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

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Abstract

Using a unique measure of foreign entry regulation, we examine the largely ignored indirect impacts of foreign entry barriers on downstream manufacturing activities in China. We find that there exists a significant liberalizing move in the manufacturing sector, whereas restrictions in the service sector remain stringent. Our results show that foreign entry barriers in the upstream manufacturing and service industries curb downstream firm productivity. The effect depends on some industry-specific features such as their distance to the world technological frontier, technology sharing similarity and labour structure similarity between upstream and downstream industries. Some firm-specific features such as R&D investment and service and material outsourcing are vital channels through which upstream regulations impact downstream productivity.

JEL Classification: L5; F14; D24; O12

Keywords: Entry regulation; investment liberalization; input-output linkages; productivity; competition; China

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1 Introduction

Despite some recent efforts to easing curbs on foreign investment, China has imposed tight regulation on foreign entry since 1990s. For instance, the 'Catalogue for the Guidance of Foreign Investment' published by China's National Development and Reform Commission has been viewed as a central policy of the Chinese government that foreign investment must be made in a manner that is consistent with China's economic policy and in a way that will promote China's economic development. A recent media report indicates that the Chinese government is increasingly under pressure to remove tight restrictions on foreign investment so that the chances of reciprocal investment barriers faced by Chinese investors can be reduced[1]. More importantly, these regulations, by generating entry barriers and impeding competition and technological spillover among upstream industries, may have significant depressing effects on the productivity of other Chinese industries through 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* by allowing greater foreign entry in both services and manufacturing sectors. The paper tends to fill this important gap. The novelty of our paper lies in at least 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 largely ignored *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 an important channel through which microeconomic shocks may generate a 'cascade effect', i.e. where production structure shows intersectoral dependence, idiosyncratic shocks may propagate throughout the economy, affect the output of other sectors, and generate sizable aggregate effects. Using French firm-level data, Di Giovanni et al. (2014) show that 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 amplified in the presence of input-output linkages. This is particularly relevant for China as the world's largest and the most dynamic developing country. Figure 1 depicts the input-output linkages between 122 4-digit Chinese industries in 2002. It shows that firms and industries are embedded in a complex production network and in particular, some sectors (the ones in the middle of the

[1]See the article on 05 November 2014 *Financial Times*, titled by 'China looks to ease curbs on foreign investment'.

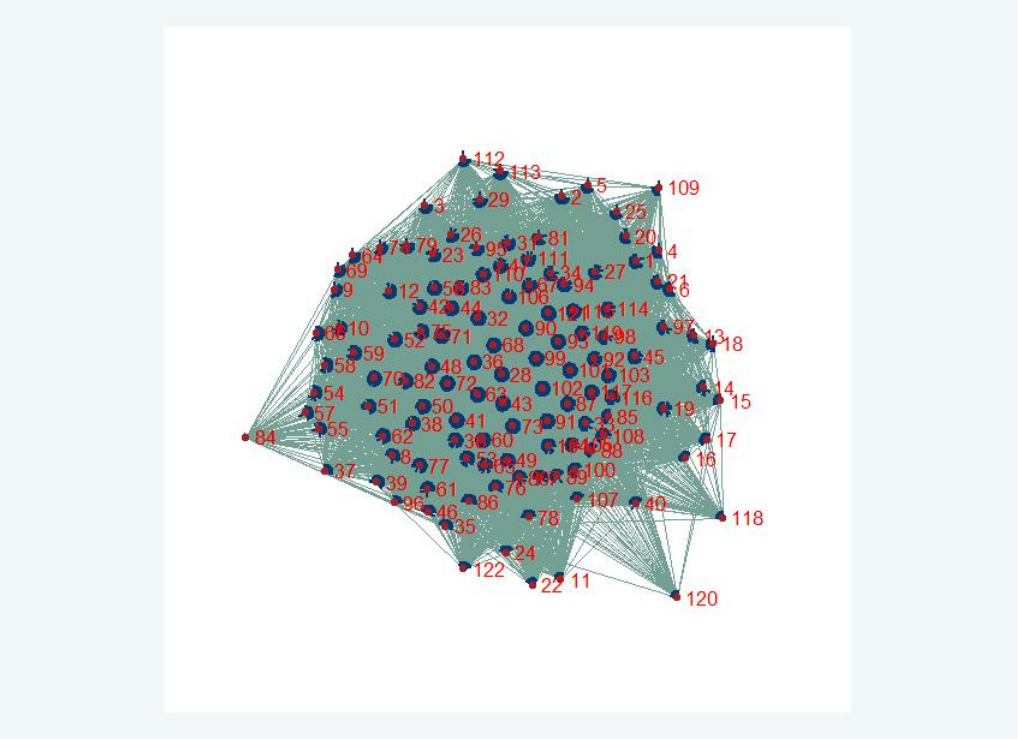

Figure 1: Intersectoral network corresponding to China's Input-Output matrix in 2002

Notes: Each vertex corresponds to a sector in the 2002 Input-Output Table of China complied by the National Bureau of Statistics.The 2002 Input-Output Table consists of 122 3-digit sectors in the Chinese economy, including 72 manufacturing sectors, 34 service sectors, and 16 other sectors including agricultural, mining, etc. For every input transaction above 5% of the total input purchase of a sector, a link is drawn between that sector and the input supplier.

network) play a disproportionately important role as input suppliers to others. Thus, regulations that bridle 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 form the regulated industries, thereby generating sizable aggregate effects. This important cross-industry influence of foreign entry regulation on productivity outcomes in China, to the best of our knowledge, has 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 for the Guidance of Foreign Investment', which provides explicit information on the sectors which Chinese government permits, encourages, restricts, and prohibits foreign investment. The challenge is that the listed sectors and product categories in the 'Catalogue' are not identified with any formal sectoral or industrial classification system. We therefore 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 from China's National Bureau of Statistics (NBS). This novel and comprehensive dataset is believed to be superior to the commonly-used OECD indicators of anti-competitive regulations on product market which covers only a very small number of broadly-defined non-manufacturing industries (Bas and Causa, 2013; Bourlès et al., 2013; Cette et al., 2013).

Third, we investigate the trickle-down effects of foreign entry regulation in 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., 2014). 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 tends to provide a rigorous evidence-based analysis of the largely ignored role of foreign entry regulation in services sectors, along with that in manufacturing sectors, in driving the productivity outcome of downstream manufacturing industries relying on those services and manufacturing inputs.

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 shapes 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 labor 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 to 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 restrictions in the services sector remain stringent. The baseline model estimation shows that foreign entry regulation in the upstream manufacturing and services industries curb downstream firm productivity. In other words, when regulations restrict 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. Consistent with the neo-Schumpeterian framework, we find that the downstream effects of lack of upstream competition are non-linear, which depend on the distance to the technological frontier of downstream industries. Some important industrial features such as technology sharing similarity and labor structure similarity between upstream and downstream industries are found to play a role in shaping the nexus between upstream regulation and downstream productivity. Besides, firms' R&D investment as well as services and material outsourcing are vital channels through which upstream regulation impacts downstream productivity. The results are robust when a number of methods are adopted to deal with the potential endogeneity (such as the Instrumental Variable approach, the Difference-in-Difference method and the use of US Input-Output Table) and when alternative measures of key variables are employed.

The structure of the paper is as follows. Section 2 briefly reviews the related theoretical and empirical literature. Section 3 addresses some background information on China's FDI inflows and market entry barriers. Section 4 explains our data, variables, model specification and estimation strategy. Section 5 presents the summary statistics, discusses the results of our baseline model estimation, and explores various channels through which foreign entry regulation affects downstream productivity. Section 6 conducts a number of robustness checks and focuses on the endogeneity and alternative measures of key variables. Section 7 concludes the paper.

2 Related literature

Our paper relates to a number of theoretical and empirical literature on the regulation of entry; the productivity effects of competition; and the liberalization of trade, FDI and services.

2.1 Regulation of entry: theory and evidence

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. As applied to entry, this view holds that the government screens new entrants to make sure that consumers buy high quality products from desirable sellers. Thus the public interest theory predicts that stricter regulation of entry should be 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, which enables the regulators to collect bribes from the potential entrants and serves no social purpose. These two strands of public choice theory predict that stricter regulation is associated with less competition and higher corruption.

There is a growing empirical literature on the effects of entry regulation on industrial structure. For instance, based on a unique cross-section dataset of entry regulation of start-up companies in 85 countries, Djankov et al. (2002) find that heavier regulation of entry is generally associated with greater corruption and a larger size of the unofficial economy. Also, entry is regulated more heavily by less democratic governments, and such regulation does not yield visible social benefits. This evidence favors public choice over the public interest theories of regulation, and has been used to motivate simplification of business start-up (Djankov, 2009). Using industry-level data for 21 OECD countries during the period of 1975-1998, Alesina et al. (2005) find that liberalization of entry in potentially competitive markets has a significant positive impact on capital accumulation in the transport, communication and utilities industries. This is consistent with the theoretical prediction that a reduction in entry barriers generates a reduction of the markup, and hence of the penalty of expanding production, in terms of lost monopoly profits, which results in greater investment and higher sectoral productivity. Klapper et al. (2006) use a cross-country firm-level dataset to identify the impact of entry regulation on entrepreneurship. They find that the costly entry regulation hampers the creation of new firms, discriminates small new entrants, and dampens the growth rate of incumbent firms in the regulated industries.

Another strand of literature focuses on the interaction between entry regulation and trade openness. Based on cross-country data from 126 countries, Freund and Bolaky (2008) find that the ease of starting a business is an important mechanism through which trade enhances incomes, i.e. increased trade is positively correlated with income in economies that facilitate firm entry, but not in more rigid economies. Helpman et al. (2008) also find that with high fixed costs of entry, firms do not move easily towards the industries that most benefit from trade openness, which dampens the productivity/growth-enhancing effects of trade.

2.2 The competition-productivity nexus: does the distance to frontier matter?

Our paper relates closely to the literature which addresses the link between competition and productivity. The Schumpeterian growth theory predicts that competition reduces productivity growth by reducing monopoly profits that reward innovation. This argument, however, is challenged by Aghion et al. (2005) which argues that there is 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. The model predicts that for firms far from the technology frontier, an increase in competition may discourage their incentives to innovate because these laggard firms know that their chance to survive the new competition is limited even if they successfully innovate, i.e. they are too far from the frontier to be able to compete with the potentially technologically advanced new entrants. By contrast, as firms approach the frontier, competition can increase their incentives to innovate because competition may increase the incremental profits from innovating, and thereby encouraging firms' R&D investments aiming at escaping competition[2].

The distance-to-frontier theory is well supported by both the cross-country evidence on economic growth (Acemoglu et al., 2006) and the microeconomic evidence on industrial organization (Aghion et al., 2009) and international trade (Amiti and Khandelwal, 2013; Ding et al., 2015). More recently, such argument has been applied to the small but rising literature which examines the trickle-down effects of anticompetitive upstream regulations on the productivity performance of downstream industries. For instance, using a panel of 15 OECD countries and 20 industries over the period of 1985-2007, Bourlès et al. (2013) find that anticompetitive upstream regulations have significantly curbed multifactor productivity growth, and the effect is stronger for observations that are close to the productivity frontier. Using similar country-industry panel data, Cette et al. (2013) examine the role of investment in R&D and in ICT (Information and communications technology) in driving the relationship between upstream competition and the performance of downstream industries. They find that the distance of country-industry multifactor productivity to the corresponding figure in the US depends not only on the upstream regulatory burden indicator, but also on the distance of country-industry R&D and ICT capital intensities to that in the US. Using ORBIS firm-level data for 2001-08, Bas and Causa (2013) explore the effect of trade and product market policies in upstream sectors on productivity in downstream

[2]Ding et al. (2015) provides a detailed discussion on the theoretical mechanisms of the distance-to-frontier model.

firms in China. Trade and product market reforms are found to deliver stronger gains for firms that are closer to the industry-level technology frontier, while the reverse holds for financial market reforms.

One similarity of all 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 (energy, transport, communication, retail distribution, banking services and professional services) are included in Bourlès et al. (2013) and Cette et al. (2013), and only 3 industries (energy, transport, and communication) are included in Bas and Causa (2013). This leaves room for further exploration of the impact of upstream regulation or competition on downstream firms' productivity in China by using our comprehensive and highly-disaggregated dataset on foreign entry regulation.

2.3 Liberalization of trade, FDI and services: cross-country and China-specific evidence

There is a large 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 spillover 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, i.e. 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 etc.

The paper also relates to the recent growing empirical literature on the role of services liberalization in driving productivity and economic growth in both developing and developed countries (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. (2014) on India). The main finding of the literature is that services liberalization, mainly characterized by the entry of foreign providers, has a positive effect on the performance of domestic firms in downstream manufacturing

sectors. The main channels through which services liberalization shapes downstream firms' efficiency include the reduction of production factor costs, access to higher-quality service inputs, positive foreign spillovers, and the availability of new varieties of services used as inputs.

3 China background

3.1 FDI inflows in China

FDI inflows have been regarded as an important factor contributing to China's rapid economic growth. It is 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 the Chinese market. 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[3], totally amounted to $117.6 Billion, surpassed the US as the world's number one destination for FDI.

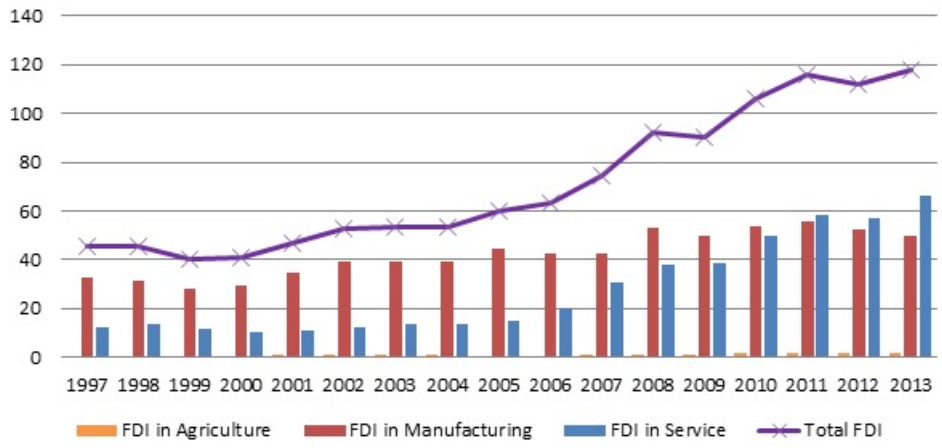

Figure 2: China's utilized inward FDI by sectors: 1997-2013 (Billion US$)

Data source: Statistical Yearbook of China (Various issues)

In addition to its' 'world factory' status by providing the manufacturing products of 'made in China', China has made a radical commitment to services liberalization in its WTO accession in 2001. For instance, China has committed to open most ser-

[3]China's data on utilized FDI includes investment in new FDI projects registered with the Ministry of Commerce but does not include other components usually included in the Balance of Payments (BoP) FDI statistics such as intra-company transfers and reinvested earnings.

vices 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. According to Figure 2 which illustrates China's FDI inflows by sectors, it is evident that China has been quite open for FDI in its manufacturing sectors; however, the services sector has not been fully liberalized until recently. Since 2005, while FDI in manufacturing sectors remains high and stable, it is the surge of FDI in services industries has contributed to the recent rise of FDI inflows to China.

3.2 Foreign entry regulation in China

Despite being an attractive destination for business investment and expansion, China has imposed significant market entry barriers on foreign investors. China's National Development and Reform Commission published a 'Catalogue for the Guidance of Foreign Investment' in 1995, which is regarded as an important official policy to guide foreign investment in China. It has been revised subsequently in 1997, 2002, 2004, 2007, 2011 and 2014, reflecting the evolvement and substantial change of 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' pinpoints that the challenge for China now is to attract the right kind of FDI as it strives to rebalance its economy, to improve the environment, and to move up the value chain. This goal is clearly reflected in the latest 2014 'Catalogue' which aims to move foreign investment away from investment in low value added and labor-intensive business, investment in conventional technology, and investment in high pollution and resource intensive technologies. Thus, China's recent FDI strategies are argued to take a more selective approach, to attract 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 shows where the Chinese government wants foreign investment to go, and it is expected that such projects are entitled to certain preferential treatment provided by the governments or authorities in terms of taxation, location choice and various subsidies. The 'prohibited' categories indicate the sectors that are hands off in China, and foreign investors are not allowed to invest in these items[4] under any

[4]The items listed in the 'Catalogue' include product categories, industries or sectors, which do not follow the official sectoral or industrial classification system in China (such as the 2002 China

circumstances. The 'restricted' category implies that foreign investors are allowed to invest in these items, but some conditions (such as the ownership, location choice, and business scope etc) may apply. It is also expected that the 'restricted' projects are subject to more stringent approval requirements. Lastly, the 'permitted' category means that foreign investors are allowed to invest in these items without any subsidy or condition. Thus understanding such regulations is crucial for foreign investors to take the opportunities and to overcome potential barriers, therefore making it easier to invest in China.

Table 1: 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 1 shows the number of regulated items listed in various issues of the 'Catalogue', ranging from 318 items in 1997 to 477 items in 2007. It is evident that Chinese government aims to 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 rises 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 even rises in the services sector (from 25 in 1997 to 36 in 2007). The number of 'prohibited' items barely changes in both manufacturing and agriculture sectors during 1997-2007, whereas the list of 'prohibited' items has been expanded in the services sector (from 14 in 1997 to 21 in 2007). This confirms that the 'Catalogue' as a whole remains nevertheless a restriction on inward FDI in China.

Standard Industrial Classification (CSIC) of All Economics Activities, i.e. GB2002). We therefore refer them to 'items' rather than 'industries'.

4 Data and empirical methodology

4.1 The datasets

In addition to the 'Catalogue' discussed above, we use a number of comprehensive microeconomic datasets in this paper, including the firm-level production data drawn from the annual survey of Chinese industrial firms by National Bureau of Statistics (NBS), China's Input-Output Tables, the product-level tariff information published by 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 accounting reports filed by industrial firms with the 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[5] and are located in all 30 Chinese provinces or province-equivalent municipal cities[6]. Following the literature (Brandt et al., 2012; Ding et al., 2015; Yu, 2015), we drop observations with negative total assets minus total fixed assets, negative total assets minus liquid assets, negative sales, and negative accumulated depreciation minus current depreciation. Firms with less than eight employees are also excluded as they fall under a different legal regime (Brandt et al., 2012). Lastly, we exclude observations in the one percent tails of each of the regression variables in order to isolate our results from potential outliers.

In order to examine the impact of foreign entry regulation on downstream firms, we need to measure the inter-sectoral linkages between upstream and downstream industries. For this purpose, China's Input-Output Tables are employed. The first China's Input-Output Table was jointly published by NBS, National Development and Reform Committee and Ministry of Finance in 1987. Then it was subsequently revised in 1992, 1997, 2002, 2007, 2010 and 2012. Corresponding to the sample period of NBS dataset, we use the 2002 and 2007 Input-Output Tables in this paper, which includes 122 3-digit industries in 2002 and 135 3-digit industries in 2007.

We obtain the tariff data from 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 empirical regression.

The construction of our distance-to-frontier proxy requires the industry-level

[5] We exclude utilities and mining sectors for our research purpose in this paper.
[6] Our dataset does not contain any firm in Tibet.

production data from the US, which is obtained from 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 adopted to compute the technology sharing similarity and labour structure similarity among industries.

4.2 Two important measures

4.2.1 Our measure of total factor productivity (TFP)

We calculate 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 many studies have shown that 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, Yu (2015) points out that one key assumption of Olley and Pakes (1996) approach is that capital is more actively responsive to unobserved productivity. He argues that this may not be applicable to China, which is a labor-abundant economy with low labor costs. He therefore suggests using the System GMM estimator 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 endogenous 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 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). In other words, productivity is due to efficiency levels and technical

progress.

It is known in the productivity literature that ideally one would use firm-specific price deflators when constructing TFP. Since such information is not available in the data, we use different industry-specific price deflators for inputs and outputs, which are directly drawn from Brandt et al. (2012). This implies that our TFP measure is 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 are also checking for the presence of second-order autocorrelation in the differenced residuals in all estimation. The estimated coefficients of the production function and the associated log of TFP by industry are reported in Appendix Table A1.

4.2.2 Our unique measure of foreign entry regulation

It is argued that there are at least two main challenges in 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 morer 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 by using China's Input-Output Tables. The main advantages of our FER indicator in empirical analysis are that they can be held to be exogenous to productivity outcomes and are directly related to 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 sys-

tem, we firstly need to establish a link between the regulation information from the 'Catalogue' and China's official list of sectoral categories, i.e. the 2002 China Standard Industrial Classification (CSIC) of All Economics Activities (GB2002)[7]. 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 under GB2002. 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 (i.e. the 'Catalogue') of prohibition, restriction or encouragement. And if there is no matching information from the 'Catalogue', the corresponding industry under GB2002 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 foreign entry regulation (FER) indicators.

First, we assign the value of 1 for 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 the government regulation on foreign entry includes both prohibition and restriction, we assign the value of 1 for 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.

Based on these two foreign entry regulation indicators, we are able to measure the extent of foreign entry barriers faced by downstream manufacturing industries. The main 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 choose to weight the extent of foreign entry regulation in each upstream sector by the reliance of downstream manufacturing firms on each upstream manufacturing and services input. Then the foreign entry barrier indicator ($Barrier$) for each downstream manufacturing industry

[7]GB2002 corresponds to the commonly-used International Standard Industrial Classification (ISIC) but with some differences.

can be 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) for 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 use the information from China's Input-Output Tables (the 2002 and 2007 version respectively) to evaluate the dependence of each manufacturing sector on the different upstream manufacturing and services sectors. 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. An advantage of using the industry-level information (rather than firm-level information) is that there is less need to be concerned about correlation between the performance of an individual firms and its input usage. The *Barrier* indicator takes the form of either $Barrier_1$ or $Barrier_2$ which is corresponding to the two measures of FER (FER_1 and FER_2) respectively.

4.3 Model specification and hypothesis

Our baseline model is specified as follows:

$$TFP_{ijt} = \beta_0 + \beta_1 Barrier_{jt} + \beta_2 X_{ijt} + \eta_t + \zeta_j + \xi_i + \mu_{ijt} \tag{3}$$

where the dependent variable, TFP_{ijt}, is the natural logarithm of TFP of firm i in industry j at year t; $Barrier_{jt}$ is the upstream foreign entry barrier for downstream manufacturing industry j at time t, taking 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 bridle on competition and technology spillovers.

X_{ijt} consists of a number of industry- and firm-specific control variables. First, a weighted measure of input tariffs ($Tariff_{jt}$) is included to capture the influence of trade liberalization on downstream manufacturing firms in industry j at time t. We

compute the weighted measure of input tariffs, 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. Thus, input tariffs at the 4-digit industry level are constructed as the weighted average of tariffs on the intermediate goods used in the production of final goods in each manufacturing industry. Following the large empirical literature which examines the productivity gains from removing trade barriers and protections (Amiti and Konings, 2007; Topalova and Khandelwal, 2011; Yu, 2015), we expect a negative effect of input tariffs on downstream firms' productivity, i.e. reducing input tariffs can raise productivity through learning, variety, and quality effects.

Second, 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. This is important as according to Brandt et al. (2012), net entry in the domestic manufacturing sector accounts for over two thirds of total TFP growth in China over the period of 1998-2007. It is computed as a weighted average of the Herfindahl index[8] of all upstream manufacturing industries faced by each downstream industry j, and the weight is taken from the 2002 China's Input-Output Table, indicating the reliance of downstream manufacturing firms on the upstream manufacturing inputs. A lower HHI indicates a higher degree of competition in the upstream industries, therefore increasing downstream firms' productivity through input-output linkages.

It is important to capture the ownership information when modelling firm productivity in China. Following Yu (2015), we define firm ownership using the official definition reported in the China City Statistical Yearbook (2006), and all firms are classified into SOEs, private firms and foreign firms[9]. It is widely believed that despite decades of economic reform, SOEs remain the least efficient sector in the economy with an average return on capital well below that in the private sector (Hsieh and Klenow, 2009; Liu and Siu, 2012; Ding et al., 2012). On the other hand, foreign ownership is associated with both higher levels of TFP and fewer financial constraints (Manova et al., 2009). We therefore expect a negative effect of SOE and a positive effect of FIE on firms' productivity.

Productivity is likely be correlated with the size of the firm, due to economies

[8]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.

[9]SOEs include firms with registration codes of 110, 141, 143 and 151; foreign firms include firms with registration codes of 310, 320, 330, 340, 210, 220, 230 and 240; and all other firms are classified as private firms. Then three ownership dummies (SOE, FIE and PRIV) are defined accordingly. We only include SOE and FIE in the estimation to avoid multi-collinearity, so the default group is the private firms.

of scale (and scope) etc. We therefore include firm size, as measured by the natural logarithm of employment in the analysis. Firm age (Age_{ijt}) is included to measure whether younger firms produce with greater efficiency and better technology than older plants (a vintage capital effect); or if productivity increases as the firm ages through learning-by-doing (Jovanovic and Nyarko, 1996). A quadratic term (Age^2_{ijt}) is also included to reflect the non-linear relationship between firm age and productivity commonly found in the literature(Brouwer et al., 2005)[10].

When examining the economic channels and mechanisms through which upstream foreign entry barriers affect downstream productivity, we estimate the following equation:

$$\begin{aligned} TFP_{ijt} = \beta_0 + \beta_1 Barrier_{jt} + \beta_2 Barrier_{jt} * Channel_{(i),jt} \\ + \beta_3 Channel_{(i),jt} + \beta_4 X_{ijt} + \eta_t + \zeta_j + \xi_i + \mu_{ijt} \end{aligned} \tag{4}$$

where economic channels ($Channel_{(i),jt}$) take the form of either industry-specific channels ($Channel_{jt}$) such as industry's distance to the world technology frontier, the technology sharing similarity and labour structure similarity between upstream and downstream industries; or firm-specific channels ($Channel_{ijt}$) such as firms' R&D investment and the outsourcing intensity. Other control variables are the same as those in equation (3).

Lastly, the error term in equations (3) and (4) comprises four 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 industry-specific fixed effect, ζ_j, reflecting time-invariant industrial features affecting productivity such as factor costs and factor intensities[11]; *iii*. the firm-specific fixed effect, ξ_i, controlling for any time-invariant unobserved firm specific features such as markups; and *iv*. an idiosyncratic error term, μ_{ijt}, with normal distribution $\mu_{ijt}\overline{N}(0, \sigma^2_{ij})$ to control for other unspecified factors. Our basic estimation method is panel data fixed effect with standard errors clustered at the 4-digit industry level, i.e. despite the dependant variable is firm-specific, our variable of interest (Barrier) is at the industry level. A number of alternative methods are used to address the potential endogeneity of regressors in subsequent sections.

[10]For instance, Huergo and Jaumandreu (2004) find that new firms usually exhibit high productivity growth for the first several years since they enter the market, and then the growth rate declines or stabilizes thereafter.

[11]Given that the industry-level technology sharing similarity and labour structure similarity variables are time-invariant, we do not include industry-specific fixed effects in these two models.

5 Basic empirical results

5.1 Some stylized facts

Figure 3 illustrates a foreign entry regulation (FER) index in China for 1997, 2002, 2004 and 2007, which is computed as the 4-digit FER indicator as a fraction of the total number of 4-digit industries in each 2-digit industry[12]. The FER index reflects the proportion of 4-digit industries in each 2-digit industry under strict regulation in terms of foreign entry. The overall index only drops from 21% to 18% over the period of 1997 to 2007, which does not show a significant liberalizing move on foreign investment regulation in China. An interesting pattern appears when we look at manufacturing and services sectors separately: the FER index drops from 17.6% to 11.6% during 1997-2007 for the manufacturing sector, but the corresponding figure rises from 24.2% to 28.3% for the services sector. Thus, the foreign entry regulation has been much relaxed in the manufacturing sector, especially following China's WTO accession, i.e. the FER index drops nearly half from 17.6% in 1997 to 9.1% in 2002. However, the regulation on services sector has become more stringent in China, despite its radical commitment to service liberalization in its WTO accession.

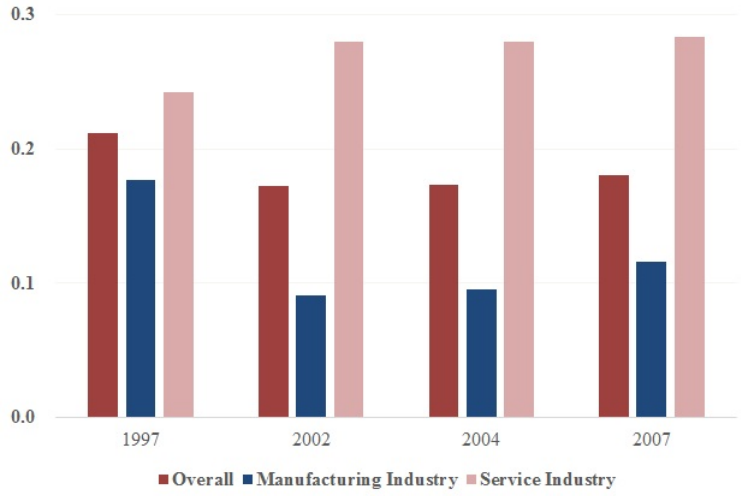

Figure 3: Foreign entry regulation (FER) index in China

Note: the foreign entry regulation (FER) index is computed as the FER indicator as a fraction of the total number of 4-digit industries in each 2-digit industry. This figure is based on the second measure of FER (FER_2).

Figure 4 presents the FER index of six important manufacturing sectors, i.e. food and beverage, chemical product, metal, electrical equipment, textile, and general

[12]This figure is based on the second measure of FER (FER_2), which captures the information of both 'prohibited' and 'restricted' items in the 'Catalogue'. The figure based on FER_1 produces similar results, and is available upon request.

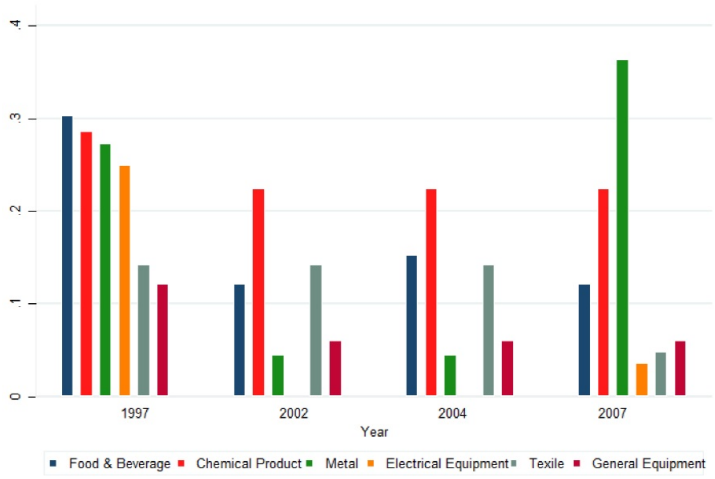

Figure 4: Foreign entry regulation (FER) index of 6 manufacturing sectors in China

equipment sectors over the period of 1997-2007. The declining trend of FER index is evident for all these industries but with significant heterogeneity. For instance, some industries (such as electrical equipment) have a quicker and more dramatic liberalization process, whereas others (such as chemical products) show some stagnancy in terms of investment liberalization. Interestingly, in the metal industry, there is a big reversal in 2007, i.e. the FER index drops from 27% in 1997 to merely 5% in 2004, but then climbs to 35% in 2007. This can be explained by the introduction of new restrictive regulation on foreign investment in the non-ferrous metal manufacturing sector in 2007 due to Chinese government's concern of natural resource conservation.

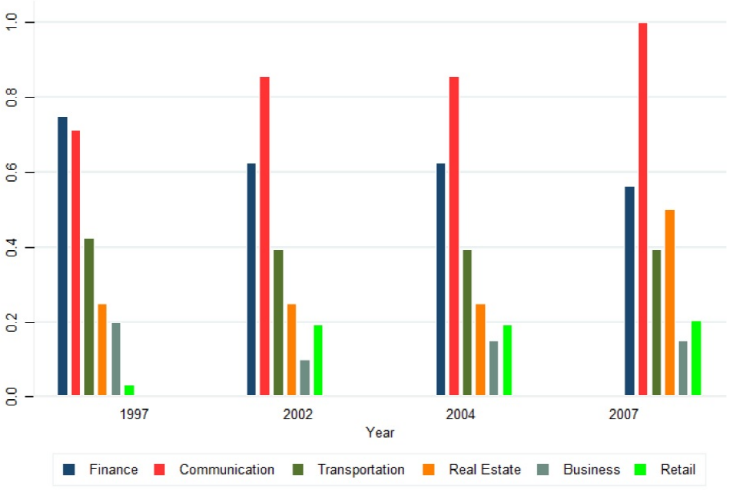

Figure 5: Foreign entry regulation (FER) index of 6 services sectors in China

Figure 5 illustrates the corresponding FER index in six services sectors, i.e. finance, communication, transportation, real estate, business services, and retail sectors. Generally speaking, there is some gradual liberalizing trend on foreign investment in three sectors (i.e. finance, transportation and business services), despite the fact that

the overall restriction level in the finance sector remains very high (ranging from 75% in 1997 to 59% in 2007). On the other hand, the regulation becomes stricter in other three sectors (communication, real estate and retail sectors). For instance, 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. This is consistent with the practical situation in China, for instance, the Internet services become fully prohibited from foreign investment in 2007. The real estate sector faces strict regulation too, for instance, house letting agent services is 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.

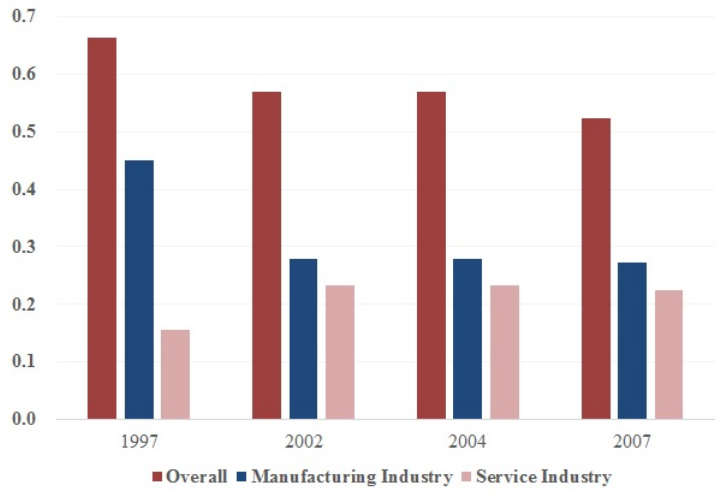

Figure 6: Foreign entry barrier (*Barrier*) indicator for downstream manufacturing industries in China

Note: the foreign entry barrier (*Barrier*) indicator is the weighted average of FER indicator for each downstream manufacturing industry, and the weight is given by the downstream industry's reliance on the intermediate inputs from upstream industries. This figure is based on the second measure of *Barrier*, i.e. $Barrier_2$.

Figure 6 depicts our foreign entry barrier (*Barrier*) indicator for downstream manufacturing industries, as defined in equation (2)[13]. Similarly, there is a general 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 in the upstream manufacturing sector is reduced from 45% in 1997 to 27.3% in 2007, whereas the barrier in the upstream services sector rises from 15.5% in 1997 to 22.5% in 2007. This confirms the message that China has been quite open in its manufacturing sector in the process of investment liberalization, but its services sector remains tightly controlled.

[13]This figure is based on the second measure of *Barrier* ($Barrier_2$). The figure based on $Barrier_1$ produces similar results, and is available upon request.

The detailed definitions and summary statistics of all variables used in the paper, including those used in the baseline model and in other robustness tests, are provided in Appendix B.

5.2 The baseline results

Table 2 reports the results of baseline model of equation (3). Both measures of foreign entry barrier ($Barrier_1$ and $Barrier_2$) show a significant and negative effect on the productivity performance of downstream firms, indicating that foreign entry regulations in the upstream manufacturing and service industries curb downstream firm productivity. In other words, when regulations restrict 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.

Table 2: The effect of foreign entry barriers on downstream productivity

	Barrier_1			Barrier_2		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Barrier	-0.004**	-0.016***	-0.020***	-0.066***	-0.049***	-0.041***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Ln Tariff			-0.004***			-0.004***
			(0.001)			(0.001)
HHI			-0.564***			-0.473***
			(0.028)			(0.028)
SOE		-0.163***	-0.163***		-0.164***	-0.165***
		(0.005)	(0.005)		(0.005)	(0.005)
FIE		0.030***	0.030***		0.030***	0.030***
		(0.005)	(0.005)		(0.005)	(0.005)
Ln Employment		0.464***	0.464***		0.463***	0.463***
		(0.002)	(0.002)		(0.002)	(0.002)
Ln Age		0.203***	0.203***		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	0.877	0.893	0.893	0.877	0.893	0.893
Observation	1824089	1824089	1824089	1824089	1824089	1824089

Note: the dependent variable is the natural logarithm of TFP based on the system GMM estimation; all year-specific, firm-specific, and industry-specific fixed effects are included; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

The effect of input tariffs on downstream firms' productivity is negative and significant, indicating that a fall in the price of imported intermediate inputs can induce

productivity improvement due to learning from the foreign technology embedded in the imported inputs, the higher input quality, and more input varieties. In particular, the productivity effect of tariff reduction on downstream firms shows that as importing firms become more productive, they can pass on benefits to other firms through sales of their goods along the vertical production chain. The significant and negative effect of Herfindahl index (HHI) shows that tougher domestic competition (for instance, through firm entry and exit) in the upstream services and manufacturing sectors can stimulate the productivity improvement of downstream firms which use the intermediate inputs from their upstream suppliers due to cost saving, quality and variety effects. Compared with the default group of private firms, SOEs have a lower level of productivity whereas foreign firms exhibit higher productivity in our sample. Both firm size and firm age have a positive and significant effect on firms' productivity, and the effect of the latter is found to be non-linear. In brief, the results of all variables in the baseline model are consistent with the hypotheses and predictions discussed in Section 4.3.

Table 3: 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	-0.050***		-0.046***	-0.047***		-0.046***
	(0.002)		(0.002)	(0.003)		(0.002)
Ln Service-Barrier		-0.050***	-0.043***		-0.080***	-0.074***
		(0.002)	(0.002)		(0.007)	(0.007)
R^2	0.894	0.893	0.894	0.893	0.893	0.893
Observation	1824089	1824089	1824089	1824089	1824089	1824089

Note: the dependent variable is the natural logarithm of TFP based on the system GMM estimation; Ln Manufacturing-Barrier and Ln Service-Barrier are the natural logarithm of foreign entry barrier in the upstream manufacturing sector and services sector faced by downstream industries respectively; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

Table 3 provides the results of the effect of foreign entry barriers in the upstream manufacturing sector and in the services sector on downstream firms' productivity. We find that the foreign entry barriers in both sectors have significantly negative effect on firms' productivity in downstream industries. Although there is no clear pattern on the magnitude of downstream effect of foreign entry barriers between the two sectors, this exercise is interesting and meaningful as it is widely believed that 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., 2014). 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, service liberalization may lead to a wider availability of services that were formally 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. It is argued that 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 service liberalization through allowing greater foreign competition in services sectors in China.

6 Economic channels and mechanisms

We hypothesize that there are at least five channels through which upstream regulations on foreign entry affect the performance of firms in downstream industries in China. 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 consist of firms' R&D investment and their outsourcing intensity.

6.1 Industry's distance to the world technology frontier

The distance-to-frontier theory is argued to be important in understanding the relationship between competition and productivity as described in Section 2.2. Following Aghion et al. (2009) and Ding et al. (2015), we construct a proxy for the distance to the technology frontier (*Distance*), which relates the labor 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 labor productivity relative to labor 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 labor 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 labor productivity of industry j in the US. For each time period t, we average over the current and the two proceeding years in order to alleviate the business cycle effects and potential measurement errors.

Table 4 shows the results on the first industry-specific channel of distance to frontier. We find that the foreign entry barrier has a negative and significant effect on the level of TFP of downstream firms, whereas the coefficient of the interaction term between the *Distance* measure and the *Barrier* indicator appears to be significantly positive. This provides evidence for the effects highlighted in the theory of Aghion et al. (2005), i.e. given the fact that the returns to efficiency improvement are higher for firms that compete neck-to-neck with rivals that are close to the technological frontier, the lack of competition pressure due to upstream foreign entry barrier is likely to reduce downstream incentives to improve efficiency more markedly when industries are close to the world technology frontier. Thus, consistent with the predictions of neo-Schumpeterian framework, the downstream effects of foreign entry barrier can be non-linear and depend on the distance to the technological frontier of downstream industries.

Table 4: The industry-specific channel 1: the distance to the world technology frontier

	Barrier_1			Barrier_2		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Barrier	-0.090***	-0.053***	-0.065***	-0.066***	-0.048***	-0.033***
	(0.006)	(0.006)	(0.006)	(0.003)	(0.003)	(0.003)
Ln Barrier*Ln Distance	0.036***	0.019***	0.021***	0.007***	0.002***	0.001
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Ln Distance	-0.013**	-0.074***	-0.080***	-0.079***	-0.113***	-0.128***
	(0.006)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)
R^2	0.881	0.897	0.897	0.881	0.897	0.897
Observation	1650634	1650634	1650634	1650634	1650634	1650634

Note: the dependent variable is the natural logarithm of TFP based on the system GMM estimation; Ln Distance is the natural logarithm of downstream industries' distance to the world technology frontier; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

6.2 Technology sharing similarity and labour structure similarity among industries

Another two industry-specific features (technology sharing similarity and labour structure similarity) may play a role in shaping the nexus between upstream and down-

stream industries, therefore influencing the upstream foreign entry regulation effect on downstream firms. Both features relate to the intellectual or technology spillovers, i.e. technologically-advanced foreign entry in upstream industries may speed the flow of new technology to downstream manufacturing industries through intermediate markets.

Table 5: The industry-specific channel 2: the technology sharing similarity among industries

	Barrier_1			Barrier_2		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Barrier	-0.081***	-0.079***	-0.084***	-0.066***	-0.067***	-0.050***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Ln Barrier*TS	-0.472***	-0.465***	-0.478***	-0.066***	-0.067***	-0.050***
	(0.013)	(0.012)	(0.012)	(0.003)	(0.003)	(0.003)
TS	2.234***	2.218***	2.385***	0.577***	0.658***	0.727***
	(0.05)	(0.046)	(0.047)	(0.018)	(0.017)	(0.017)
R^2	0.877	0.893	0.893	0.877	0.893	0.893
Observation	1754107	1754107	1754107	1754107	1754107	1754107

Note: the dependent variable is the natural logarithm of TFP based on the system GMM estimation; TS is the technology sharing similarity between upstream and downstream industries; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

On the one hand, 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 higher quality or higher technology intermediates from 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 expressed as

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

where $Patent_{sj}$ is the patent citation number between upstream industry s and downstream industry j; and w_{sj} is 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 to shed light on the importance of exchanging technology and intellectual spillovers

between upstream and downstream industries.

On the other hand, technology spillover from upstream to downstream industries may be facilitated by the fact that industries use the same 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 ($Labour_{sj}$) can be measured through 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 expressed as

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

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.

Table 6: The industry-specific channel 3: the labor structure similarity among industries

	Barrier_1			Barrier_2		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Barrier	-0.094***	-0.111***	-0.116***	-0.111***	-0.133***	-0.157***
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Ln Barrier *LS	-0.073***	-0.101***	-0.095***	-0.024***	-0.077***	-0.119***
	(0.009)	(0.009)	(0.009)	(0.008)	(0.007)	(0.007)
LS	0.385***	0.487***	0.772***	0.337***	0.399***	0.738***
	(0.037)	(0.035)	(0.035)	(0.019)	(0.017)	(0.02)
R^2	0.878	0.895	0.895	0.878	0.895	0.895
Observation	1714971	1714971	1714971	1714971	1714971	1714971

Note: the dependent variable is the natural logarithm of TFP based on the system GMM estimation; LS is the labour structure similarity between upstream and downstream industries; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

Table 5 and Table 6 provide results of the two channels. In addition to the significantly negative effect of foreign entry barrier on downstream productivity, the interaction term between the TS (or LS) and the *Barrier* indicator appears to be

significantly negative. Thus, the productivity effect of foreign entry barrier is larger for downstream firms in industries using similar technology or labour structure with their upstream industries. In other words, liberalization of foreign investment in upstream industries (a reduction of *Barrier*) can provide more benefits to firms in industries using similar technology or labour structure, as they have better chance to exploit the higher quality or higher technology intermediates from foreign providers.

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

Table 7 presents the results of the first firm-specific channel, i.e. R&D investment. Investment liberalization in upstream industries offers an opportunity for downstream firms to exploit higher quality and higher technology intermediates which allow firms to increase their efficiency and competitiveness. However, only the most productive firms, such as firms that actively engage in R&D investment, can reap these benefits due to *absorptive capacity*. This is because some knowledge is tacit and is difficult to acquire unless the firm is directly involved in R&D in the area. We test this hypothesis by interacting a R&D dummy[14] with the upstream foreign entry barrier indicator. It is interesting to see that the R&D itself has a positive and significant impact on firm productivity. There may be two explanations. One channel is through the development of absorptive capacity, as it permits the identification, assimilation and exploitation of innovations made by other firms. The other channel 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 is negative and significant, indicating that firms engaging in R&D investment can better reap the benefits of easing the foreign entry barriers in upstream industries.

Table 8 provides results on the second firm-specific channel, i.e. outsourcing intensity. Outsourcing refers to the process of transferring some manufacturing and related services tasks to other companies. The 'make-or-buy' decision is argued to be 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 some trade-off between internalizing and outsourcing. On the one hand, it is argued that TFP

[14]The firm-level R&D data is available in the NBS dataset (1998-2007) except for the years 1998, 1999 and 2004. We define a R&D dummy which is equal to 1 if the value of R&D is great than 0, and 0 otherwise.

Table 7: The firm-specific channel 1: the R&D investment

	Barrier_1			Barrier_2		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Barrier	-0.007***	-0.012***	-0.017***	-0.027***	-0.019***	-0.012***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
Ln Barrier *R&D	-0.004***	-0.002**	-0.002**	-0.040***	-0.030***	-0.030***
	(0.001)	(0.001)	(0.001)	(0.006)	(0.005)	(0.005)
R&D	0.102***	0.067***	0.066***	0.084***	0.051***	0.051***
	(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

Note: the dependent variable is the natural logarithm of TFP based on the system GMM estimation; R&D is a dummy variable which is equal to 1 if the firm has R&D, and 0 otherwise; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

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 supplier might be highly specialized with particular expertise in the activity, which can reduce 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 8: The firm-specific channel 2: the outsourcing intensity

	Barrier_1			Barrier_2		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Barrier	-0.011***	-0.023***	-0.027***	-0.053***	-0.070***	-0.069***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)
Ln Barrier*Ln Outsourcing	-0.022***	-0.022***	-0.023***	-0.016**	-0.012**	-0.012**
	(0.003)	(0.003)	(0.003)	(0.006)	(0.006)	(0.006)
Ln Outsourcing	-0.068***	-0.072***	-0.072***	-0.014***	-0.017***	-0.017***
	(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

Note: the dependent variable is the natural logarithm of TFP based on the system GMM estimation; Ln Outsourcing is the natural logarithm of the ratio of intermediate inputs to firms' total output; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

Since outsourcing enlarges the linkages among industries, we hypothesize that the downstream effect of foreign entry barriers is more marked on firms with high

outsourcing intensity. We define outsourcing intensity as the ratio of intermediate inputs to firms' total output, which is available from the NBS dataset. Interestingly, we find that the effect of outsourcing itself on firms' productivity is 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 hypothesis that firms' outsourcing behaviour intensifies the complex linkages among upstream and downstream industries, which magnifies the downstream effect of foreign entry barriers in China.

7 Further robustness checks

7.1 Endogeneity

Despite the largely exogenous nature of our policy variable on foreign entry regulation, endogeneity can arise for the following three reasons. First, according to Bourlès et al. (2013), lobbyism can make policies endogenous. For instance, low productivity firms may have incentives to exert political pressures for raising anti-competitive regulations on foreign entry, thereby protecting 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 is indeed relevant to China, 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 input weights, thus making the policy variables endogenous; also, China's input-output matrices may be highly related to domestic policies.

In this paper, we adopt three methods to deal with the problem of endogeneity, i.e. the Instrumental Variable (IV) approach, the Difference-in-Difference approach and an alternative weight using the US Input-Output Table.

First, following Arnold et al. (2014) which uses China's measure of service reform to instrument the service liberalization for India, we instrument our foreign entry barrier variable using India's measure of anti-competitive regulations on product market from the OECD dataset. The justification is that China and India are close com-

petitors, so that India's market-opening commitments are likely to have influence on China's foreign entry policy. The results are provided in Table 9. The first-stage regression results show a positive and significant correlation between China and India's market-opening policy. And 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 both Durbin and Wu-Hausman tests suggests the rejection of the null of exogeneity for the foreign entry barrier indicator. The Hausman specification test also rejects the null hypothesis that there is no systematic difference between the OLS and IV estimators, suggesting that our IV specification is appropriate and the selected instruments are valid.

Table 9: Robustness test: the Instrumental Variable (IV) approach

	Barrier_1			Barrier_2		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Barrier	-1.390***	-1.216***	-0.239***	-0.985***	-0.726***	-0.229***
	(0.013)	(0.014)	(0.009)	(0.007)	(0.006)	(0.008)
Durbin (score) χ^2	14808.5***	10843.1***	11118.0***	1810.1***	149.0***	21334.8***
Wu-Hausman F	14929.7***	10907.9***	11186.1***	1811.9***	149.1***	21587.2***
Hausman test	14808.5***	276614.2***	79397.9***	7337.3***	199664.6***	2619.5***
Observation	1824089	1824089	1824089	1824089	1824089	1824089
First-Stage Regressions						
IV-India	0.154***	0.129***	0.324***	0.218***	0.216***	0.188***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.001)

Note: the dependent variable is the natural logarithm of TFP based on the system GMM estimation; IV-India is India's measure of anti-competitive regulations on product market from the OECD dataset; 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 test is that the there is no systematic difference between the two estimators; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

Second, we adopt the Difference-in-Difference approach to estimate the productivity effect of foreign entry barrier on downstream manufacturing firms. According to Figure 3 and Figure 6, we can see that following China's WTO accession, there was a significant liberalizing move on its foreign entry regulation in 2002 (mainly in the manufacturing sector). 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[15]. 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,

[15]This small time span is selected to capture the effect of 2002 policy change, as in 2004 another 'Catalogue' is released.

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 even 'encouraged' after 2002, then the degree of the 2002 investment liberalization of this upstream industry s is n/m. Then weighting this measure with the information from China's Input-Output Table, we are able to compute an index of the effect of 2002 reform on downstream industries ($Index$).

Table 10: Robustness test: the Difference-in-Difference approach

	Method 1			Method 2		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.043***	0.031**	0.063***			
	(0.015)	(0.015)	(0.015)			
Treatment*Post	0.004***	0.007***	0.010***			
	(0.001)	(0.001)	(0.001)			
Index				0.245***	0.236***	0.332***
				(0.031)	(0.03)	(0.031)
Index*Post				0.008***	0.033***	0.032**
				(0.002)	(0.012)	(0.013)
Post	0.154***	0.124***	0.132***	0.159***	0.120***	0.111***
	(0.003)	(0.003)	(0.005)	(0.007)	(0.006)	(0.007)
R^2	0.93	0.938	0.938	0.927	0.934	0.934
Observation	158682	158682	158682	223060	223060	223060

Note: the dependent variable is the natural logarithm of TFP based on the system GMM estimation; Treatment is equal to 1 if the firm belongs to the treatment group, and 0 otherwise; Post is the time dummy which takes the value of 1 for year 2002 and 2003, and 0 for year 2001; Index is the index of the effect of 2002 reform on downstream industries; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

We report the results of two variants of the Difference-in-Difference approach in Table 10. The first method is to select the top 1/3 observations of this index as the treatment group, and the bottom 1/3 of 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, showing that the liberalizing move on foreign entry regulation in 2002 has a significantly positive effect on downstream firms' productivity. The second method is to directly include the index of the effect of 2002 reform on downstream industries ($Index$) and interact it with the time dummy ($Post$). This functional form is firstly used by Rajan and Zingales (1998) to test whether industrial sectors that are relatively more dependent on external financing develop faster in countries with better developed

financial markets. Nunn (2007) also use the similar specification to test whether countries with better contract enforcement specialize in contract intensive industries. In our case, the positive and significant interaction term echos the previous finding of the positive effect of investment liberalization in 2002 on downstream firms' productivity.

Lastly, the 2002 US Input-Output Table (including 369 industries) is used to contract an alternative set of input weights for the foreign entry barrier indicator. On the one hand, the US input-output coefficients may reflect technological differences rather than country-specific determinants. On the other hand, it is not correlated with Chinese firm and industry characteristics. The results are reported in Table 11, and our findings remain robust.

Table 11: Robustness test: an alternative weight using the US Input-Output Table

	Barrier_1			Barrier_2		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Barrier	-0.029***	-0.047***	-0.046***	-0.053***	-0.066***	-0.137***
	(0.007)	(0.006)	(0.006)	(0.012)	(0.011)	(0.013)
R^2	0.872	0.891	0.897	0.875	0.891	0.893
Observation	1824089	1824089	1824089	1824089	1824089	1824089

Note: the dependent variable is the natural logarithm of TFP based on the system GMM estimation; the input weights for the foreign entry barrier indicator is based on the US input-output coefficients; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

7.2 Other robustness tests

We adopt some alternative measures of key variables as further robustness tests. Firstly, we construct an alternative measure of TFP by using the semi-parametric Olley and Pakes (1996) approach. 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, only assuming that it evolves according to a Markov process (Van Biesebroeck, 2007). The results are reported in Table 12 and our main findings remain robust.

Secondly, we construct an alternative measure of foreign entry regulation, as neither FER_1 nor FER_2 captures the information of the 'encouragement' policy in the 'Catalogue'. To tackle this problem, we assign the value of 2 for the 'prohibited' items, the value of 1 for the 'restricted' items, and the value of -1 for the 'encouraged' items

Table 12: Robustness test: an alternative measure of TFP

	Barrier_1			Barrier_2		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Barrier	-0.029***	-0.047***	-0.046***	-0.053***	-0.066***	-0.137***
	(0.007)	(0.006)	(0.006)	(0.012)	(0.011)	(0.013)
R^2	0.872	0.891	0.897	0.875	0.891	0.893
Observation	1824089	1824089	1824089	1824089	1824089	1824089

Note: the dependent variable is the natural logarithm of TFP based on the Olley and Pakes (1996) approach; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

in each 4-digit industry. The new 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 use intermediate inputs calculated from national input-output matrices, we are able to obtain the new measure of foreign entry barrier (Barrier_3) faced by downstream firms. Table 13 presents the results of this new measure of foreign entry barrier, and our findings remain intact.

Table 13: Robustness test: an alternative measure of foreign entry regulation

	TFP^{GMM}			TFP^{OP}		
	(1)	(2)	(3)	(4)	(5)	(6)
Barrier_3	-0.047***	-0.066***	-0.064***	-0.039***	-0.032***	-0.031***
	(0.004)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)
R^2	0.877	0.893	0.893	0.822	0.823	0.824
Observation	1824089	1824089	1824089	1824089	1824089	1824089

Note: the dependent variable is the natural logarithm of TFP based on either the system GMM estimation or the Olley and Pakes (1996) method; Barrier_3 is the third measure of foreign entry barrier faced by downstream industries; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

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, it has been argued that some rules and laws on foreign entry which are not officially recorded in the 'Catalogue' actually exist and are implemented by local governments. In order to tackle this problem, we estimate the direct effect of foreign entry on downstream firms' productivity in Table 14, 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

Table 14: Robustness test: 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: the dependent variable is the natural logarithm of TFP based on the system GMM estimation; Foreign share is the weighted share of foreign firms in total value added or employment of upstream industries; all other control variables are included but not reported to save space; standard errors are reported in parentheses, which are clustered at the 4-digit industry level; *** p<0.01, ** p<0.05, * p<0.1.

by the downstream manufacturing industry. The results show that for both measures of foreign share, there is a positive and significant effect of foreign entry on downstream firms' productivity, which echos our earlier findings that the anti-competitive foreign entry regulations or foreign entry barriers in the upstream industries curb downstream productivity.

Lastly, according to Arnold et al. (2011), one advantage of using the firm-level data is that it allows us to isolate the effect on domestic firms, which is the outcome likely to be of highest interest to national policy makers. For this reason, we estimate the 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. In this paper, we examine the effect of foreign entry barriers in upstream industries on the productivity performance 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 build an indicator of foreign entry barrier for downstream industries by crossing the upstream foreign entry regulation measure with the intensity of use intermediate inputs calculated from national input-output matrices. We find that foreign entry regulations in the upstream manufacturing and service industries curb

downstream firm productivity. The effect can be non-linear and depends on the distance to the technological frontier of downstream industries. Some industrial features such as technology sharing similarity and labor structure similarity between upstream and downstream industries are also found to play a role in shaping the nexus between upstream regulation and downstream productivity. Firms' R&D investment and service and material outsourcing are vital firm-specific channels through which upstream regulations impact downstream productivity.

Our findings have important policy implications for both the Chinese government and foreign investors. For instance, some recent policy reports have highlighted increasing concerns by foreign investors over restrictive government policies in China. Our results indicate that removing remaining entry restrictions in upstream industries could bring substantive productivity gains and benefit not only firms producing in these industries but also those that use inputs from these industries. In particular, we find that most barriers to foreign investment today are not in goods but in 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. Our research also pinpoints the importance of complementary labor and product market reforms in order to improve the resource allocation efficiency by reallocating more resources from less 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 TFP estimates

Table A1: 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 B Variables and summary statistics

Appendix B.1 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;

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 Service-Barrier$_1$ and Ln Service-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;

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

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

Barrier$_3$: the third measure of foreign entry barrier faced by downstream 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.

Appendix B.2 Summary statistics

Table B2: 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
Ln Tariff	4220	1.901	0.457	0.718	3.383
HHI	4220	0.08	0.057	0	0.401
SOE	1824089	0.1	0.3	0	1
FIE	1824089	0.208	0.406	0	1
Ln Employment	1824089	4.785	1.125	2.079	12.145
Ln Age	1824089	2.019	0.911	0	3.913
Ln Age^2	1824089	4.906	4.216	0	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 Service-Barrier$_1$	4220	-3.469	0.537	-4.981	-2.204
Ln Service-Barrier$_2$	4220	-1.944	0.297	-3.044	-1.293
Ln Distance	3727	2.802	0.622	0.478	5.957
TS	408	0.1	0.102	0.005	0.53
LS	387	0.594	0.16	0.057	0.835
R&D	1219093	0.114	0.318	0	1
Ln Outsourcing	1822175	-0.319	0.336	-15.07	5.263
Ln TFP^{OP}	1794069	2.285	1.449	-2.588	10.162
IV-India	4220	0.231	0.162	0.057	0.866
Barrier$_3$	4220	0.15	0.369	-0.751	1.694
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