barrier_2		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. The R&D investment						
Ln(Barrier)	-0.008***	-0.011***	-0.017***	-0.025***	-0.018***	-0.018***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Ln(Barrier)∗R&D	-0.004***	-0.004***	-0.003***	-0.042***	-0.035***	-0.029***
	(0.001)	(0.001)	(0.001)	(0.006)	(0.006)	(0.005)
R&D	0.105***	0.067***	0.066***	0.085***	0.052***	0.053***
	(0.009)	(0.008)	(0.008)	(0.005)	(0.004)	(0.004)
R^2	0.898	0.912	0.912	0.898	0.912	0.912
Observation	1219093	1219093	1219093	1219093	1219093	1219093
Panel B. The outsourcing intensity						
Ln(Barrier)	-0.013***	-0.024***	-0.026***	-0.055***	-0.075***	-0.069***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)
Ln(Barrier)∗Ln(Outsourcing)	-0.024***	-0.023***	-0.023***	-0.019**	-0.017**	-0.016**
	(0.003)	(0.003)	(0.003)	(0.006)	(0.006)	(0.006)
Ln(Outsourcing)	-0.075***	-0.076***	-0.072***	-0.019***	-0.017***	-0.016***
	(0.008)	(0.007)	(0.007)	(0.003)	(0.002)	(0.002)
R^2	0.877	0.894	0.894	0.877	0.894	0.894
Observation	1822175	1822175	1822175	1822175	1822175	1822175

Notes: we report only the coefficients of key variables to save space; see notes of Tables 1 and 3 for other information.

Since outsourcing extends the linkages among industries, we hypothesize that the downstream effect of foreign entry barriers is more marked for firms with high outsourcing intensity. We define outsourcing intensity, $Ln(Outsourcing)$, as the natural logarithm of firms' intermediate inputs as a share of total output. The results are reported in Panel B,

Table 4. The effect of outsourcing itself on firms' productivity is found to be significantly negative, suggesting that the market failure effect dominates the benefits of outsourcing as discussed above. This is not entirely surprising, given that the hold-up problem emerging from incomplete contracts or various agency costs arising from asymmetric information can be prevalent in a transition economy like China. The negative and significant interaction term between outsourcing intensity and the foreign entry barrier indicator confirms our view that firms' outsourcing behaviour intensifies the linkages between upstream and downstream industries and thus magnifies the downstream effect of foreign entry barriers.

7 Further robustness checks

7.1 Endogeneity

Despite the largely exogenous nature of our policy variable on foreign entry regulation, endogeneity can arise from the following three causes. First, lobbyism can make policies endogenous (Bourlès et al., 2013). For instance, low productivity firms may have incentives to exert political pressures for raising anti-competitive regulations on foreign entry in order to protect their existing market shares and rents. Second, if the foreign entry policy is endogenous to changes in the overall economic conditions, then the causality between the policy and performance may run in both directions. This might be the case for China, as reflected by the frequent revision of foreign entry regulation according to its economic development. Third, endogenous bias might arise as a direct consequence of the way the policy variables are computed. For instance, industry productivity may affect the input weights, thus making the policy variables endogenous; also, China's input-output matrices may be highly related to domestic policies.

We adopt three methods to deal with the problem of endogeneity, namely the Instrumental Variable (IV) approach, the Difference-in-Difference (DID) approach and an alternative weight using the US Input-Output Table to construct the foreign entry barrier indicator. The results are presented in Table 5.

First, inspired by Arnold et al. (2016), we use India's measure of anti-competitive

regulations on product market from the OECD dataset ($IV\text{-}India$) as an instrument for our foreign entry barrier variable. The justification is that China and India are close competitors, so that India's market-opening commitments are likely to have influence on China's foreign entry policy. In Panel A, Table 5, the first-stage regression results show a positive and significant correlation between China and India's market-opening policy. The second-stage results confirm the exogenous role of foreign entry barrier in dampening the productivity of downstream manufacturing firms in China. The highly significant statistics of Durbin and Wu-Hausman tests suggest the rejection of the null hypothesis of exogeneity for the foreign entry barrier indicator. The Hausman test rejects the null hypothesis that there is no systematic difference between the OLS and IV estimators, implying that our IV specification is appropriate and the selected instruments are valid.

Table 5: The endogeneity tests

	Barrier_1			Barrier_2		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. The Instrumental Variable (IV) approach						
Ln(Barrier)	-1.396***	-1.233***	-0.478***	-0.972***	-0.755***	-0.787***
	(0.011)	(0.015)	(0.004)	(0.006)	(0.008)	(0.010)
Durbin χ^2 test	14801.9***	10831.6***	11125.5***	1819.6***	192.3***	21336.1***
Wu-Hausman F test	14938.4***	10919.1***	11192.3***	1816.4***	153.2***	21593.1***
Hausman test	14801.3***	276624.5***	79382.1***	7342.1***	199666.3***	2618.5***
Observation	1824089	1824089	1824089	1824089	1824089	1824089
First-Stage Regressions						
IV-India	0.156***	0.128***	0.329***	0.212***	0.214***	0.178***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)
Panel B. The Difference-in-Difference approach						
Treatment	0.043***	0.031**	0.046***			
	(0.015)	(0.015)	(0.015)			
Treatment∗Post	0.004***	0.007***	0.005**			
	(0.001)	(0.002)	(0.002)			
Index				0.245***	0.236***	0.296***
				(0.031)	(0.030)	(0.030)
Index∗Post				0.008**	0.033***	0.025**
				(0.004)	(0.012)	(0.013)
Post	0.154***	0.124***	0.083***	0.159***	0.120***	0.063***
	(0.003)	(0.003)	(0.006)	(0.007)	(0.006)	(0.008)
R^2	0.93	0.938	0.938	0.927	0.934	0.934
Observation	158682	158682	158682	223060	223060	223060
Panel C. Using the US Input-Output Table to compute the Barrier measure						
$\text{Ln}(\text{Barrier}_{US})$	-0.016***	-0.022***	-0.029***	-0.056***	-0.068***	-0.069***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)
R^2	0.876	0.892	0.895	0.875	0.893	0.894
Observation	1822175	1822175	1822175	1822175	1822175	1822175

Notes: we report only the coefficients of key variables to save space; the null hypothesis of the Durbin and Wu-Hausman tests of endogeneity is that the variable under consideration can be treated as exogenous; the null hypothesis of the Hausman specification test is that there is no systematic difference between the two estimators; see notes of Tables 1 and 3 for other information.

Second, we adopt the DID approach to estimate the productivity effect of foreign entry barriers on downstream manufacturing firms. There was a significant liberalizing move on China's foreign entry regulation in 2002 (mainly in the manufacturing sector) following its WTO accession, as shown in Figures 2 and 5. We therefore select 2002 as the benchmark to examine the effect of this policy change on downstream firms' productivity over the period of 2001-03.[10] We first construct a 2002 reform index for each upstream industry which records the proportion of 4-digit industries that are exposed to the 2002 policy change of investment liberalization in each 3-digit industry in the Input-Output Table. For instance, a 3-digit upstream industry s has m 'restricted' or 'prohibited' 4-digit sectors in 2001 (according to the 1997 'Catalogue'), and n of them are changed to the status of being 'permitted' or 'encouraged' after 2002, then the degree of the 2002 investment liberalization of this upstream industry s is n/m. An index of the effect of 2002 reform on downstream industries ($Index$) is computed by weighting this measure with the information from China's Input-Output Table.

We report the results of two variants of the DID approach in Panel B, Table 5. The first method is to select the top 1/3 observations of this index as the treatment group, and the bottom 1/3 observations as the control group. The treatment group dummy ($Treatment$) is equal to 1 if the firm belongs to the treatment group, and 0 otherwise. We also define a time dummy ($Post$) which takes the value of 1 for year 2002 and 2003, and 0 for year 2001. We find that the coefficient of the interaction term between the treatment group and the time dummy is positive and significant, indicating that the foreign entry liberalization in 2002 improves the productivity of downstream firms. Inspired by Rajan and Zingales (1998) and Nunn (2007), we include directly the index of the effect of 2002 reform on downstream industries ($Index$) and interact it with the time dummy ($Post$). The positive and significant interaction term of the second approach echos the previous finding of the productivity-enhancing effect of investment liberalization in 2002.

Lastly, the 2002 US Input-Output Table (including 369 industries) is used to construct an alternative set of input weights for the foreign entry barrier indicator ($Barrier_{US}$). On the one hand, the US input-output coefficients may reflect technological differences

[10] This time span is selected because another 'Catalogue' was released (a new policy change) in 2004.

rather than country-specific determinants. On the other hand, it is not correlated with Chinese firm and industry characteristics. The results are reported in Panel C, Table 5 and our main findings remain intact.

7.2 Other robustness tests

Table 6: Other robustness tests

Panel A. An alternative measure of TFP based on Olley and Pakes (1996) approach						
	$Barrier_1$			$Barrier_2$		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Barrier)	-0.075***	-0.065***	-0.084***	-0.085***	-0.083***	-0.097***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)
R^2	0.822	0.822	0.824	0.821	0.822	0.822
Observation	1824089	1824089	1824089	1824089	1824089	1824089
Panel B. An alternative measure of foreign entry barrier						
	$Ln(TFP^{GMM})$			$Ln(TFP^{OP})$		
	(1)	(2)	(3)	(4)	(5)	(6)
$Barrier_3$	-0.046***	-0.065***	-0.063***	-0.037***	-0.032***	-0.019***
	(0.004)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)
R^2	0.876	0.892	0.893	0.821	0.821	0.823
Observation	1824089	1824089	1824089	1794069	1794069	1794069
Panel C. The direct effect of foreign entry						
	Foreign share (value added)			Foreign share (employment)		
	(1)	(2)	(3)	(4)	(5)	(6)
Foreign share	0.073***	0.077***	0.057***	0.099***	0.102***	0.087***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
R^2	0.877	0.893	0.893	0.877	0.893	0.894
Observation	1824089	1824089	1824089	1824089	1824089	1824089

Note: we report only the coefficients of key variables to save space; the dependent variable in Panel A is the natural logarithm of TFP based on the Olley and Pakes (1996) approach; the dependent variable in Panel B is the natural logarithm of TFP based on either the System GMM estimation (TFP^{GMM}) or the Olley and Pakes (1996) method (TFP^{OP}); the dependent variable in Panel C is the natural logarithm of TFP based on the system GMM estimation; see notes of Tables 1 and 3 for other information.

We compute some alternative measures of key variables as further robustness tests. Firstly, we construct another measure of TFP using the semi-parametric Olley and Pakes (1996) approach (TFP^{OP}). This method is useful to alleviate both the selection bias and simultaneity bias (between input choices and productivity shocks). Another advantage of Olley-Pakes method is the flexible characterization of productivity, which only assumes that it evolves according to a Markov process (Van Biesebroeck, 2007). The results are reported in Panel A, Table 6 and our results remain robust.

Secondly, we construct a new measure of foreign entry regulation, as neither FER_1 nor FER_2 captures the information of the 'encouragement' policy in the 'Catalogue'. To deal with this problem, we assign the value of 2 to the 'prohibited' items, the value of 1 to the 'restricted' items, and the value of -1 to the 'encouraged' items in each 4-digit industry. The corresponding foreign entry regulation indicator of an industry (FER_3) is the sum of values of all items in this industry. Crossing FER_3 with the intensity of intermediate input use calculated from national input-output matrices, we obtain the new measure of foreign entry barrier ($Barrier_3$) faced by downstream firms. Panel B, Table 6 presents the results of this new measure and our key findings remain intact.

Thirdly, there is some concern that the policy information from the 'Catalogue' may not fully reflect the situation of foreign entry regulation or corresponding barriers in China. For instance, some rules and laws on foreign entry which are not officially recorded in the 'Catalogue' may actually exist and are implemented by local governments. To tackle this potential criticism, we estimate the direct effect of foreign entry on downstream firms' productivity in Panel C, Table 6, where *Foreign share* is the weighted share of foreign firms in total value added or employment of each upstream industry, and the weight is given by the amount of intermediate inputs sourced from each upstream industry expressed as a fraction of the overall inputs used by the downstream manufacturing industry. We find a positive and significant effect of foreign entry on downstream firms' productivity for both measures of foreign share. This confirms our earlier findings that the anti-competitive foreign entry regulations or barriers on the upstream industries curb downstream productivity, and investment liberalization, on the other hand, is conducive to the productivity gains.

Lastly, according to Arnold et al. (2011), one advantage of using the firm-level dataset is to pinpoint the effect on domestic firms, which is of high interests to national policy makers. For this reason, we estimate the baseline model for the sample of domestic firms only, and our results remain robust. To save space, the results are not reported but available upon request.

8 Conclusion

Entry barriers are argued to be the most effective instrument for restricting competition (Djankov et al., 2002; Klapper et al., 2006). According to Aghion et al. (2009), foreign entry can induce reallocation of inputs and outputs, trigger knowledge spillovers, and affect innovation and productivity of incumbent firms. We examined the trickle-down effect of upstream foreign entry barriers on the productivity of downstream manufacturing firms.

By making the assumption that the impact of foreign entry regulation is more pronounced in manufacturing sectors relying more heavily on manufacturing and services inputs, we built an indicator of the foreign entry barrier for downstream industries by crossing the upstream foreign entry regulation measure with the intensity of intermediate input use calculated from national input-output matrices. We found that foreign entry regulations on the upstream manufacturing and services industries have powerful depressing effects on downstream productivity, and the relationship depends on a number of industry- and firm-specific features.

Our findings have important policy implications for both the Chinese governments and foreign investors. For instance, some recent policy reports have highlighted the increasing concerns by foreign investors over restrictive government policies in China. Our results indicate that removing any remaining entry restrictions on upstream industries could bring substantive productivity gains and benefits to not only firms producing in these industries but also those using inputs from these industries. In particular, we find that most barriers to foreign investment today are not on goods but on the services sectors, which strengthens the argument for further liberalization of services industries and opening of services sectors to foreign providers. Our urgent call for services liberalization is consistent with China's recent policy of developing a modern services industry in order to maintain its growth momentum. This research also highlights the importance of complementary labour and product market reforms in order to improve the resource allocation efficiency by reallocating resources to more technologically developed and R&D intensive sectors where firms respond more positively to trade and services liberalization.

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Appendix A Additional information of our measures of foreign entry regulation and barrier

Table A1: Number of regulated items in various issues of 'Catalogue for the Guidance of Foreign Investment'

	1997			2002			2004			2007		
	E	R	P	E	R	P	E	R	P	E	R	P
Agriculture	6	4	3	11	2	3	11	2	3	12	3	3
Manufacturing	176	73	14	216	41	14	209	41	14	298	48	15
Services	3	25	14	35	32	18	36	35	17	41	36	21
Total	185	102	31	262	75	35	256	78	34	351	87	39

Notes: 'E' refers to the 'encouraged' items; 'R' refers to the 'restricted' items, and 'P' refers to the 'prohibited' items.

Table A2: Proportion of foreign firms in manufacturing industries

	Number of foreign firms	Number of all firms	Foreign share (%)
1998			
Restricted Industries	5089	37331	13.6
Unrestricted Industries	20819	110940	18.8
2002			
Restricted Industries	2805	19996	14.0
Unrestricted Industries	30915	145502	21.2
2004			
Restricted Industries	4573	31933	14.3
Unrestricted Industries	51437	226474	22.7
2007			
Restricted Industries	5333	38085	14.0
Unrestricted Industries	60470	273356	22.1

Notes: the information comes from the NBS firm-level dataset; industry classification is based on the measure of Barrier_2, where Restricted Industries are those Barrier_2=1 and unrestricted Industries are those Barrier_2=0.

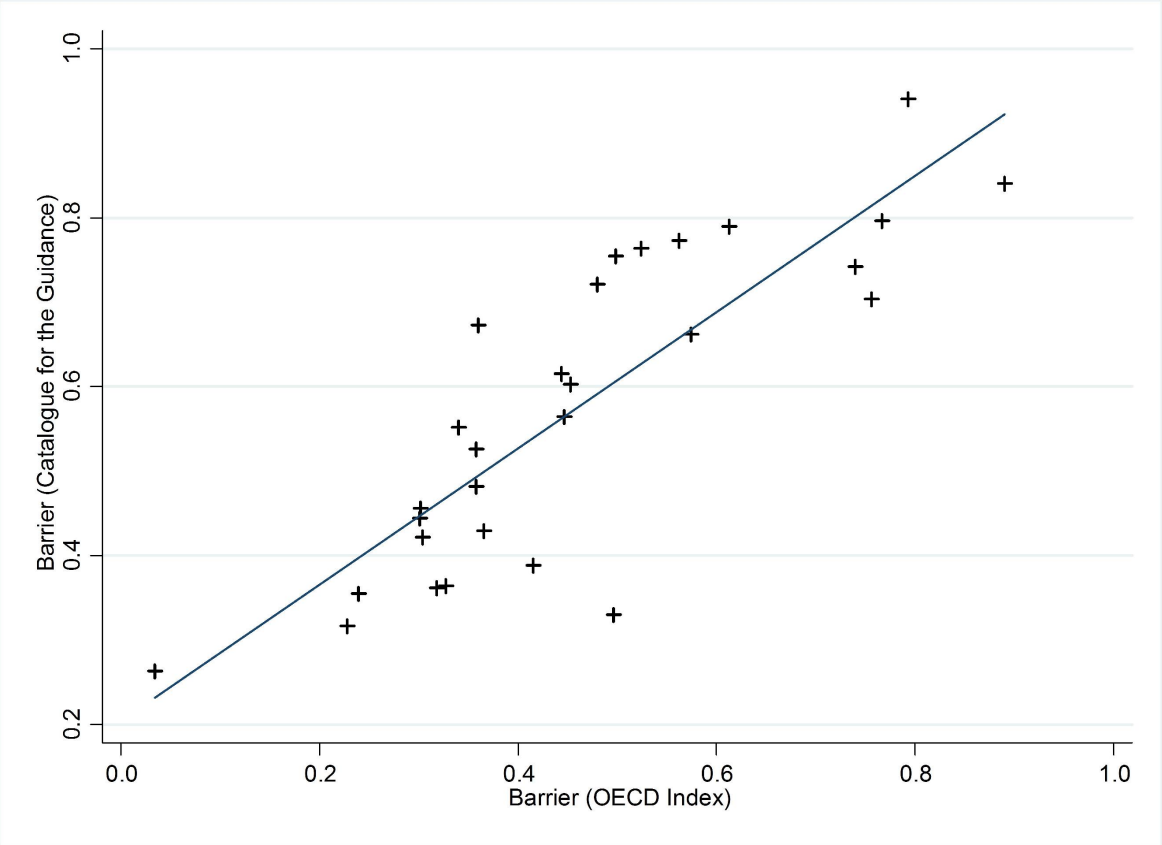

Figure A1: Correlation between two foreign entry barrier measures

Note: the vertical axis is the foreign entry barrier measure computed based on the information from the 'Catalogue for the Guidance of Foreign Investment' (Barrier_2); the horizontal axis is the foreign entry barrier measure computed based on the information from OECD's FDI Restrictiveness Index; the year is 2003 which is the first available year of OECD Index; results for Barrier_1 and other years are similar and available upon request.

Table A3: The FER index of each 2-digit industry in China (%)

Manufacturing (code)	1997	2002	2004	2007	Services (code)	1997	2002	2004	2007
13	20	17.65	17.65	5.88	51	0	40	40	40
14	5.26	5	5	0	52	40	40	40	40
15	66.67	23.08	30.77	30.77	53	20	0	0	0
16	33.33	33.33	33.33	33.33	54	66.67	66.67	66.67	66.67
17	10	9.52	9.52	4.76	55	66.67	33.33	33.33	33.33
18	0	0	0	0	56	0	0	0	0
19	10	0	0	0	57	50	50	50	50
20	0	0	0	0	58	0	0	0	0
21	0	0	0	0	59	100	100	100	100
22	40	16.67	16.67	16.67	60	71.43	85.71	85.71	100
23	60	20	20	20	61	0	0	0	0
24	0	0	0	0	62	0	0	0	0
25	25	25	25	75	63	4.17	22.92	22.92	27.08
26	23.33	17.14	17.14	14.29	65	2.22	15.56	15.56	13.33
27	16.67	28.57	28.57	28.57	66	33.33	33.33	33.33	33.33
28	28.57	14.29	14.29	14.29	67	0	0	0	0
29	22.22	33.33	33.33	22.22	68	66.67	66.67	66.67	66.67
30	0	0	0	0	69	75	25	25	25
31	10	0	0	0	70	100	100	100	100
32	0	0	0	0	71	66.67	66.67	66.67	50
33	33.33	16.67	16.67	50	72	25	25	25	50
34	16.67	4.17	4.17	4.17	73	0	100	100	0
35	9.68	6.06	6.06	6.06	74	20	10	15	15
36	11.9	17.65	19.61	19.61	75	0	0	0	20
37	26.09	0	0	11.11	76	10	30	20	20
39	25	0	0	3.57	77	0	0	0	0
40	18.75	9.52	9.52	9.52	78	20	40	40	40
41	8	0	0	4	79	0	0	0	0
42	41.67	13.33	13.33	33.33	80	25	25	25	25
					81	20	0	20	20
					82	0	0	0	11.11
					83	0	0	0	0
					84	76.92	23.08	23.08	30.77
					85	100	100	100	100
					86	0	0	0	0
					87	0	0	0	0
					88	85.71	85.71	85.71	100
					89	100	100	80	80
					90	0	0	0	10
					91	0	0	0	66.67
					92	25	25	25	100

Notes: the FER index illustrates the proportion of regulated 4-digit industries in each 2-digit industry; manufacturing industries include: 13: Processing of food from agriculture products; 14: Manufacture of foods; 15: Manufacture of beverages; 16: Manufacture of tobacco; 17: Manufacture of textiles; 18: Manufacture of textiles apparel, footwear and headgear; 19: Manufacture of leather, fur, feather (velvet) and related products; 20: Processing of timber, manufacture of wood, bamboo, rattan, palm and straw products; 21: Manufacture of furniture; 22: Manufacture of paper and paper products; 23: Printing and reproduction of recorded media; 24: Manufacture of articles for culture, education and sport activity; 25: Processing of petroleum, coking, processing of nuclear fuel; 26: Manufacture of chemical raw materials and chemical products; 27: Manufacture of medical and pharmaceutical products; 28: Manufacture of chemical fibers; 29: Manufacture of rubber; 30: Manufacture of plastics; 31: Manufacture of non-metallic products; 32: Smelting and pressing of ferrous metals; 33: Smelting and pressing of nonferrous metals; 34: Manufacture of metal products; 35: Ordinary machinery products; 36: Special purpose equipment products; 37: Transport equipment products; 39: Electric equipment and machinery products; 40: Telecommunication equipment , computer and other electronic products; 41: Manufacture of measuring instruments and machinery for cultural activity and office work; 42: Manufacture of artwork and other manufacturing; services industries include: 51: Railway transport; 52: Road transport; 53: Urban public transport; 54: Water transport; 55: Air transport; 56: Pipeline transport; 57: Loading ,unloading, removal, and other transport services; 58: Storage; 59: Postal services; 60: Telecommunications and other information transfer services; 61: Computer services; 62: Software; 63: Wholesale trade; 65: Retail trade; 66: Accommodation; 67: Catering; 68: Banking; 69: Securities; 70: Insurance; 71: Other financial activities; 72: Real estate; 73: Leasing; 74: Commercial services; 75: Research and experimental development; 76: Polytechnic services; 77: Scientific exchange and distribution; 78: Geological prospecting; 79: Water management (conservancy); 80: Environmental management; 81: Management of public facilities; 82: Resident services; 83: Other service activities; 84: Education; 85: Health care; 86: Social insurance; 87: Social welfare; 88: News and publishing; 89: Radio , television, film, and audiovisual media; 90: Culture and arts; 91: Sports and 92: Entertainment.

Appendix B TFP estimates

Table B4: TFP Estimates using the system GMM approach

Chinese Industry	Estimated Coefficients			Tests (p-value)		TFP	Std. Dev.
	Labor	Capital	Materials	AR(2)	Hansen		
13	0.059	0.127	0.86	0.279	0.928	7.333	1.727
14	0.207	0.119	0.887	0.231	0.937	9.316	2.719
15	0.088	0.099	0.778	0.316	0.947	6.779	1.582
16	0.189	0.07	0.71	0.722	0.952	7.317	1.868
17	0.05	-0.045	0.81	0.377	0.938	6.782	1.546
18	0.046	0.165	0.892	0.425	0.971	8.299	1.622
19	0.207	0.082	0.718	0.558	0.392	5.539	2.475
20	0.149	0.071	0.775	0.519	0.577	6.571	1.951
21	0.154	0.091	0.76	0.182	0.871	6.632	2.199
22	0.025	0.174	0.897	0.191	0.182	6.764	2.153
23	0.384	0.096	0.772	0.327	0.933	8.414	2.685
24	0.181	0.131	0.688	0.533	0.842	5.752	1.343
25	0.155	0.254	0.668	0.421	0.258	6.485	1.221
26	0.165	0.088	0.753	0.819	0.173	5.733	1.351
27	0.179	0.13	0.69	0.613	0.834	6.739	1.496
28	0.306	0.103	0.71	0.134	0.727	6.428	1.44
29	0.273	0.113	0.65	0.212	0.914	5.998	1.501
30	0.209	0.083	0.632	0.652	0.573	5.592	1.69
31	0.155	0.18	0.574	0.473	0.298	6.665	1.253
32	0.265	0.112	0.684	0.442	0.473	6.385	1.748
33	0.18	0.153	0.693	0.573	0.218	6.295	1.605
34	0.166	0.026	0.651	0.271	0.993	6.599	1.72
35	0.166	0.186	0.762	0.392	0.471	7.789	1.668
36	0.267	0.131	0.648	0.412	0.528	6.109	1.457
37	0.107	0.041	0.786	0.317	0.388	5.991	1.292
39	0.31	0.144	0.677	0.289	0.911	7.497	1.614
40	0.311	0.184	0.504	0.358	0.467	6.014	1.745
41	0.203	0.196	0.673	0.247	0.657	5.67	1.557
42	0.238	0.176	0.735	0.275	0.372	5.777	1.348

Notes: industry code corresponds to the 2002 2-digit China Standard Industrial Classification (CSIC) code, GB2002.

Appendix C Summary statistics

Table C5: Summary statistics of all variables used in the paper

Variable	Observation	Mean	Std. Dev.	Min	Max
Variables used in the baseline model					
Ln(TFP^{GMM})	1824089	8.637	1.326	-2.852	16.615
Ln(Barrier$_1$)	4220	-2.361	0.77	-4.177	-0.209
Ln(Barrier$_2$)	4220	-0.598	0.378	-2.329	-0.044
FER$_1$	4220	0.018	0.132	0.000	1.000
FER$_2$	4220	0.131	0.333	0.000	1.000
Ln(Tariff)	4220	1.901	0.457	0.718	3.383
HHI	4220	0.080	0.057	0.000	0.401
SOE	1824089	0.100	0.300	0.000	1.000
FIE	1824089	0.208	0.406	0.000	1.000
Ln(Employment)	1824089	4.785	1.125	2.079	12.145
Ln(Age)	1824089	2.019	0.911	0.000	3.913
Ln(Age^2)	1824089	4.906	4.216	0.000	7.827
Variables used in various economic mechanisms and the robustness checks					
Ln(Manufacturing-Barrier$_1$)	4220	-3.266	0.972	-5.503	-0.553
Ln(Manufacturing-Barrier$_2$)	4220	-1.139	0.663	-4.178	-0.236
Ln(Services-Barrier$_1$)	4220	-3.469	0.537	-4.981	-2.204
Ln(Services-Barrier$_2$)	4220	-1.944	0.297	-3.044	-1.293
Ln(Distance)	3727	2.802	0.622	0.478	5.957
TS	408	0.100	0.102	0.005	0.530
LS	387	0.594	0.160	0.057	0.835
R&D	1219093	0.114	0.318	0.000	1.000
Ln(Outsourcing)	1822175	-0.319	0.336	-15.07	5.263
IV-India	4220	0.231	0.162	0.057	0.866
Treatment	280	0.500	0.501	0.000	1.000
Index	422	0.172	0.189	0.009	0.372
Ln(Barrier$_{US}$)	4220	-0.621	0.379	-2.219	-0.038
Ln(TFP^{OP})	1794069	2.285	1.449	-2.588	10.162
Barrier$_3$	4220	0.150	0.369	-0.751	1.694
FER$_3$	4220	-0.128	0.594	-1.000	2.500
Foreign share (value added)	4220	0.191	0.093	0.000	0.675
Foreign share (employment)	4220	0.141	0.085	0.000	0.629

Appendix D Variable definitions

Ln(TFP^{GMM}): the natural logarithm of firms' TFP based on the System GMM estimation;

Ln(Barrier$_1$) and Ln(Barrier$_2$): the natural logarithm of two measures of overall foreign entry barrier faced by downstream industries;

FER$_1$ and FER$_2$: the two measures of foreign entry regulation in the manufacturing industries;

Ln(Tariff): the natural logarithm of the weighted measure of input tariffs faced by downstream manufacturing industries;

HHI: the Herfindahl index of upstream industries;

SOE and FIE: the dummy variables for state-owned firms and foreign firms respectively;

Ln(Employment): the natural logarithm of employment of each firm;

Ln(Age) and Ln(Age^2): the natural logarithm of firm age and its quadratic term;

Ln(Manufacturing-Barrier$_1$) and Ln(Manufacturing-Barrier$_2$): the natural logarithm of two measures of foreign entry barrier in the upstream manufacturing sector faced by downstream industries;

Ln(Services-Barrier$_1$) and Ln(Services-Barrier$_2$): the natural logarithm of two measures of foreign entry barrier in the upstream services sector faced by downstream industries;

Ln(Distance): the natural logarithm of downstream industries' distance to the world technology frontier;

TS and LS: the technology sharing similarity and labour structure similarity between upstream and downstream industries respectively;

R&D: a dummy variable which is equal to 1 if the firm has R&D, and 0 otherwise;

Ln(Outsourcing): the natural logarithm of the ratio of intermediate inputs to firms' total output;

IV-India: India's measure of anti-competitive regulations on product market from the

OECD dataset;

Index: an index of the effect of 2002 reform on downstream industries;

Treatment: the treatment group dummy which is equal to 1 if the firm belongs to the treatment group, and 0 otherwise;

Post: a time dummy which takes the value of 1 for year 2002 and 2003, and 0 for year 2001;

Ln(Barrier_{US}): the natural logarithm of foreign entry barrier indicator where the weights are using the US input-output coefficients;

Ln(TFP^{OP}): the natural logarithm of firms' TFP based on the Olley and Pakes (1996) approach;

Barrier_3: the third measure of foreign entry barrier faced by downstream industries;

FER_3: the third measure of foreign entry regulation in the manufacturing industries;

Foreign share (value added): the weighted share of foreign firms in total value added of upstream industries;

Foreign share (employment): the weighted share of foreign firms in total employment of upstream industries.