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The impact of foreign direct investment on the productivity of the Chinese forest products industry

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ABSTRACT

The aim of this study is to examine the impact of FDI on the total factor productivity of the forest products industry in China. We investigated three forestry-related manufacturing industries in the study. The first is the wood products industry, which encompasses the processing of timber and the manufacture of wood, bamboo, rattan, palm, and straw products. The second is the manufacture of furniture, and the third is the manufacture of paper and papermaking products. We used firm-level census data related to 78,555 forestry firms for the period 1999-2007to conduct our tests for within-firm, within-industry, and vertical effects, and calculated the effect of FDI on the productivity of Chinese forestry firms. In this study FDI is divided into two categories: capital from HMT (Hong Kong, Macau, and Taiwan) regions and capital from non-HMT regions. The impact of FDI on the productivity of the forest products industry is complicated. At the industry level, FDI from HMT regions tends to have a significant positive impact on the productivity of the wood products industry. FDI from non-HMT regions and HMT regions tends to have the same impact on the productivity of the forest products industry in terms of the forward effects but a different impact in terms of the backward effects. Our findings have immediate implications for policymakers in China as well as for the governments of less-developed countries that are formulating their foreign investment policies.

1. Introduction

With the globalization of the economy and the flow of factors of production, the impact of foreign direct investment (FDI) on various industries, including the forest products industry, is becoming increasingly important. Raising the productivity of the forest products industry has become an important issue to study because of the increasing demand for manufactured forest products and the need to pursue a green environmental policy (Chen et al., 2017; Cheng et al., 2010). Although scholars have paid attention to some factors affecting the productivity of the forest products industry, there is a lack of research on the impact of FDI on the productivity of the forest products industry.

The impact of FDI on total factor productivity (TFP) cannot be ignored given the trend of increasing FDI. According to the United Nations Conference on Trade and Development (UNCTAD, 2017), FDI flows to developing economies reached $670 billion (or 47 percent of global flows) in 2017. Accordingly, scholars have discussed the impact of FDI extensively, including the impact on the manufacturing industry in entire countries or regions (Jiang, 2017; Abraham et al., 2010; Aitken and Harrison, 1999; Blomström and Persson, 1983). A few scholars have studied the role of FDI in specific industries of the host countries. Walkenhorst (2000) reported on spillovers from FDI on the sugar beet-processing industry in Central European transition countries and drew the conclusion that FDI improves the productivity of the related industries. Dries and Swinnen (2004) argued that FDI has negative implications for small local suppliers. Jefferson and Hu (2002) found that FDI tends to reduce the productivity and market share of domestic firms in the electronic and textile industries in the short term, but the influence is different in the long term. Jin et al. (2017) investigated the impact of FDI on the TFP of Chinese food firms and found that it depends significantly on the type of FDI and its home countries. The impacts of FDI on a specific industry are different from those on the whole manufacturing industry, and the impacts on different industries are also different. FDI in the forest industry has increased rapidly since the 1990s (Laaksonen-Craig, 2004). For example, based on the available statistics for the wood products industry, the global FDI stock in 2010 was about six times larger than it was in 1990 and reached a peak

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of 142 billion US dollars in 2007 (Zhang et al., 2014). This growth makes it extremely important to study the impact of FDI on the productivity of the forest products industry.

Although FDI is becoming increasingly important for the development of the forest products industry, the existing research on the productivity of the forest products industry mainly focuses on the production tools, management tools, macro-policies, and innovation; the impact of FDI on the forest products industry has been neglected. Simon et al. (2018) concentrated on the ways to improve the efficiency of forestry production by using high-efficiency harvesting tools. Through the analysis of forestry in the northeastern United States, Kelly et al. (2017) concluded that effective management measures would have a positive impact on productivity. For countries with scarce forestry resources, increasing productivity not only promotes industrial development, it is also a necessary requirement for sustainable development. As a populous country, China's per capita resources are quite limited, so improving TFP is an important direction for forest products industry development. Zang et al. (2015) believed that the main factors affecting the productivity of forestry in China are the differences in the macro-policies, the inadequacy and change of investment in forestry science and technology, the differences in the allocation of forestry resources, and the imbalance of the regional economic development levels. Chen et al. (2017) found that there are two main ways to improve forestry productivity in China: one is to reform the state-owned forestry enterprises and the other is for the Chinese government to take individual measures to improve the efficiency of the forest products industry according to the specific conditions of the different provinces. Institutional innovation will have a positive impact on the TFP of enterprises, and the entry of private capital will also promote the production efficiency of the state-owned forestry enterprises (He and Weng, 2012). Kreuser and Newman (2018) used firm-level data for the period 2010–2013 to estimate TFP and found that firm size has a positive effect on productivity. Yang et al. (2016) conducted an empirical study on the TFP of state-owned forestry enterprises from 2001 to 2011 and concluded that technological progress and other inputs would affect TFP, and that technological progress was the main driving force for productivity growth. Although scholars have discussed the factors affecting the productivity of the forest products industry from different aspects, which has provided us with a strong baseline, there is a lack of research on the impact of FDI on the productivity of the forest products industry. Thus, the impact of FDI on the TFP of China's forest products industry will be examined in this study.

The rest of the paper is organized as follows. The next section introduces the FDI in China's forest products industry. Section 3 discusses the methodology and data. In Section 4 the results are presented for different specifications, and Section 5 presents our conclusions.

2. Foreign direct investment in China's forest products industry

With the implementation of China's reform and opening-up strategy, its forest products industry began to enter the embryonic stage of using foreign capital. In 1979, the National People's Congress promulgated the Law on Sino-Foreign Joint Venture Enterprises, which was the first law to regulate the matters affecting the attraction of investment and laid a legal foundation for the development of this investment. As a result of this, China began to attract FDI in many industries including the forest products industry. In order to improve the usage rate of FDI, the state introduced many preferential policies, such as land leasing, taxation, and national treatment. During this period, the legal and policy effects of attracting foreign investment developed. The amount of FDI in the forest products industry was relatively small. One reason for this was that not all fields were opened to the outside world in this period, and another reason was that the needs of forestry development in this period were more concentrated on infrastructure construction, which is dominated by state funds. Accordingly, as shown in Fig. 1, the number of forest products enterprises with FDI increased only slowly between 1979 and 1988.

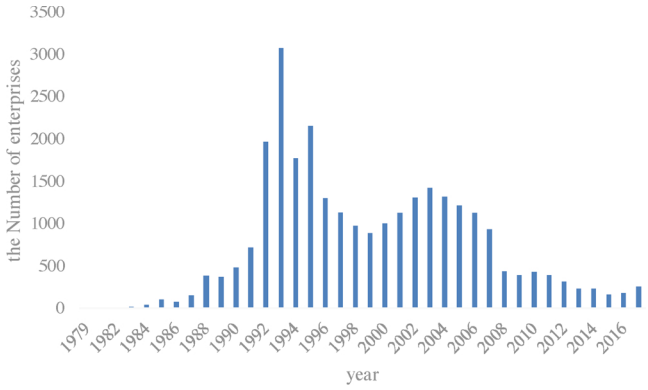

Fig. 1. Number of forest products enterprises with FDI from 1979 to 2017. Source: State Enterprise Credit Information Publicity System of China

After more than ten years of initial development, the forest products industry officially opened at a preliminary level after Deng Xiaoping's southern tour in 1992. Deng Xiaoping's southern speech opened a new chapter in China's reform and opening-up, and this provided better policy space and development opportunities for the forest products industry to introduce and use foreign capital. Thereafter, China's forest products industry entered a period of steady development by using FDI. China's investment policies and laws and regulations were also further improved in this period, which provided the right conditions for China's forest products industry to broaden the depth and breadth of FDI. From 1992 to 1994 the number of forest products enterprises with FDI increased greatly from 713 to 3077. In 1995 the Ministry of Foreign Trade and Economic Cooperation promulgated the Provisional Provisions on Several Issues Concerning the Establishment of Foreign-funded Joint Stock Limited Companies and the Provisional Provisions on Foreign-funded Investment Companies in the form of departmental regulations, which expanded and enriched the forms of foreign investment. In the same year the State Planning Commission, the State Economic and Trade Commission, and the Ministry of Foreign Trade and Economic Cooperation jointly issued the Interim Provisions for the Guidance of Foreign Investment and the Catalogue of Foreign Investment Industries. These two regulations further clarified the direction and scope of foreign investment and specified the Permission and Prohibition specific catalogue for foreign investors. In 2001, China revised the Law on Sino-foreign Joint Ventures for the first time. This revision specified that the scope of foreign investment should be in line with the Catalogue of Guidance for Foreign Investment Industries. Overall, the relevant policies, laws, and regulations in this period in respect of using foreign capital were much improved, which thereby provided more specific and appropriate guidance for China's use of foreign capital and made the use of foreign capital in the forest products industry more standardized and diversified. During this period China's forest products industry used foreign capital with relatively little international borrowing and international aid, and the proportion of FDI increased. It can be seen from Fig. 1 that the total amount of foreign capital used by China's forest products industry reached ￥39.12($4.72) billion in 2001.

China's accession to the World Trade Organization(WTO) at the end of 2001 provided a more favorable international environment for China in which to further expand its market and use foreign capital. After China's accession to the WTO, China promised to reduce the conditions placed on market access to the relevant fields and to open the market for forest products. These changes enabled all foreign individuals and enterprises, including those who had not previously invested or registered in China, to enjoy the same treatment in terms of trade rights as Chinese enterprises and ensured the elimination of state-owned monopolies. At the same time, in conjunction with the need to upgrade the overall industrial structure, the Chinese government began to adjust

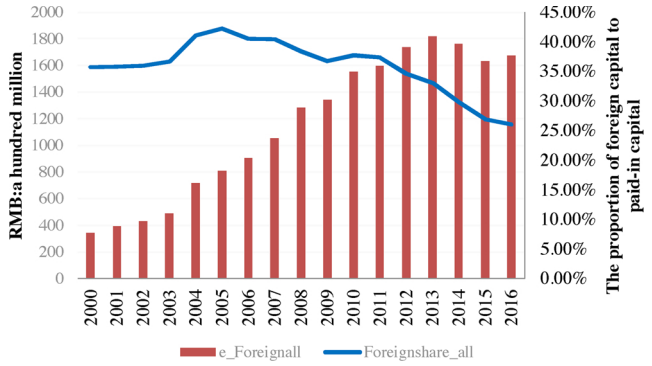

Fig. 2. Total foreign capital use of forest products enterprises from 2000 to 2016.
Source: National Bureau of Statistics of China

the FDI usage policy. In 2004 and 2007, the Ministry of Commerce revised the Catalogue of Guidance for Foreign Investment Industries twice, thereby further expanding the field and scope of forest products industry investment. These revisions encouraged foreign-funded enterprises to enter forest areas and introduce new technologies for the comprehensive use of "sub-small, firewood", timber and bamboo timber, undertake new product development and production, and produce high-grade paper and cardboard. At the same time, the foreign-funded enterprises were also given certain tax and tariff preferences in these areas. In 2007 the National People's Congress promulgated the Enterprise Income Tax Law, which set out the tax differences between domestic and foreign-funded enterprises. The FDI in the forest products industry increased from ￥39.12($4.72) billion in 2001 to ￥105.24($13.85) billion in 2007 (see Fig. 2).

The global financial crisis broke out in 2008, and the world economy suffered heavy losses. Although China's advantage in using foreign capital was still substantial, foreign capital inflows into China were negatively affected, due to the influence of the world economic downturn. The number of forest products enterprises had been declining, but the amount of FDI increased slightly from 2008 to 2010 (see Fig. 1). During those three years, the use of foreign capital in the forest products industry was relatively stable, and the industry was in an adjustment stage. The amount of FDI in the forest products industry in 2008 and 2009 was similar (see Fig. 1). In order to improve the quality and level of the use of foreign capital in this special period and to play a positive role in using foreign capital to promote scientific and technological innovation, industrial upgrading, and better coordinated regional development, the State Council published Some Opinions on Further Perfecting the Work of Utilizing Foreign Capital in 2010. This document decreed that the examination and approval of the use of foreign capital in the forest products industry should be delegated to local governments by the relevant departments of the State Council within the scope permitted by the laws and regulations, and that the contents of the examination and approval process should be adjusted to simplify the examination and approval procedures. At the same time, the momentum of the progress of using FDI in the forest products industry was tilted to the central and western regions. The total FDI amounted to ￥155.321($22.78) billion by the end of 2010 compared with ￥105.24($13.85) billion in 2007 (see Fig. 2).

In 2011 the global economy slowly recovered from the economic crisis. To take advantage of the expanding global FDI flows, the Ministry of Commerce and the National Development and Reform Commission revised the Catalogue of Guidance for Foreign Investment Industries twice in 2011. These revisions further expanded the scope for foreign investment, especially the categories of encouragement, restriction, and prohibition, which in 2007 had decreased by three and increased by seven and one, respectively. At the same time, the proportion of allowable foreign investment holdings in some areas was abolished, and the requirement for equity in the encouragement and restriction categories was reduced by 11 items compared with 2007. For the forest products industry specifically, a new "synchronous construction of high-grade paper and cardboard production" category was added to the 2007 Catalogue of Guidance for the Foreign Investment Industry. These changes show that China was beginning to present a scientific and rational plan for the use of FDI in the forest products industry. The average use of foreign capital between 2011 and 2016 was ￥170.472($27.05) billion per year (see Fig. 2). The amount of foreign capital used by China's forest products industry has been rising since 2011, but the rate of increase was slower than it was before 2008 (see Fig. 2).

3. Methodology and data

3.1. The empirical model

The main parts of the forest products industry in this study are classified at the level of the 2-digit Chinese Standard Industry Classification code (CSIC, GBT 4754-2002): the wood products industry (2-digit CSIC code 20), the furniture manufacturing industry (2-digit CSIC code 21), and the papermaking and paper industry (2-digit CSIC code 22). The 2-digit CSIC forest products industry code 20 comprises the processing of timber, wood-based panel manufacturing, manufacture of wood, and manufacture of bamboo, rattan, palm, and straw products. The CSIC forest products industry code 21 comprises wooden furniture manufacturing as well as bamboo and rattan furniture manufacturing. The CSIC forest products industry code 22 comprises pulp making, papermaking, and paper products manufacturing.

Many scholars use TFP as an indicator of productivity to determine the role of other factors in improving productivity because it provides accurate and robust measures of productivity at the firm level, which allows for a comparison of the productivity distributions and trajectories across the manufacturing subsectors (Añón Higón et al., 2018; Keng and Wu, 2014; Bernini et al., 2017). We use TFP to represent productivity to find out the effects of FDI on the productivity of the forest products industry.

To study the relationships between the variables, we adopt a multiple regression equation following the related literature (Jin et al., 2017; Du et al., 2012; Jefferson and Hu, 2002).

$$LnTFPlmt = \beta 0 + \beta 1 FDIlmt + \beta 2 Controlslmt + \mu m + \mu t + \varepsilon lmt \quad (1)$$

where $LnTFPlmt$ is the natural logarithm of TFP for firm l in the 3-digit CSIC industry code m in year t. A widely accepted method used to measure TFP was published by Olley and Pakes in 1996. Their method has been extensively used in previous studies (Liu, 2007; Amiti and Konings, 2007; Javorcik, 2004), since the method is able to overcome both simultaneity bias and selection bias that may occur if ordinary least square (OLS) is used to estimate the parameters in the production function (Du et al., 2012; Abraham et al., 2010; Liu, 2007). See Appendix 2 for the technical details on how the method is implemented. We calculate the firms' TFP separately for the different 2-digit forest products industry because each 2-digit industry has distinct features, and we subsequently estimate Eq. (1) separately for each industry. As illustrated in Fig. 3, the TFP of the three industries showed an overall upward trend from 1999 to 2007. The TFP of the wood products industry was higher than that of the furniture manufacturing industry and papermaking and paper industry, while the papermaking and paper industry had the lowest TFP.

$FDIlmt$ denotes the vector FDI variables, and it includes four variables: $Firmlmt$, $Industrymt$, $Upstreamnt$ and $Downstreamnt$[1] . $Firmlmt$

[1] $Industrymt = \frac{\sum_{l \in m} Firmlmt \times Ylmt}{\sum_{l \in m} Ylmt}$ Y_{lmt} is the revenue for firm l in 3-digit industry m in time t. $Upstreamnt = \sum_{n \neq k} \partial nk \frac{\sum_{l \in k} Firm \ln t \times Y \ln t}{\sum_{l \in k} Y \ln t}$

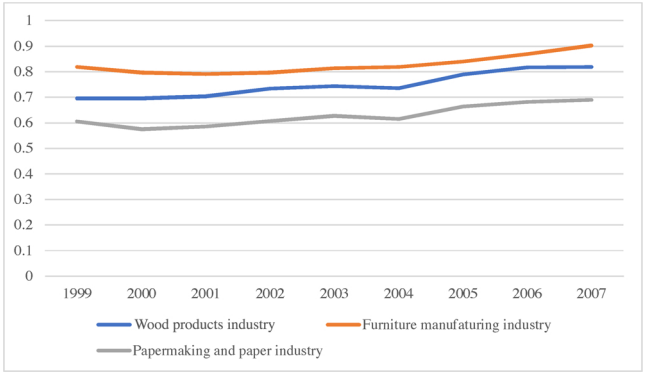

Fig. 3. LnTFP of the three forest products industries between 1999–2007.

means the proportion of foreign capital in a firm and is used to calculate the influence of FDI on the productivity of forest products firms. Foreign-invested enterprises improve their quality and productivity through training employees and implementing advanced management techniques (Cai and Liu, 2009; Borensztein et al., 1998). In addition, foreign-funded enterprises can obtain more information about the international market through their information channels and obtain cheap and/or high-quality intermediate goods imported from overseas, thereby making their enterprises more competitive (Bwalya, 2006; Borensztein et al., 1998).

FDI will affect not only the TFP of a single foreign-funded enterprise, but also the TFP of other domestic enterprises in the same industry. It can raise the productivity and efficiency of the entire industry by technology spillover (Bwalya, 2006; Blomström and Persson, 1983; Findlay, 1978; Koizumi and Kopecky, 1977). Domestic-funded enterprises can learn advanced production technology and managerial skills from foreign firms through the participation of employees of the foreign-funded enterprises and exchanges between enterprises in the same industry (Bwalya, 2006; Görg and Strobl, 2010; Fosfuri et al., 1998). FDI changes the structure of an imperfectly competitive industry and achieves superior competition in the industry (Bwalya, 2006; Teece, 1977). It is noteworthy that the positive horizontal spillover effect assumes that the domestic enterprises have sufficient learning ability and that the personnel flow between industries and the technological exchange have no barriers (Lin et al., 2009). Therefore, we should make it clear that the horizontal effect is not entirely positive. For example, the foreign-funded enterprises may reduce the productivity of the domestic enterprises in the industry by squeezing their market share (Zhang et al., 2010; Aitken and Harrison, 1999). Theoretically, the net horizontal effect of FDI on domestic firms is indefinite, and it depends on the relative magnitudes of the positive and the negative effect. The variable $Industry_{mt}$ is used to measure the ratio of foreign capital at the 3-digit industry level and is also known as the horizontal effect. This variable allows us to measure the impact of foreign ownership within the industry on the TFP of Chinese forest products firms. Note that this variable changes only over m and t.

Finally, from the perspective of inter-industry linkages, the FDI may generate vertical effects, which include forward and backward effects. The positive forward effect occur when foreign participation in the downstream sectors enhances the productivity of the upstream food firms (Jin et al., 2017). The positive forward effect is achieved mainly in the following ways. A high proportion of foreign capital in the downstream industry will improve the quality requirements for the upstream industry products so that local suppliers have to upgrade their technology and management to meet the higher product quality requirements of the foreign buyers (e.g. Foreign Investment Enterprises (FIEs) would require their suppliers to become International Organization for Standardization (ISO) certified) (Javorcik, 2004). Foreign investment in downstream industries promotes the growth of upstream industries by increasing the demand for intermediate inputs from upstream industries (Markusen and Venables, 1997). The positive backward effect may take place when upstream foreign-funded enterprises transmit advanced production technologies to downstream enterprises through their supply chain links to promote the efficiency of the downstream enterprises (Javorcik, 2004). In addition, downstream domestic companies may benefit from new, high-quality and low-cost intermediary products from upstream foreign firms. However, the effects can be ambiguous, depending on the condition of the domestic firms (Trebbin, 2014). The negative forward effect may occur when an industry in upstream sectors cannot comply with the higher standards and grading requirements for the products supplied from the downstream sectors. In addition, firms in downstream sectors may have more bargaining power with upstream firms. As such, they may reduce the suppliers' productivity by lowering the price of intermediate products. Similarly, the negative backward effect may take place when foreign-funded firms capture a higher market share leaving domestic customers with fewer alternatives, hence higher input prices (Orlic et al., 2018). Following Javorcik (2004), the final two FDI variables in this study, *Upstreamnt* and *Downstreamnt*, are used at the 2-digit CSIC industry level to test whether FDI has vertical effects. The variable *Upstreamnt* is used to measure the forward effect, that is whether FDI in the downstream sector, which directly uses forest products as materials, has an impact on the TFP of the forest products industry n in time t. Similarly, the variable *Downstreamnt* was used to measure backward effect, that is, whether FDI in the upstream sector, which directly supplies products as forest products' materials, has an impact on the TFP of the forest products industry n in time t.

Controlslmt is a vector of the control variables in the firm l of industry m in time t, and it includes $Ln(K/L)lmt$, *Statecontrollmt*, *L arg escalelmt*, *Smallscalelmt*. $Ln(K/L)lmt$ is an indicator variable which is measured by the natural logarithm of fixed assets per employee, and it is used to reflect the fact that factor endowment may influence productivity. *Statecontrollmt* is an indicator variable that equals 1 if the share of total equity owned by the state is larger than 50 percent, since state-owned enterprises may have lower productivity due to their low input-allocation efficiency (Yu, 2015; Jefferson and Hu, 2002). *L arg escalelmt* is an indicator variable for whether the firm's sales rank is among the top 25 percent in the forest products industry, while *Smallscalelmt* represents whether the firm's sales rank is among the bottom 25 percent in the forest products industry. (β_0, β_1, β_2) represents the vector of the parameters, μm and μt are unobservable industry- and time-specific factors that may be correlated with *FDIlmt* and *Controlslmt*, and εlmt is the idiosyncratic error term.

Some scholars have found that FDI from the HMT regions (Hong Kong, Macao, and Taiwan) and non-HMT regions may have different effects (Jin et al., 2017; Abraham et al., 2010; Jefferson and Hu, 2002), so we have a difference in every variable to determine whether the impact of FDI from different regions on the forest products industry varied. From research carried out by scholars, we speculate that there may be some reasons that contribute to the different effects that FDI from different sources has on TFP. First, investors form HMT regions tend to make use of China's cheap production costs and their investment is mainly export-driven (Abraham et al., 2010). The effects of

(*footnote continued*)

$Downstreamnt = \sum_{j \neq n} \beta nj \frac{\sum_{l \in j} Firm \ln t \times (Y \ln t - EX \ln t)}{\sum_{l \in j} Y \ln t - EX \ln t}$ where $Firm_{\ln t}$ and $Y_{\ln t}$ represent the foreign equity share and revenue of firm l in the 2-digit forest products industry n in time t, α_{nk} represents the proportion of sector n's production supplied to downstream sector k, and βnjrepresents the proportion of sector n's production bought from the upstream sector j. The above two coefficients were sourced from the input–output table provided by the Chinese government. The input-output coefficients connect the forest products industry n with all of the other industries' foreign capital presence. Because only the domestic intermediates sold in the domestic market can represent the true contacts between the forestry sector and its domestic suppliers, firm exports ($EX_{\ln t}$) were excluded when calculating*Downstreamnt*

export-oriented FDI are weaker than those of domestic-market-oriented FDI (Lin et al., 2009). Second, FDI from non-HMT regions is more likely to utilize advanced technology, which creates a negative competition effect for domestic firms (Jefferson and Hu, 2002). The investors from HMT regions in the forest products industry tend to use China's forestry resources to capture profit. We use *Firm_fs* to refer to the share of the firms' equity owned by non-HMT investors and *Firm_hmt* for the share of the firms' equity owned by HMT investors. All of the other FDI variables are calculated based on those two kinds of foreign investment.

3.2. Data resources

The empirical model is tested using data from the Annual Industrial Survey collected by the China National Bureau of Statistics and spanning the years 1999 to 2007. The data contain firm-level data of "firms above a designated size," which refers to the enterprises, whether state-owned or non-state-owned manufacturing enterprises, with an annual revenue from their principle business of over ¥5 million (about $0.63 million). In order to measure our problem more precisely, we carried out the selected work set out below.

For one thing, we applied the sequential identification method of Brandt et al. (2012) to identify firms using a single indicator. For another, we applied methods based on previous studies (Cai and Liu, 2009; Jefferson et al., 2008; Levinsohn and Petrin, 2003) to exclude unreliable data where (a) any important financial indicators, such as total assets, total fixed assets, price of fixed assets, sales, received capital, or industrial intermediate inputs are missing or negative, (b) the average number of employees is less than ten per year, (c) if the scale is inadequate (i.e. the sales revenue of products is less than ¥5 million (about $0.63 million), (d) there is non-conformity with International Accounting Standards, (i.e. the total assets are less than the total of current assets, total assets are less than the total of fixed assets, and accumulated depreciation is less than the current depreciation), and (e) enterprises with the highest and lowest productivity. In order to get a more accurate estimate, the original data were deflated following Yu (2015) and Amiti and Konings (2007). We used the appropriate index deflated output, intermediate input, and capital[2] .

Finally, we calculated the variables we needed by using the selected data. We proxy firms' gross output value for output, fixed assets (measured at the original purchase price) for capital, industrial intermediate input for material input, and the number of employees for labor in order to calculate TFP (Jin et al., 2017). We calculated the explanatory variables (*Firm*, *Industry*, *Upstream*, *Downstream*) and control variables ($Ln(K/L)lmt$, *Statecontrollmt*, *Largescalelmt*, *Smallscalelmt*) by using total output, export, sales, capital, and so on.

The capital is divided into two types: the capital from HMT regions and that from non-HMT regions. It is necessary to make clear that the source of the capital will have different effects. Each explanatory variable has been computed into two indicators based on the source of funds; for example, we used *Firm_fs* to measure the effect of capital from the non-HMT regions on the TFP of the forest products industry, while we used to measure the effect of capital from the HMT regions on the TFP of the forest products industry. Table 1 shows a brief description of the variables.

4. Empirical results and discussions

In consideration of the heterogeneity across different industries, we split the sample by 2-digit industries and regress each separately. The year dummy variable and time trend item were added to the regression at the firm level and the industry level. Since we divide the sample by industry, the variables *Upstreamnt* and *Downstreamnt* are only time varying. Therefore, we exclude the year dummy variables in these models.

Table 2 shows the results of the impact of the firm-level FDI on the Chinese forest products firms' productivity, and Table 3 shows the results of the influence of the FDI within the same industry, while Table 4 shows the results of the influence of the FDI from the vertical supply chains[3] . The four FDI-related variables set earlier enter the model separately in order to avoid potential multicollinearity problems because the four FDI variables are highly correlated with each other.

According to the results of Hausman test, fixed effects are used in most regressions. Considering the possibility of heteroscedasticity of random perturbation terms, robust standard error is used in regression. The p-values for the significance tests for regression are all less than 0.0001. With regard to the control variables, the natural logarithm of the capital-labor ratio, $Ln(K/L)$, is negatively related to the TFP, which is consistent with the results from Jin et al. (2017); firm size contributes positively to productivity, which indicates scale economies in Chinese forest products firms.

4.1. Firm-level productivity effects

Based on the influential factors identified in the conceptual and methodological framework, Table 2 displays the estimates of the influences of foreign equity on the productivity of the three forest products industries. Columns (1), (3), and (5) show the results of the impact of non-HMT foreign ownership on firm productivity, while the remaining columns present the results of the impact of HMT ownership.

As can be seen from Table 2, there is no significant evidence to indicate that foreign equity from non-HMT regions or HMT regions will influence the productivity of the three forest products industries that we have discussed. This result is different from the research findings of many scholars who found that FDI from non-HMT regions or HMT regions will have significant impact on productivity (Du et al., 2012; Cai and Liu, 2009; Bwalya, 2006; Borensztein et al., 1998). The empirical results of many scholars show that FDI may improve productivity by contributing advanced technology, management experience, and intermediate products with high technology content (Bwalya, 2006; Görg and Strobl, 2010; Borensztein et al., 1998), but Du et al. (2012) found that HMT-invested firms did not have productivity advantages to achieve higher TFP, and Broadman and Sun (2010) found that FDI from HMT regions had a negative effect on productivity. The effect of FDI on productivity is highly complex, as different mechanisms of action may counteract each other. FDI that brings advanced technology, management experience, qualified human resources and high-quality intermediate products can improve productivity at the firm level, while FDI from HMT regions will have negative effect because the investment may only be due to resource needs and investment convenience.

4.2. Intra-industry effects

Table 3 presents the estimates of the productivity spillover effects of the FDI presence in the same industry.

The coefficient of Industry_hmt turns out to be positive in column (2), and the effect is significant at the $p = 0.1$ level, which means that HMT invested firms have overt positive influences on the wood

[2] The output is deflated using the national forestry-related industry producer price indices for industrial products. The intermediate input is deflated using the timber and paper pulp products' purchasing price indices for industrial producers. The capital is deflated using the national price indices of investment in fixed assets.

[3] We used the translog production function to calculate TFP for the robustness check. The regression results, which used these translog TFP measures, are qualitatively similar to the results obtained using Olley and Pakes' TFP measures. In light of the consistency of results across specifications, and the fact that the translog appeared to be overly flexible in the context of our data, we have elected to retain Cobb-Douglas specification.

Table 1
Description of the variables.[a]

Variable	Description
LnTFP	The natural logarithm of total factor productivity.
Firm[b]	The proportion of foreign capital in a firm.
Industry[a]	The ratio of foreign capital at the 3-digit industry level.
Upstream[a]	The proportion of foreign capital in the downstream industry of forest products industry at the 2-digit industry level.
Downstream[a]	The proportion of foreign capital in the upstream industry of forest products industry at the 2-digit industry level.
Ln(K/L)	The natural logarithm of the capital to labor ratio in a firm.
StateControl	An indicator variable for whether the share of total equity owned by the state is greater than 50 percent.
LargeScale	An indicator variable for whether the firm's sales rank is among the top 25 percent in the forest products industry.
SmallScale	An indicator variable for whether the firm's sales rank is among the bottom 25 percent in the forest products industry.

[a] These FDI-related variables are divided into _fs and _hmt in order to differentiate between the impact of capital from HMT and non-HMT regions.
[b] As we use panel data, the conventional descriptive statistics of listed variables is not included.

Table 2
Impact of FDI on firm productivity at firm level.

	20 Wood products industry		21 Furniture manufacturing industry		22 Papermaking and paper industry	
	(1)	(2)	(3)	(4)	(5)	(6)
Firm_fs	−0.0139(−0.62)		0.0018 (0.08)		−0.0229(−0.93)	
Firm_hmt		0.0051 (0.20)		−0.0090 (−0.42)		−0.0075(−0.54)
Ln(K/L)	−0.0188***(−4.74)	−0.0166***(−3.97)	−0.0189***(−2.76)	−0.0220***(−2.87)	−0.0202***(−5.62)	−0.0204***(−5.13)
Statecontrol	−0.0151 (−0.71)	−0.0104(−0.42)	−0.0225(−0.77)	−0.0152(−0.47)	−0.0112(−1.11)	−0.0101(−0.87)
Largescale	0.0823*** (11.99)	0.0847*** (11.51)	0.0855*** (6.97)	0.0858*** (6.15)	0.0797*** (12.90)	0.0827*** (12.53)
Smallscale	−0.114*** (−9.97)	−0.119***(−9.54)	−0.110***(−7.54)	−0.108***(−6.77)	−0.0861***(−13.49)	−0.0881***(−13.35)
IndustryDummy	Yes	Yes	Yes	Yes	Yes	Yes
YearDummy	Yes	Yes	Yes	Yes	Yes	Yes
TimeTrend	Yes	Yes	Yes	Yes	Yes	Yes

Note: ***, **, and * indicate the significance of the coefficients at the 1%, 5%, and 10% levels, and the values in parentheses are standard deviations.

Table 3
Impact of FDI on domestic forest products firm productivity in the same industry.

	20 Wood products industry		21 Furniture manufacturing industry		22 Papermaking and paper industry	
	(1)	(2)	(3)	(4)	(5)	(6)
Industry_fs	0.107 (0.44)		−0.0229 (−0.12)		−0.0115(−0.14)	
Industry_hmt		0.668* (1.73)		−0.0952(−0.75)		0.0285 (0.15)
Ln(K/L)	−0.0201*** (−4.28)	−0.0201*** (−4.28)	−0.0203***(−4.43)	−0.0223**(−2.52)	−0.0207*** (−4.98)	−0.0207***(−4.98)
Statecontrol	−0.0037 (−0.13)	−0.0038(−0.13)	−0.0596**(−2.50)	−0.0252(−0.57)	−0.0125(−0.95)	−0.0125(−0.95)
Largescale	0.0775*** (10.55)	0.0778*** (10.62)	0.0780*** (7.03)	0.0831*** (4.56)	0.0825*** (12.59)	0.0825*** (12.59)
Smallscale	−0.118*** (−8.28)	−0.119***(−8.19)	−0.0893***(−6.82)	−0.102***(−6.03)	−0.0891*** (−12.85)	−0.0891***(−12.85)
IndustryDummy	Yes	Yes	Yes	Yes	Yes	Yes
YearDummy	Yes	Yes	Yes	Yes	Yes	Yes
TimeTrend	Yes	Yes	Yes	Yes	Yes	Yes

Note: ***, **, and * indicate the significance of the coefficients at the 1%, 5%, and 10% levels, and the values in parentheses are standard deviations.

products industry. This shows that HMT invested firms benefit the forest products firms' productivity in the wood products industry. We speculate that there are two reasons for this effect. First, foreign investment from HMT will increase competition within the industry, thus prompting enterprises to endeavor to increase their productivity (Bwalya, 2006). Second, due to geographical and cultural factors, investment enterprises from HMT are closely linked to and cooperate with domestic enterprises in the same industry. This situation will accelerate the flow of technology, management experience, and information from foreign-funded enterprises to domestic-funded enterprises, thereby improving the TFP of domestic-funded enterprises. The result is quite different from Lin et al.'s (2009) research, which investigated FDI effects in the entire manufacturing industry in China and showed that FDI from HMT regions has a negative effect.

Foreign capital from non-HMT regions has no significant impact on the three forest products industries that we have discussed. The result is quite different from the findings of Lv and Huang (2006a), who observed significant positive spillovers in the Chinese agricultural products processing industry by applying industry-level panel data. A possible reason for this result is that the potential positive spillover

Table 4
Impact of FDI on domestic forest products firm productivity of foreign ownership in downstream and upstream sectors.

	20 Wood products industry				21Furniture manufacturing industry				22Papermaking and paper industry			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Upstream_fs	0.0244 (0.07)				−19.39*** (−2.96)				−0.274(−1.08)			
Upstream_hmt		−0.563* (−1.91)				−9.896*(−1.76)				−1.620***(−7.27)		
Downstream_fs			2.824*** (2.92)				0.627 (1.13)				2.220*** (5.91)	
Downstream_hmt				3.632*** (2.76)				0.484 (0.99)				2.130*** (5.63)
Ln(K/L)	−0.0175*** (−4.32)	−0.0181*** (−4.47)	−0.0182*** (−4.50)	−0.0183*** (−4.52)	−0.0213*** (−3.13)	−0.0213*** (−3.11)	−0.0210*** (−3.09)	−0.0210*** (−3.08)	−0.0198*** (−5.60)	−0.0206*** (−5.80)	−0.0204*** (−5.75)	−0.0204***(−5.75)
Statecontrol	0.104** (2.33)	0.104** (2.32)	0.104** (2.32)	0.104** (2.32)	−0.0113 (−0.29)	−0.0116(−0.29)	−0.0109(−0.28)	−0.0109(−0.28)	−0.0020(−0.20)	−0.0049(−0.49)	−0.0034(−0.34)	−0.0032(−0.33)
Largescale	0.0868*** (10.12)	0.0851*** (9.93)	0.0859*** (10.12)	0.0855*** (10.07)	0.0925*** (7.48)	0.0922*** (7.44)	0.0928*** (7.50)	0.0930*** (7.52)	0.0811*** (13.20)	0.0796*** (12.97)	0.0804*** (13.13)	0.0804*** (13.12)
Smallscale	−0.121*** (−9.89)	−0.120*** (−9.80)	−0.120*** (−9.81)	−0.120*** (−9.78)	−0.112*** (−7.70)	−0.113*** (−7.77)	−0.113*** (−7.79)	−0.113*** (−7.78)	−0.0881*** (−13.81)	−0.0874*** (−13.80)	−0.0880*** (−13.86)	−0.0879***(−13.84)
IndustryDummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
TimeTrend	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: ***, **, and * indicate the significance of the coefficients at the 1%, 5%, and 10% levels, and the values in parentheses are standard deviation.

effect and negative effect on domestic firms may cancel out, and cause the non-significant result in our estimation (Lin et al., 2009). The apparent heterogeneity in the spillover effects across different industries means that it is more beneficial to investigate the impact of FDI on the Chinese forest products industry specifically.

4.3. Vertical effects

Table 4 shows the results from the models investigating the impact of foreign equity in the upstream and downstream sectors on the Chinese forest products firms' productivity. As can be seen from columns (5)in Table 4, the coefficients of the furniture manufacturing industry was significant at the p = 0.01 level. The result in column (5) reveals that FDI from non-HMT regions in downstream sectors will decrease the productivity of the furniture manufacturing industry. This may be because firms in the furniture manufacturing industry cannot comply with the higher standards and grading requirements for the supplied products (Farina and Reardon, 2000).

The results regarding the backward effects caused by non-HMT investments are shown in the columns (3), (7), and (11). The coefficients of the wood products industry and papermaking and paper industry were significant and positive at the p = 0.01 level (columns (3) and (11)). Obviously, non-HMT investment in upstream sectors plays a positive role in facilitating the productivity of domestic forest products firms in the wood products industry and papermaking and paper industry. This may be attributed to cheaper and higher-quality intermediate products being provided by the foreign firms in the upstream sectors. The results are consistent with other findings for Chinese manufacturing firms (Jin et al., 2017; Du et al., 2012; Liu, 2007)

In respect to the coefficient on *Upstreamhmt* and *Downstreamhmt*, the results vary. According to the regression results, the coefficients on *Upstreamhmt* are negative and significant in all of the three industries. The coefficient on *Upstreamhmt* implies that the appearance of HMT investment in the downstream sector decreases the productivity of the domestic forest products firms. This result is contrary to the finding by Lin et al. (2009). He found that there were positive forward spillovers of HMT investment to the whole manufacturing industry in China. At the same time, the result of the current study's forward effect is similar to that of Jin et al. (2017), where they found that there were significant negative forward effects of HMT foreign investment on food firms. Our results reveal that the capital from the HMT regions generates a different vertical impact on the Chinese forest products industry compared with the other individual manufacturing industries, or the manufacturing industries as a whole. The FDI from HMT regions is partly driven by the preferential exchange rate policy. Moreover, some of the capital invested by HMT regions comes from mainland China. This form of FDI will not have a significant effect on the productivity of upstream firms.

The findings of this study show that the positive backward effect of HMT investment is quite different from the negative forward effect of HMT investment. There may be several explanations for this. One possible reason lies in the stronger market power possessed by firms with an HMT investment share in the downstream and upstream sectors. If so, HMT firms in the downstream sectors may have more bargaining power with the domestic forest products firms and thereby reduce the suppliers' productivity by lowering the price of intermediate products, whereas HMT-invested firms in upstream sectors may increase the productivity of the forest products firms by providing higher-quality intermediate input products for the forest products firms.

5. Conclusions and implications

With FDI flowing into developing economies, domestic forest products firms in the host countries not only potentially benefit from technological spillovers, but also potentially suffer from foreign competitors, suppliers, or buyers in the domestic market. Since China has

implemented preferential FDI policies for more than 20 years, the experiences of China may have important implications for other developing countries (Huang et al., 2010).

We systematically investigated the productivity effects of FDI on the Chinese forest products industry using firm-level data from 1999 to 2007. The approach applied to calculate the firms' TFP was published by Olley and Pakes in 1996. The impact of FDI on productivity in the forest products industry was measured from the firm level, industry level, and the vertical effect level. The results show that FDI at various levels or originating from different sources affects the Chinese forest products sector in significantly different ways. Although one of the initial purposes of China's policy to encourage FDI was to enhance the productivity of domestic firms, our results show that, under some circumstances, FDI may harm the productivity of forest products firms. Our empirical findings have important implications for China's policies related to FDI in the forest products industry. First, the policy makers have to understand that the origin of FDI may affect the type and magnitude of FDI spillovers. Therefore, they should be cautious when offering FDI incentives and should pay attention to the sources and technological levels of FDI in order to understand the potential impact on domestic forest products firms. Second, the government should formulate some policies to strengthen the links between foreign-funded enterprises and domestic enterprises, since the significant positive effect of FDI on domestic firms requires the implementation of a specific policy to maximize the linkage between foreign and domestic firms. Third, the government should monitor the different impacts of upstream and downstream FDI. Taking China as an example, we found that the forward and backward effects of FDI are different. The backward effects are positive while the forward effects are negative. Therefore, from the perspective of promoting the development of the forest products industry, we should encourage upstream industry FDI and treat the current downstream industry with caution.

Although we explored the impact of FDI on the productivity of the forest products industry from four aspects, we did not determine the mechanism of the FDI's effect on the productivity of the forest products industry; we only compared it with the research of other scholars to find possible ways that the mechanism may work. Although this is beyond the scope of this present study, it provides an interesting avenue for future research.

Declaration of Competing Interest

None.

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Appendix A. Forest products industry classifications

As noted in the text, the industry index *n* refers to the 2-digit Chinese Standard Industry Classification (CSIC), and the index *m* refers to the 3-digit CSIC. The variables Industry and Industry Dummy are classified at the 3-digit CSIC level (these variables are with m subscripts) for two reasons. Firstly, a large number of firms have a wide business scope, which may include various sub-industries at the 4-digit level, although they belong to only one specific 4-digit CSIC code. This means that the 4-digit CSIC codes of some firms are likely to have changed over time, which would lead to measurement errors if the variables were calculated at the 4-digit level. Secondly, the Chinese industry classification standard was adjusted in 2003, which made some 4-digit CSIC codes after 2003 different from those before 2003; however, the 3-digit CSIC codes have generally remained the same.

The reason we did not use the 3-digit CSIC industry codes to classify the backward and forward FDI variables is that the Chinese input-output table represents the relationship among industries only at a 2-digit CSIC level. Since we regress different 2-digit industries separately, in each regression the backward and forward variables are only time-varying, i.e., without the subscript n in Eq. (1).

Overall, there are three 2-digit forest products industries in our research: the wood products industry, the furniture manufacturing industry, and the papermaking and paper industry. In each 2-digit industry *n* there are several 3-digit industries *m*. The specific forest products industries are displayed in Table S1 below.

Appendix B. TFP estimation using the Olley and Pakes (1996) method

Assume a Cobb-Douglas production function:

$$Yit = AitMit^{\beta m}Lit^{\beta l}Kit^{\beta k} \tag{B.1}$$

where Y_{it} represents output, and M_{it}, L_{it}, and K_{it} expresses materials input, labor, and capital, respectively, for firm i in year t. A_{it} refers to total factor productivity (TFP). Formula B.2 is obtained by taking logarithms on both sides of Formula B.1:

$$yit = \beta 0 + \beta mmit + \beta llit + \beta KKit + \omega it + \varepsilon it \tag{B.2}$$

where the lower-case letters indicate log values. The term ($\beta_0 + \omega_{it} + \varepsilon_{it}$) expresses the natural logarithm of A_{it}, where ω_{it} is a productivity shock to firm i that is not observable by the econometrician but is observed by the firm, and ε_{it} is a random productivity shock that cannot be observed by the firm's decision-makers or econometricians.

There are two problems in estimating the production functions under OLS: simultaneity bias caused by a correlation between the input factors and the realization of the productivity shock ??$_{????}$, and selection bias that arises because firms with low productivity are more likely to exit from the market. To account for these two issues, Olley and Pakes (1996) developed a semi-parametric method that assumes that a firm's investment demand depends on capital (K) and the productivity shock (??) via:

$$iit = i(\omega it, kit) \tag{B.3}$$

where? ?$_{????}$ is the natural logarithm of current investment? ?$_{????}$, $Iit = Kit - (1 - \delta)Ki.\ t - 1$ and? ? denotes the depreciation rate. The inverse function of Eq. (B.3) generates:

$$\omega it = i^{-1}(iit, kit) = h(iit, kit) \tag{B.4}$$

Substituting (B.4) into (B.2) yields

$$yit = \beta mmit + \beta llit + \varphi(iit, kit) + \varepsilon it \quad \text{(B.5)}$$

where $\varphi(iit, kit) = \beta 0 + \beta kkit + h(iit, kit)$

Therefore, the simultaneity problem is eliminated. In the first step, we estimate the parameters βm and $\beta 1$. Since the functional form of? ?(·) is unknown, we use a kernel estimator to estimate the function. In the second step, we estimate βk by estimating the firms' survival probabilities to overcome the selection bias using a probit regression. Finally, we estimate

$$yit - \hat{\beta}mmit - \hat{\beta}llit = \beta kkit + g(\hat{\varphi}t - 1 - \beta kki, t - 1, Pi, t - 1) + \eta it + \varepsilon it \quad \text{(B.6)}$$

where $\hat{\beta}m$ and $\hat{\beta}l$ are coefficients estimated in the first step. The function g(·) is also unknown and is approximated using a kernel estimator. In the last step, the productivity is calculated via: $nA_{it} = y_{it} - \widehat{\beta_m} mit - \widehat{\beta_i} lit - \widehat{\beta_k} kit$

We used a depreciation rate of 15 percent following Amiti and Konings (2007) and Yu (2015). Furthermore, since we could not distinguish between firms exiting from the market and firms leaving the dataset because their revenue was below ¥ 5 million (about $0.63 million), we classified both situations as an exit. The estimated elasticities of the three input variables using the Olley-Pakes method are shown in Table S2.

References

Abraham, F., Konings, J., Slootmaekers, V., 2010. FDI spillovers in the Chinese manufacturing sector: evidence of firm heterogeneity. Econ. Transit. 18 (1), 143–182.

Aitken, Harrison, A.E., 1999. Do domestic firms benefit from direct foreign investment? Evidence from Venezuela. Am. Econ. Rev. 89 (3), 605–618.

Amiti, M., Konings, J., 2007. Trade liberalization, intermediate inputs, and productivity: evidence from Indonesia. Am. Econ. Rev. 97 (5), 1611–1638.

Añón Higón, D., Máñez, J.A., Rochina-Barrachina, M.E., Sanchis, A., Sanchis, J.A., 2018. The impact of the Great Recession on TFP convergence among EU countries. Appl. Econ. Lett. 25 (6), 393–396.

Bernini, C., Cerqua, A., Pellegrini, G., 2017. Public subsidies, TFP and efficiency: a tale of complex relationships. Res. Policy 46 (4), 751–767.

Blomström, M., Persson, H., 1983. Foreign investment and spillover efficiency in an underdeveloped economy: evidence from the Mexican manufacturing industry. World Dev. 11, 493–501.

Borensztein, E., De Gregorio, J., Lee, J.W., 1998. How does foreign direct investment affect economic growth? J. Int. Econ. 45 (1), 115–135.

Brandt, L., Biesebroeck, J.V., Zhang, Y., 2012. Creative accounting or creative destruction? Firm-level productivity growth in Chinese manufacturing. J. Dev. Econ. 97 (2), 0–351.

Broadman, H.G., Sun, X., 2010. The distribution of foreign direct investment in China. World Econ. 20 (3), 339–361.

Bwalya, S.M., 2006. Foreign direct investment and technology spillovers: evidence from panel data analysis of manufacturing firms in Zambia. J. Dev. Econ. 81 (2), 0–526.

Cai, H., Liu, Q., 2009. Competition and corporate tax avoidance: evidence from Chinese industrial firms. Econ. J. 119 (537), 764–795.

Chen, J., Wu, Y., Song, M., Zhu, Z., 2017. Stochastic frontier analysis of productive efficiency in China's forestry industry. J. For. Econ. 28, 87–95.

Cheng, S., Xu, Z., Su, Y., Zhen, L., 2010. Spatial and temporal flows of China's forest resources: development of a framework for evaluating resource efficiency. Ecol. Econ. 69 (7), 1405–1415.

Dries, L., Swinnen, J.F.M., 2004. Foreign direct investment, vertical integration, and local suppliers: evidence from the polish dairy sector. World Dev. 32 (9), 1525–1544.

Du, L., Harrison, A., Jefferson, G.H., 2012. Testing for horizontal and vertical foreign investment spillovers in China, 1998–2007. J. Asian Econ. 23 (3), 234–243.

Findlay, R., 1978. Relative backwardness, direct foreign investment, and the transfer of technology: a simple dynamic model. Q. J. Econ. 92 (1), 1–16.

Fosfuri, A., Motta, M., Ronde, T., 1998. Foreign direct investments and spillovers through workers' mobility. Econ. Work. Pap. 53 (1), 205–222.

Farina, E.M.M.Q., Reardon, T., 2000. Agrifood irades and standards in the extended Mercosur: their role in the changing agrifood system. Am. J. Agric. Econ. 82 (5), 1170–1176.

Görg, H., Strobl, E., 2010. Spillovers from foreign firms through worker mobility: an empirical investigation. Scand. J. Econ. 107 (4), 693–709.

He, H., Weng, Q., 2012. Ownership, autonomy, incentives and efficiency: evidence from the forest product processing industry in China. J. For. Econ. 18 (3), 177–193.

Huang, J.K., Yang, J., Rozelle, S., 2010. China's agriculture: drivers of change and implications for China and the rest of world. Agric. Econ. 41 (s1), 47–55.

Javorcik, B.S., 2004. Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. Am. Econ. Rev. 94 (3), 605–627.

Jefferson, G.H., Hu, A.G.Z., 2002. FDI impact and spillover: evidence from China's electronic and textile industries. World Econ. 25 (8), 1063–1076.

Jefferson, G.H., Rawski, T.G., Zhang, Y., 2008. Productivity growth and convergence across China's industrial economy. J. Chin. Econ. Bus. Stud. 6 (2), 121–140.

Jiang, Z., 2017. The impact of FDI intra and inter industry spillovers on TFP change in Chinese manufacturing sector. Econ. Theory Bus. Manage. 2, 78–87.

Jin, S., Guo, H., Delgado, M.S., Wang, H.H., 2017. Benefit or damage? The productivity effects of FDI in the Chinese food industry. Food Policy 68, 1–9.

Kelly, M.C., Germain, R.H., Bick, S., 2017. Impacts of forestry best management practices on logging costs and productivity in the northeastern USA. J. For. 115 (6), 503–512.

Keng, S.H., Wu, S.Y., 2014. Living happily ever after? The effect of Taiwan's national health insurance on the happiness of the elderly. J. Happiness Stud. 15 (4), 783–808.

Koizumi, T., Kopecky, K.J., 1977. Economic growth, capital movements and the international transfer of technical knowledge. J. Int. Econ. 7 (1), 45–65.

Kreuser, C.F., Newman, C., 2018. Total factor productivity in South African manufacturing firms. South Afr. J. Econ. 86, 40–78.

Laaksonen-Craig, S., 2004. Foreign direct investments in the forest sector: implications for sustainable forest management in developed and developing countries. For. Policy Econ. 6 (3–4), 0–370.

Levinsohn, J., Petrin, A., 2003. Estimating production functions using inputs to control for unobservable. Rev. Econ. Stud. 70 (2), 317–341.

Lin, P., Liu, Z., Zhang, Y., 2009. Do Chinese domestic firms benefit from FDI inflow? Evidence of horizontal and vertical spillovers. China Econ. Rev. 20 (4), 677–691.

Liu, Z., 2007. Foreign direct investment and technology spillovers: theory and evidence. J. Dev. Econ. 85 (1), 176–193.

Lv, L., Huang, Z., 2006a. Empirical study on the effects of foreign direct investment on Chinese agricultural products processing industry. Chin. Rural Econ. 5, 18–24 (in Chinese).

Markusen, J.R., Venables, A.J., 1997. Foreign direct investment as a catalyst for industrial development. NBER Work. Pap. 43 (2), 335–356.

Olley, G.S., Pakes, A., 1996. The dynamics of productivity in the telecommunications equipment industry. Econometrica 64 (6), 1263–1297.

Orlic, E., Hashi, I., Hisarciklilar, M., 2018. Cross sectoral FDI spillovers and their impact on manufacturing productivity. Int. Bus. Rev. 27 (4), 777–796.

Simon, B., Mika, Y., Rin, S., Hideo, S., 2018. Productivity of loaders and forwarders in Japanese forestry operation conditions. J. For. Res. 23 (3), 149–155.

Teece, D.J., 1977. Technology transfer by multinational firms: the resource cost of transferring technological know-how. Econ. J. 87, 242–261.

Trebbin, A., 2014. Linking small farmers to modern retail through producer organizations - experiences with producer companies in India. Food Policy 45 (4), 35–44.

United Nations Conference on Trade and Development, 2017. World Investment Report 2017: Investment and the Digital Economy. UN. .

Walkenhorst, P., 2000. Foreign direct investment, technological spillovers and the agricultural transition in central Europe. Post-Commun. Econ. 12 (1), 61–75.

Yang, H., Yuan, T., Zhang, X., Li, S., 2016. A decade trend of total factor productivity of key state-owned forestry enterprises in China. Forests 7 (5), 97.

Yu, M., 2015. Processing trade, tariff reductions, and firm productivity: evidence from Chinese products. Econ. J. 125 (585), 943–988.

Zang, L.Z., Zhang, C.H., Xu, D.Y., Xu, Z.C., 2015. Research on temporal-spatial evolution of regional disparity of forestry total factor productivity in China. Adv. J. Food Sci. Technol. 9 (5), 332–341.

Zhang, K.H., Aghion, P., Carlin, W., 2010. How does foreign direct investment affect economic growth in China? Econ. Transit. 9 (3), 679–693.

Zhang, Y., Toppinen, A., Uusivuori, J., 2014. Internationalization of the forest products industry: a synthesis of literature and implications for future research. For. Policy Econ. 38, 8–16.