Benefit or Damage? The Productivity Effects of FDI in Chinese Food Industry

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Abstract

This paper systematically investigated the impact of foreign direct investment (FDI) on Chinese food firms' total factor productivity (TFP) by using the firm-level census data between 1998 and 2007 (174,539 sample food firms). We tested for "own-plant" effects, intra-industry effects, regional effects and vertical effects. The results show that food firms' foreign ownership has weakly positive or no impact on the productivity of invested firms. At the industry level, FDI generates adverse influences on domestic firms productivity in some sub food sectors. Further, mixed regional effects are observed in different sub food sectors and across investment with different origins. Finally, both positive backward and forward spillovers generated by FDI originating outside Hong Kong, Macaw and Taiwan (HMT) are observed, while HMT investment has negative vertical spillovers.

Keywords：food industry, foreign direct investment (FDI), China, productivity

JEL codes: Q13 Q17 Q18

1. Introduction

In recent years, developing countries have become increasingly attractive destinations for international investors. According to UNCTAD (United Nations Conference on Trade and Development), foreign direct investment (FDI) flows to developing economies reached a new high of US$ 778 billion (or 54 percent of global flows) in 2013, maintaining overwhelming superiority over those to developed economies (39 percent of global flows). As an emerging economy, China has maintained a leading position in absorbing international investment, occupying 16 percent of total FDI flows to developing countries (UNCTAD, 2014). As such, FDI is an important source of external capital for Chinese companies (Broadman and Sun, 1997; Jeon et al., 2013).

Under this background of booming global investment, agriculture-related multinational enterprises (MNEs) are also expanding their scale around the world. In 2007, world FDI flows into food, beverages, and tobacco industries reached US$ 45 billion, more than five times the 1990 level (US$ 80 billion; (UNCTAD, 2009). In the Chinese food sector, foreign equity occupied about a quarter of owners' equity in 2012, playing a significant part in the whole sector.[1] Foreign invested food firms possessed 28 percent of sectoral assets and generated almost a quarter of sectoral profits and revenue, despite making up only 11 percent of total firm numbers (see Figure 1).

[Insert Figure 1 here]

It is widely believed that FDI from developed countries can greatly contribute to the development and structural upgrading of the Chinese food industry. FDI not only provides financial support to the domestic food sector, which relatively lacks capital compared to other sectors, but also helps improve productivity of the whole industry and save limited natural resources due to spillovers of advanced production and management technologies (Cheng, 2012; Jin and Tokunaga, 2007; Ni, 2011; Yin, 2010). Domestic food firms benefit from technology spillovers and global market information, and become more competitive in the international market (Lv and Huang, 2006b). However, as agriculture-related MNEs spread rapidly in China, there emerge some concerns about the negative impact of FDI on the domestic food industry (Ni, 2011; Yin, 2010). In

[1] Food sector (industry) in this paper refers to three industries (classified at 2-digit Chinese Standard Industry Classification (CSIC， GBT 4754-2002)): agro-food processing industry (2-digit CSIC code: 13), food manufacturing industry (2-digit CSIC code: 14), beverages and alcohol industry (2-digit CSIC code: 15).

recent years, foreign capital has controlled some key steps in the industry chain, and is capable of influencing the whole industry. For instance, in the edible oil processing industry, foreign equity constitutes 66 percent of the entire industry equity, and MNEs occupied as high as 85 percent of the edible oil market share in China (Lv, 2009; Ni, 2011). With respect to the dairy industry, foreign invested firms have more than 1/3 of the domestic market share (Lv, 2009). Compared to domestic middle and small-sized food firms, MNEs have signal competitive advantages and might crowd out domestic companies with low-price strategies (Ding and Kong, 2014). As a result, Cheng (2012) shows concern that FDI inflows may destabilize food price stability and even harm Chinese food security. However, little research has been done to understand the influences of FDI on the Chinese food industry, although abundant investigation has been performed on the productivity impact of FDI in the Chinese manufacturing industry (e.g., (Abraham et al., 2010; Du et al., 2012; Hu and Jefferson, 2002; Lin et al., 2009). Since the food industry is a sector with lower technological levels, it is more vulnerable to competitive MNEs than other industries with higher technology (Jeon et al., 2013). Therefore, the influences of FDI in the food sector may be different from those of the manufacturing sector as a whole.

Based on firm-level census data from 1998 to 2007 (174,539 sample food firms), this paper aims to systematically investigate the impact of FDI on the productivity of the Chinese food industry. Specifically, we test the productivity effects of FDI at four levels: (i) foreign equity share within firms ("own-plant" effects); (ii) foreign capital participation within the same industry of the whole country (intra-industry effects); (iii) foreign investment within city in the same industry (regional effects); and (iv) foreign capital participation in upstream and downstream sectors (vertical effects).

Moreover, we also aim to see whether investment from Hong Kong, Macao and Taiwan (HMT) and investment from other countries result in different spillover effects. The reasons are threefold. First, MNEs with non-HMT origins (mainly OECD countries) are more likely to be enterprises equipped with advanced technology and managerial skills, aiming at the access to domestic market, whereas, investment from HMT mainly flows into labor-intensive industries and are more export-oriented (Abraham et al., 2010; Girma et al., 2009). Second, a great deal of so-called HMT investment is actually domestic capital that is routed through HMT to benefit from preferential tax

treatment to joint ventures (Broadman and Sun, 1997; Du et al., 2012). Third, HMT equity constitutes a large part of total foreign equity in Chinese enterprises (Xu and Sheng, 2012); the ratio is about 33 percent in the food sector during 1998-2007.[2] Therefore, it is necessary to analyze the impact of FDI from different origins separately.

This paper is divided into five parts. In Section 2, we begin with a conceptual discussion of the impact of FDI on productivity of firms in host countries. Next, we construct an econometric model to analyze the impact of FDI on food firms, and provide details about the data. Section 4 presents the estimation results and discussion. Finally, Section 5 draws our conclusions and policy implications.

2. The impact of FDI on productivity

Many studies have attempted to explain the productivity effects of FDI (e.g., (Aitken and Harrison, 1999; Borensztein, 1998; Findlay, 1978; Javorcik, 2004; Markusen and Venables, 1999). According to literature, FDI may affect productivity in the following ways.

First, FDI plays an important role in improving the invested firms productivity. Foreign investment brings advanced manufacturing techniques and qualified human resources (Borensztein, 1998; Hallam, 2009; Jongwanich, 2009). In addition, with a comprehensive international production network, MNEs enjoy cheap or high-quality intermediate goods imported from overseas (Borensztein, 1998; Jongwanich, 2009), and compared with domestic firms, more firm specific staff training in MNEs (Görg and Strobl, 2005) upgrades firms' general level of technique.

Besides the "own-plant" effects, intra-industry effects may occur with foreign investment inflows. FDI can influence firm productivity in the entire industry mainly in three ways: (i) domestic food firms can improve technical levels by imitating and learning from MNEs, and thus enhance productivity (Blomström and Persson, 1983; Findlay, 1978; Koizumi and Kopecky, 1977); (ii) domestic companies can benefit from the technological and managerial knowledge brought by skilled employees who have worked in foreign affiliates (Fosfuri et al., 2001; Görg and Strobl, 2005); (iii) the entry of MNEs intensifies the competition in the host country market, forcing

[2] Calculated by the authors, based on the dataset used in this study.

domestic firms to improve productivity (Teece, 1977). However, a prerequisite for positive intra-industry effects is a domestic sector with absorptive capacity (Hallam, 2009; Kokko, 1994). If the technological gap between domestic firms and foreign investors in the same industry is large, then a negative intra-industry effect is more likely to take place (Jeon et al., 2013). Foreign invested enterprises (FIEs) may use their technological advantage to crowd out the market share of domestically owned firms (Zhang, 2001), and the latter will bear higher average costs because of the decline in sales volume (Aitken and Harrison, 1999). As a result, FDI decreases domestic firm's productivity, which is known as the "market-stealing" effects.

Moreover, FDI participation within industry may influence the neighboring domestic firms and the more distant ones differently (Aitken and Harrison, 1999; Findlay, 1978; Madariaga and Poncet, 2007; Wei and Liu, 2006; Xu and Sheng, 2012). Skilled employees who have worked in FIEs tend to choose new jobs in firms in nearby regions, which means that technology transfers through human capital mobility can be more frequent in local areas. Similarly, FIEs' new products or technical innovation can first be demonstrated by local firms due to more frequent contact. Nevertheless, the "market-stealing" effects may be more intense within the same region, since FIEs may share more common trading areas with domestic firms if they locate nearby.

Last but not least, from the perspective of inter-industry linkages, the entrance of FDI may generate vertical spillovers, including backward and forward spillovers. Backward spillovers occur when foreign participation in the downstream sectors enhances the productivity of upstream domestic firms. According to Javorcik (2004), backward spillovers may take place mainly through three channels. First, foreign companies provide direct technological support to local suppliers. Second, local suppliers have to upgrade their technology and management to meet higher requirements for product quality of foreign buyers (e.g., MNEs would require their suppliers become ISO certified). Third, increased demand for intermediate goods caused by the entrance of MNEs can create scale economies in local suppliers. With respect to forward spillovers, they may take place when FIEs in the upstream sectors enhance the productivity of downstream domestic firms by providing them with improved or less costly intermediate goods and services (Javorcik, 2004). In addition, local companies may benefit from price reductions of intermediate goods if FDI

inflows into the upstream sectors increases the degree of industry competition (Markusen and Venables, 1999).

3. Model and Data

3.1. Model

We employ the following linear regression model to measure the effects of FDI on Chinese food firms' TFP from various aspects:

$$LnTFP_{ijct}^{OP} = \alpha + \beta\ FDI_effect + \theta\ X_{ijct} + \mu_{ijct} \quad (1)$$

where α is the intercept term, μ_{ijct} is the error term.

$LnTFP_{ijct}^{OP}$ stands for the natural logarithm of TFP of firm *i* in industry *j* at city *c* and year *t*.[3] We assume a Cobb–Douglas production function to calculate firm-level TFP following Olley and Pakes (1996).[4] In the consideration that each sub food industry (agro-food processing industry, food manufacturing industry, beverages and alcohol industry) has distinct features, we calculate TFP of firms in different sub food industries separately, and consequently equation (1) is also estimated separately.

FDI_effect refers to the following five variables that describe FDI participation at various levels. In order to get distinct results caused by each FDI measure without interference, the

[3] Industry *j* is classified at a 3-digit CSIC level for two considerations. First, a large number of firms have a wide business scope, which may include various sub industries at a 4-digit level, while they only belong to one specific 4-digit CSIC code. It means that some firms' 4-digit CSIC codes probably changed over the years, leading to biased measurement of variables. Second, the standard of Chinese industry classification was adjusted in 2003, making some 4-digit CSIC codes after 2003 different from those before 2003, but 3-digit CSIC codes generally remained the same. There are 8, 7, and 4 3-digit CSIC industries in agro-food processing industry, food manufacturing industry, beverages and alcohol industry, specifically. However, industry classification is a little different in calculating vertical FDI effect variables, see footnote 8.

[4] The traditional OLS method to calculate TFP may generate simultaneity bias (inputs are endogenous because firms may adjust inputs according to TFP changes) and selection bias (firms with low productivity are more likely to exit from the market) (Olley and Pakes, 1996; Levinsohn and Petrin, 2003). Olley and Pakes (1996) use investment as a proxy variable for unobservable productivity shocks, and apply a Probit model to estimate firms' probability of surviving. In this way, Olley-Pakes is able to overcome both simultaneity bias and selection bias (Abraham et al., 2010; Du et al., 2012; Liu, 2008). Therefore, we deploy Olley-Pakes. However, two issues need to be noticed. First, since the dataset does not include annual investment, we obtain investment via the perpetual inventory method with depreciation rate of 15% following Yu (2011) and Amiti and Konings (2007). Second, since we cannot distinguish whether firms exit from the market or whether they leave the dataset because their revenues are below 5 million, both situations are allowed when constructing the "exit" variable. The estimated elasticity of three input variables using Olley-Pakes are shown in Table A.2.

variables enter the model separately.[5] First, we use $Foreignshare_{ijct}$, the share of the total equity in the firms owned by foreign investors, to test the influence of foreign investment on the productivity of food firms receiving FDI.

Second, in order to explore how the presence of foreign ownership within the industry affects food firms' TFP, we construct variable $Intra-industry_{jt}$. It is defined as the foreign equity participation averaged over all firms in sector *j* at time *t*, weighted by each firm's share in sectoral revenue: [6]

$$Intra-industry_{jt}=\frac{\sum_{i\ for\ all\ i\in j} Foreign\ Share_{ijct}\times Y_{ijct}}{\sum_{i\ for\ all\ i\in j} Y_{ijct}} \quad (2)$$

where Y_{ijct} proxies for revenue of firm *i* in sector *j* at region *c* and time *t*.

Third, considering that the learning effect, human capital shifting effect, and competition effect can be different in neighboring areas, we construct a variable to capture the extent of the foreign presence in the same sector and the same region. $Regional_{jct}$ is a proxy for foreign presence in sector *j* at city *c* and time *t*, and it is calculated as:[7]

$$Regional_{jct}=\frac{\sum_{i\ for\ all\ i\in j,c} Foreign\ Share_{ijct}\times Y_{ijct}}{\sum_{i\ for\ all\ i\in j,c} Y_{ijct}} \quad (3)$$

At last, two sector-level FDI variables are constructed to test for vertical effects following Javorcik (2004). These two variables are intended to capture the extent of potential contacts between food industry and its foreign customers or suppliers. Therefore, $Backward_{jt}$ and $Forward_{jt}$ refer to the foreign equity presence in the downstream industries and upstream

[5] Since some of these FDI variables are highly correlated with each other, the regression results in which FDI measures enter the models simultaneously are biased. We have also performed regressions with all FDI variables included simultaneously, but the estimates are quite different from those in which FDI measures enter the model separately. Thus, we apply the more reliable way – FDI variables entering the model separately.

[6] Aitken and Harrison (1999) put forward two kinds of weights to calculate this variable: employment (each firm's share in sectoral employment) and physical capital (each firm's share in sectoral output). Since foreign firms are typically more capital intensive than domestic firms, the share of foreign investment may be underestimated if weighted by employment (Javorcik, 2004). Therefore, we choose weighted physical capital to measure foreign equity participation at the sector level.

[7] There are 33 provincial-level divisions in China. As province-level region is very large, we use prefecture-level city instead, which is a level between provinces and counties. There are totally 349 cities in the dataset according to 4-digit area codes.

industries of sub food sector *j* at time *t*, respectively.[8] They are calculated as:

$$Backward_{jt} = \sum_{m\ if\ m\neq j}\left[\alpha_{jm}\frac{\sum_{i\ for\ all\ i\in m} Foreign\ Share_{imct}\times Y_{imct}}{\sum_{i\ for\ all\ i\in m} Y_{imct}}\right] \quad (4)$$

$$Forward_{jt} = \sum_{n\ if\ n\neq j}\left[\beta_{jn}\frac{\sum_{i\ for\ all\ i\in n} Foreign\ Share_{inct}\times (Y_{inct}-EX_{inct})}{\sum_{i\ for\ all\ i\in n}(Y_{inct}-EX_{inct})}\right] \quad (5)$$

where α_{jm} represents the proportion of sector *j*'s production supplied to downstream sector *m* and β_{jn} represents the proportion of sector *j*'s production bought from upstream sector *n*. The above two coefficients are from the input-output table made by Chinese government. For the reason that only the domestic intermediates sold in the domestic market can represent the true contacts between food sector and its suppliers, exports (EX_{inct}) are excluded when calculating *Forward* variable.

In order to distinguish investment with HMT origins from that with other sources, we use *Foreignshare_fs* for the share of firms' total equity owned by non-HMT investors, and *Foreignshare_hmt* for the share of firms' total equity owned by HMT investors. All the other independent variables described above are calculated based on those two kinds of foreign investment, respectively.[9]

X_{ijct} represents a vector including control variables that may influence firm productivity. The control variables are: (i) firm size (natural logarithm of labor, LnL_{ijct}) to control for scale economy; (ii) capital intensity of firm *i* (natural logarithm of fixed assets per employee, $Ln(K/L)_{ijct}$) in the consideration that factor endowment may influence productivity; (iii) city dummy variables to control for unobservable regional effects; (iv) year dummy variables to control for macroeconomic fluctuations in different years that impact productivity.

3.2. Data

The dataset employed in this study is from Annual Industrial Survey collected by China National Bureau of Statistics. It covers firm-level data of "firms above designate size".[10] The data

[8] Since the Chinese input-out table only represents the relationship among industries at a 2-digit level of CSIC, here industries *j*, *m*, *n* are classified at 2-digit CSIC level. Therefore, different from other variables, industries *j* used to calculate vertical effect variables refers to three sub food industries: agro-food processing industry, food manufacturing industry and beverages and alcohol industry.

[9] These variables are: *Intra-industry_fs, Intra-industry_hmt, Regional_fs, Regional_hmt, Backward_fs, Backward_hmt, Forward_fs, Forward_hmt.*

[10] "Firms above designate size" refer to non-state owned manufacturing enterprises with annual revenue from principle business over 5 million Chinese Yuan and all state-owned manufacturing enterprises.

has been widely used in previous empirical studies for its reliability (Brandt et al., 2012; Du et al., 2012; Jeon et al., 2013; Liu, 2008; Song et al., 2011). The dataset contains information of every firm for more than 100 variables, including firm demographic information (e.g. name, corporate ID, location, 4-digit industry classification code, employees) and financial information (e.g. total assets, ownership structure, fixed assets, intermediate input costs, output, sales). The key information we need to obtain measurement of firm-level foreign share and spillover variables includes paid-in capital, foreign equity, HMT equity, revenue from principle business, and export sales. Information on output, fixed assets, employees, and intermediate inputs is used to calculate TFP.

In this study, we use an unbalanced panel dataset, from year 1998 to 2007. The observations included in the dataset per year vary from a low of 162,034 in 1999 to 336,768 in 2007. There are two main steps to take before we get the final sample. First, since the firm name or corporate ID may change due to restructuring, mergers and acquisitions, or statistical errors, we cannot identify firms using a single indicator. To solve this problem, we apply the sequential identification method of Brandt et al. (2012).[11] Second, in order to exclude the unreliable data due to misstatement of firms or mistakes in collecting data, we apply methods based on previous studies (Cai and Liu, 2009; Jefferson et al., 2008; Levinsohn and Petrin, 2003).[12] For the analysis here, we only focus on the food sector; the final sample is shown in Table A.1.

In calculating TFP estimators, we proxy firms' gross output value for output, fixed assets (measured at the original purchase price) for capital, number of employees for labor, and intermediate inputs for raw material inputs. The original data are deflated following Yu (2011)and Amiti and Konings (2007): output is deflated by national food industry producer price indices for industrial products; intermediate input is deflated by agricultural products' purchasing price indices for industrial producer; capital is deflated by national price indices of investment in fixed assets. All these indices are taken from *China Statistical Yearbook (2012)* and *Chinese City (Town) Yearbook*

[11] We first link firms using corporate ID, then using firm name, and last using information of legal representative, postal code, address, and telephone number. This method is carried out with software Stata 10.0 and relevant code can be gained from http://www.econ.kuleuven.be/public/N07057/CHINA/appendix/

[12] We drop the following observations: (i) any of key financial indicators (paid-in capital, foreign equity, total assets, total fixed assets, original value of fixed assets, sales, intermediate input costs) are lost or negative; (ii) employees are less than ten; (iii) annual sales is less than 5 million Chinese Yuan; (iv) financial indexes violate International Accounting Standards (IAS) including that total assets is less than total current assets or total fixed assets, and that accumulated depreciation is less than depreciation for the year.

of Life and Price (2012). By calculating the basic matrix input-output table, we can get the matrix of direct input coefficients. Since Chinese input-output table is remade every five years and there is no data about food industries in the table of year 1997 and 2002, we get α_{jk} and β_{jm} based on the input-output table of year 2007, assuming that relationship among industries did not change over the years we study. Table 1 shows the descriptive statistics of all the variables constructed (dummy variables not included).

[Insert Table 1 here]

4. Results and Discussion

Table 2 – 6 show the regression estimates of FDI measures at various levels. Considering the heterogeneity across different industries, we split the whole sample by sub sectors (according to 2-digit CSIC code) and regress separately. The overall p-values of the equations are all less than 0.0001, and the R^2 are stably between 0.13 and 0.19, indicating a good overall estimation of models. With regard to the control variables, the coefficient of firm size variable (*LnL*) is negative and significant, which may be caused by large but inefficient state-owned and collective enterprises (Chuang and Hsu, 2004). The logarithm of capital-labor ratio (*Ln(K/L)*) is also negatively related with TFP in the whole, which is consistent with Yu (2011)'s result in investigating Chinese manufacturing industry.

4.1. Impact of FDI at the Firm Level

Table 2 displays the OLS estimators of the influence of foreign equity on the productivity of food firms. Columns (1), (3), and (5) present results of non-HMT foreign ownership's impact and the rest of the columns present results of HMT ownership's impact.

[Insert Table 2 here]

As can be seen from Table 2, higher rates of non-HMT foreign equity participation (*Foreignshare_fs*) can significantly improve firm productivity in the agro-food processing industry and the beverages and alcohol industry. Besides, FDI from HMT regions (*Foreignshare_HMT*) also has significant positive impact on the agro-food processing firms' productivity. This result is consistent with theoretical analysis: foreign investment may bring advanced technologies and management experience, which will help firms produce higher-quality products or decrease

production costs. From Table 2, we can find that non-HMT investment seem to pose stronger positive influence on productivity than HMT investment, which may be due to higher technical levels and organizational skills of non-HMT investment (Buckley et al., 2002).

4.2. Intra-industry Effect

Table 3 presents the results of the impact on firm productivity of the share of FDI in the same industry. Specifically, in order to study whether domestic firm productivity is affected by the foreign investment in the whole industry, we also take domestic firms (firms with no foreign equity participation) as the sub sample in addition to the entire sample of all firms.[13] Columns (1), (3), (5), (7), (9), and (11) present results for all enterprises and the rest of the columns present results for domestic firms.

[Insert Table 3 here]

As can be seen from Table 3, no significantly positive intra-industry spillovers are observed. The results indicate that in Chinese food industry, domestic firms cannot get productivity spillover benefit from FDI in the entire industry. On the contrary, the coefficients of *Intra-industry* variables turn out to be significantly negative in columns (5), (6) and (12), which means that foreign invested firms may generate adverse influences on domestic firm productivity by crowding out their market share in the food manufacturing industry and the beverage and alcohol industry. This result is quite different from the findings of Lv and Huang (2006a), who observe significantly positive spillovers in the Chinese agricultural products processing industry by applying industry-level panel data. Such differences probably arise from the endogeneity bias (Jefferson and Ouyang, 2014) and the problems existing in Chinese aggregate macro data (Yu et al., 2013).

4.3. Regional Intra-industry Effect

Although positive intra-industry spillovers in the food sector over the whole country are not observed, it does not mean that domestic firms are totally unaffected by MNEs in the same industry.

[13] According to Chinese laws, "foreign-owned" companies are defined as firms with over 25% of foreign equity participation. Therefore, we also performed robust test to see whether the results based on firm samples with less than 25% foreign share are different from those based on firm samples with no foreign equity at all. As the significant levels are the same between these two thresholds, we do not present the regression results of robust check owing to space constraints.

On the one hand, mobility of skilled workers, demonstrations of new technologies take place more often in adjacent areas; on the other hand, competition may also become fiercer in the same region.

Table 4 shows regression estimates of the regional intra-industry effects on firm productivity. We can see that localized intra-industry spillovers vary across different industries. For the agro-food processing industry, the coefficient of *Regional_fs* is significantly positive in column (1) while insignificant in column (2). It indicates that although all firms (including domestic firms and joint ventures) benefit from non-HMT capital inflow into the region, domestic firm productivity does not rise. The reason might be that connection among joint ventures is closer than that between joint ventures and domestic firms within industry and city. Aitken and Harrison (1999)'s study on Venezuela also finds that joint ventures are more capable of absorbing positive intra-industry spillovers than domestic ones.

[Insert Table 4 here]

In contrast, coefficients are negative and significant in columns (6) and (10). The results mean that in the food manufacturing industry and the beverages and alcohol industry, non-HMT investment in the region has negative effects on domestic firms. The reason why the localized effects of non-HMT investment in the agro-food processing industry differs from that in the other sub food sectors may lie in higher export ratio in non-HMT joint ventures of the agro-food processing industry. As shown in Figure 2, non-HMT foreign invested firms have a higher tendency to export in the agro-food processing industry than the other sub food industries (weighted mean export proportion of the agro-food processing industry is about 28%, much higher than 20% of the food manufacturing industry and 10% of the beverages and alcohol industry). This suggests that the motivation for the foreign investors' entrance into the Chinese agro-food processing industry lies more in getting access to raw materials and low cost labor, and selling products back to home countries or a third country. However, MNEs in the food manufacturing industry and the beverages and alcohol industry aim more at entering the domestic food market, as a result of which poses greater pressure on domestic firms in the same sector (Jin and Liu, 2010). Thus, MNEs with a higher level of technology and management skills crowd out domestic final consumption products market, decreasing productivity of domestic firms.

[Insert Figure 2 here]

With respect to the regional impact of HMT investment, the coefficients of *City_hmt* are significantly negative in columns (3) and (4), but insignificant in the other four columns, indicating that HMT investment in the region has an adverse impact on the agro-food processing industries while not much influence on the other industries.

Different from previous findings of positive localized spillovers found in the Polish food industry (Jensen, 2004) and in the manufacturing sector of China (Wei and Liu, 2006; Xu and Sheng, 2012), we do not observe similar regional intra-industry effects in the Chinese food sector. According to Madariaga and Poncet (2007), with the exception of local FDI, Chinese cities can also take advantage of FDI in surrounding areas. Hence, localized spillovers might be stronger if replacing FDI within the city by FDI inflows into nearby firms calculated by spatial distances.

4.4. Vertical effects

Table 5 and Table 6 show the results of the impact of foreign equity in downstream sectors and in upstream sectors on the food sector. As can be seen from Table 5, the coefficients of *Backward_fs* are all significant and positive, suggesting that non-HMT FDI in downstream sectors does help promote productivity growth in the food sector, by providing technical support or higher requirement of material quality. This finding is similar to previous studies performed in the Polish dairy sector (Dries and Swinnen, 2004) and in the sugar beet-processing industry of Central Europe transition economies (Walkenhorst, 2000).

The results of forward effect caused by non-HMT investment are similar with that of backward effect; the coefficients of *Forward_fs* are all significant and positive in Table 6. Obviously, non-HMT investment in upstream sectors plays a positive role in facilitating food firm productivity in all three sub food sectors. This may be attributed to cheaper and higher quality intermediate products provided by foreign firms in the upstream sectors. The results are consistent with findings for Chinese manufacturing firms (Du et al., 2012; Liu, 2008).

[Insert Table 5 and Table 6 here]

However, the coefficients of *Backward_hmt* and *Forward_hmt* are significantly negative, implying that the appearance of HMT investment in the downstream and upstream sectors decreases productivity of the food sector. The results of the vertical effects of HMT investment are quite

different from those of non-HMT foreign investment. There may be several explanations for this. One possible reason lies in the stronger market power possessed by firms with HMT share in the downstream and upstream of the food sector. If so, powerful HMT invested firms in downstream sectors have more bargaining power with domestic food firms and thus reduce suppliers' productivity by lowering the price of intermediate products; powerful HMT invested firms in upstream sectors may reduce the productivity of food firms by increasing the price of needed intermediate inputs of food firms.

Another reason that leads to negative backward effect of HMT FDI may be the low communication costs between HMT regions and Mainland China. As Rodriguez-Clare (1996) pointed out, communication costs between headquarters and producing plants can influence the direction of vertical spillovers. Since HMT regions are adjacent to Mainland China, the culture, language, and society is similar as in Mainland China. Therefore, the communication costs are much lower between producing plants and HMT investors than those between producing plants and overseas investors. Firms with HMT shares are more likely to import raw materials from overseas suppliers closely connected with headquarters rather than use local materials, and thus crowd out domestic material suppliers' (food firms) market share. In this way, HMT equity participation in the downstream sectors restrains the improvement of productivity of domestic food firms.

5. Conclusion and Policy Implications

With FDI flowing into developing economies, domestic firms in host countries potentially benefit from technology spillovers, but also potentially suffer from powerful foreign competitors, suppliers, or buyers. Although the food sector is more vulnerable to competitive MNEs than other industries with high technology, few have studied the impact of FDI on the food sector in China. In this paper, we construct a comprehensive analytical framework to systematically investigate direct and indirect effects of FDI using firm-level data from China from 1998 to 2007. First, we apply the approach of Olley and Pakes (1996) to calculate firm TFP; then we test the impact of FDI at firm level, within industry, within region, and also in upstream and downstream sectors after controlling for year and region effects.

We show that FDI at various levels or originating from different sources affect Chinese food sector differently. First, joint firms' own foreign equity has a generally slight facilitating effect on

food firm productivity in the agro-food processing industry and the beverages and alcohol industry. The own-plant effect generated by non-HMT FDI is a little stronger than that by HMT FDI on the whole, indicating that the former FDI is equipped with higher level of technologies and management skills.

Second, FDI generates negative impact on domestic firm productivity in some sub food sectors, which may be caused by "market-stealing" effect. Third, FDI within the region influences the productivity of domestic firms in the same sector, and the direction of the regional effects varies in different sub food sectors and across investment with different origins. FDI originating outside HMT areas improves agro-food processing firm productivity within region, while it decreases domestic firm productivity in the food manufacturing industry and the beverages and alcohol industry. The reason for this may lie in a higher export ratio in non-HMT joint ventures of agro-food processing industry. Since FDI may generate a different impact on every sub food industry, so specific policies suitable for each sub food industry should be made.

Finally, we observe significant vertical effects of FDI in Chinese food sector. Both positive backward and forward spillovers generated by non-HMT investment take place in all sub food sectors. However, HMT investment in upstream or downstream sectors poses a negative effect on firm productivity. The different effects by FDI originating from different sources might due to differences in communication costs and market power. These findings have important implications for policymakers. For the fact that FDI can influence the food sector through vertical linkages, policymakers ought to take FDI flows to other sectors that have close relations with food sector (e.g., agriculture, forestry, and fishing) into consideration when deliberating on the potential impact of FDI on domestic food sector. Besides, more attention should be made to introduce FDI from overseas countries than that from HMT regions, since the former benefits domestic food firms more. Relative authorities should enhance supervision on HMT investment for it may be actually domestic capital that routed through HMT regions.

Despite these findings, we have to acknowledge that there exists limitation in the dataset. Although the firm-level census data (174,539 sample food firms) used in our analysis occupy a large proportion of gross industrial assets and outputs, non-state owned food firms with annual revenues less than 5 million Yuan are unfortunately not included in the original dataset. Thus the

results cannot reflect the impact of FDI on the productivity of those small and micro food firms. More negative impacts may be found if taking non-state owned small and micro food firms into account due to their relatively lower productivity.

Tables and Figures

Table 1. Descriptive statistics of all variables

Variable	Variable symbol	Observations	Mean	Std. Dev.	Min	Max
Natural logarithm of output	LnY[a]	175254	10.213	1.196	0.065	16.850
Natural logarithm of intermediate inputs	LnM[a]	175254	9.878	1.232	0.076	16.326
Natural logarithm of capital	LnK[a]	175254	8.541	1.633	0.004	16.065
Natural logarithm of labor	LnL[a]	175254	4.620	1.095	2.303	11.527
Natural logarithm of Olley-Pakes TFP	LnTFP[op]	175254	0.809	0.359	-7.727	10.302
Foreign share (except HMT) at firm level	Foreginshare_fs	175254	7.224	23.397	0.000	100.000
HMT share at firm level	Foreginshare_hmt	175254	4.747	19.346	0.000	100.000
Foreign share (except HMT) within industry	Intra-industry_fs[b]	175254	14.406	9.082	1.223	48.043
HMT share within industry	Intra-industry_hmt[b]	175254	7.625	5.223	0.000	35.269
Foreign share (except HMT) within industry and city	Regional_fs[b]	175254	10.200	18.081	0.000	100.000
HMT share within industry and city	Regional_hmt[b]	175254	6.151	13.899	0.000	100.000
Backward linkage caused by foreign participation (except HMT)	Backward_fs[c]	175254	5.365	3.708	0.565	9.285
Backward linkage caused by HMT participation	Backward_hmt[c]	175254	3.961	2.822	0.367	7.101
Forward linkage caused by foreign participation (except HMT)	Forward_fs[c]	154652[d]	1.726	1.340	0.525	3.893
Forward linkage caused by HMT participation	Forward_hmt[c]	154652 [d]	1.062	0.770	0.421	2.553
Capital intensity of firm	Ln(K/L)	175254	3.921	1.239	-5.007	10.072

Notes:

a: Variables that are used to calculate TFP;

b: Variables that are measured at the 3-digit CSIC level;

c: Variables that are measured at the 2-digit CSIC level;

d: Variable Forward in 2004 is not constructed due to the lack of export information in 2004.

Table 2. Impact of foreign ownership at firm level on food firm productivity

	Agro-food processing industry		Food manufacturing industry		Beverages and alcohol industry	
	(1)	(2)	(3)	(4)	(5)	（6）
Foreignshare_fs	0.0002**		0.0001		0.0006***	
	（0.0001）		（0.0001）		（0.0001）	
Foreignshare_hmt		0.0001*		0.00002		-0.0000
		（0.0001）		（0.0001）		（0.0001）
Ln(K/L)	-0.0412***	-0.0414***	-0.0257***	-0.0255***	-0.0219***	-0.0206***
	（0.0013）	（0.0012）	（0.0020）	（0.0020）	（0.0024）	（0.0024）
LnL	-0.0415***	-0.0411***	-0.0296***	-0.0294***	-0.0254	-0.0244
	（0.0012）	（0.0013）	（0.0023）	（0.0023）	（0.0029）	（0.0029）
Observations	107100	107100	40309	40309	27845	27845
P>wald	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.16	0.16	0.13	0.13	0.14	0.14

Notes: The dependent variable is Ln*TFP*. Year and city dummy variables are included in the regressions. Robust standard errors are presented in parentheses. *, **, *** denote significance at the 0.1, 0.05, and 0.01 level, respectively.

Table 3. Impact of foreign ownership within industry on food firm productivity

	Agro-food processing industry				Food manufacturing industry				Beverages and alcohol industry			
	(1) All[a]	(2) Domestic[b]	(3) All[a]	(4) Domestic[b]	(5) All[a]	(6) Domestic[b]	(7) All[a]	(8) Domestic[b]	(9) All[a]	(10) Domestic[b]	(11) All[a]	(12) Domesti
Intra-industry_fs	-0.00002	-0.00004			-0.0006***	-0.0006**			0.0002	0.0002		
	（0.0002）	（0.0002）			（0.0002）	（0.0003）			（0.0003）	（0.0003）		
Intra-industry_hmt			-0.0004	0.0001			-0.0003	0.0001			0.0004	-0.0012*
			（0.0005）	（0.0005）			（0.0003）	（0.0003）			（0.0005）	（0.0005
Ln(K/L)	-0.0414***	-0.0440***	-0.0370***	-0.0439***	-0.0256***	-0.0275***	-0.0255***	-0.0273***	-0.0207***	-0.0248***	-0.0205***	-0.0246**
	（0.0012）	（0.0013）	（0.0012）	（0.0013）	（0.0020）	（0.0022）	（0.0020）	（0.0022）	（0.0024）	（0.0027）	（0.0024）	（0.0027
LnL	-0.0410***	-0.0452***	-0.0409***	-0.0454***	-0.0294***	-0.0335***	-0.0294***	-0.0333**	-0.0243***	-0.0315***	-0.0245***	-0.0318**
	（0.0013）	（0.0014）	（0.0013）	（0.0014）	（0.0023）	（0.0026）	（0.0023）	（0.0026）	（0.0029）	（0.0032）	（0.0029）	（0.0032
Observations	107100	90587	107100	90587	40309	29881	40309	29881	27845	22678	27845	22678
P>wald	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.16	0.17	0.15	0.17	0.13	0.15	0.13	0.15	0.14	0.16	0.14	0.16

Notes: The dependent variable is Ln*TFP*. Year and city dummy variables are included in the regressions. Robust standard errors are presented in parentheses. *, **, *** denote significance at the 0.1, 0.05, and 0.01 level, respectively.

a: regression sample includes all firms (including domestic and foreign invested firms) in the industry;

b: regression sample includes all domestic firms with zero foreign (total, including HMT shares) equity participation in the industry.

Table 4. Impact of foreign ownership within region in the same industry on food firm productivity

	Agro-food processing industry				Food manufacturing industry				Beverages and alcohol industry			
	(1) All[a]	(2) Domestic[b]	(3) All[a]	(4) Domestic[b]	(5) All[a]	(6) Domestic[b]	(7) All[a]	(8) Domestic[b]	(9) All[a]	(10) Domestic[b]	(11) All[a]	(12) Domestic[b]
Regional_fs	0.0004***	-0.0001			-0.0001	-0.0004***			-0.0000	-0.0006***		
	（0.0001）	（0.0001）			（0.0001）	（0.0001）			（0.0002）	（0.0002）		
Regional_hmt			-0.0003**	-0.0005***			-0.0000	0.0000			0.0001	0.0001
			（0.0001）	（0.0002）			（0.0100）	（0.0002）			（0.0002）	（0.0003）
Ln(K/L)	-0.0414***	-0.0440***	-0.0414***	-0.0441***	-0.0254***	-0.0275***	-0.0254***	-0.0273***	-0.0206***	-0.0249***	-0.0206***	-0.0249***
	（0.0012）	（0.0013）	（0.0012）	（0.0013）	（0.0020）	（0.0022）	（0.0020）	（0.0022）	（0.0024）	（0.0027）	（0.0024）	（0.0027）
LnL	-0.0411***	-0.0452***	-0.0409***	-0.0453***	-0.0293***	-0.0336**	-0.0294***	-0.0334***	-0.0244***	-0.0316***	-0.0244***	-0.0313***
	（0.0013）	（0.0014）	（0.0013）	（0.0014）	（0.0023）	（0.0026）	（0.0023）	（0.0026）	（0.0029）	（0.0031）	（0.0029）	（0.0032）
Observations	107100	90587	107100	90587	40309	29881	40309	29881	27845	22678	27845	22678
P>wald	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.16	0.17	0.16	0.17	0.13	0.15	0.13	0.15	0.14	0.16	0.14	0.16

Notes: The dependent variable is Ln*TFP*. Year and city dummy variables are included in the regressions. Robust standard errors are presented in parentheses. *, **, *** denote significance at the 0.1, 0.05, and 0.01 level, respectively.

a: regression sample includes all firms (including domestic and foreign invested firms) in the industry;

b: regression sample includes all domestic firms with zero foreign (total, including HMT shares) equity participation in the industry.

Table 5. Impact of foreign ownership in downstream sectors (backward effects) on food firm productivity

	Agro-food processing industry				Food manufacturing industry				Beverages and alcohol industry			
	(1) All[a]	(2) Domestic[b]	(3) All[a]	(4) Domestic[b]	(5) All[a]	(6) Domestic[b]	(7) All[a]	(8) Domestic[b]	(9) All[a]	(10) Domestic[b]	(11) All[a]	(12) Domestic[b]
Backward _fs	0.1444*** (0.0027)	0.1483*** (0.0029)			0.7469*** (0.0264)	0.7325*** (0.0270)			1.0913*** (0.0437)	1.0752*** (0.0497)		
Backward _hmt			-0.1656*** (0.0031)	-0.1700*** (0.0033)			-7.5762*** (0.2679)	-7.4302*** (0.2734)			-21.5414*** (0.8635)	-21.2231*** (0.9811)
Ln(K/L)	-0.0414*** (0.0012)	-0.0440*** (0.0013)	-0.0414*** (0.0012)	-0.0440*** (0.0013)	-0.0254*** (0.0020)	-0.0273*** (0.0022)	-0.0254*** (0.0020)	-0.0273*** (0.0022)	-0.0206*** (0.0024)	-0.0248*** (0.0027)	-0.0206*** (0.0024)	-0.0249*** (0.0027)
LnL	-0.0410*** (0.0013)	-0.0452*** (0.0014)	-0.0410*** (0.0013)	-0.0452*** (0.0014)	-0.0293*** (0.0023)	-0.0333*** (0.0026)	-0.0294*** (0.0023)	-0.0333*** (0.0026)	-0.0243*** (0.0029)	-0.0314*** (0.0032)	-0.0244*** (0.0029)	-0.0314*** (0.0032)
Observations	107100	90587	107100	90587	40309	29881	40309	29881	27845	22678	27845	22678
P>wald	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.16	0.17	0.16	0.17	0.13	0.15	0.13	0.15	0.14	0.16	0.14	0.16

Notes: The dependent variable is Ln*TFP*. Year and city dummy variables are included in the regressions. Robust standard errors are presented in parentheses. *, **, *** denote significance at the 0.1, 0.05, and 0.01 level, respectively.

a: regression sample includes all firms (including domestic and foreign invested firms) in the industry;

b: regression sample includes all domestic firms with zero foreign (total, including HMT shares) equity participation in the industry.

Table 6. Impact of foreign ownership in upstream sectors (forward effects) on food firm productivity

	Agro-food processing industry				Food manufacturing industry				Beverages and alcohol industry			
	(1) All[a]	(2) Domestic[b]	(3) All[a]	(4) Domestic[b]	(5) All[a]	(6) Domestic[b]	(7) All[a]	(8) Domestic[b]	(9) All[a]	(10) Domestic[b]	(11) All[a]	(12) Domestic[b]
Forward_fs	1.2385***	1.2746***			0.1885***	0.1850***			0.2442***	0.2403***		
	（0.0230）	（0.0248）			（0.0067）	（0.0068）			（0.0097）	（0.0111）		
Forward_hmt			-4.7409***	-4.8789***			-1.2918***	-1.2674***			-0.8000***	-0.7875***
			（0.0882）	（0.0950）			（0.0456）	（0.0465）			（0.0319）	（0.0364）
Ln(K/L)	-0.0415***	-0.0441***	-0.0415***	-0.0441***	-0.0255***	-0.0273***	-0.0255***	-0.0273***	-0.0221***	-0.0265***	-0.0221***	-0.0265***
	（0.0012）	（0.0013）	（0.0012）	（0.0013）	（0.0021）	（0.0022）	（0.0021）	（0.0022）	（0.0024）	（0.0028）	（0.0024）	（0.0027）
LnL	-0.0407***	-0.0449***	-0.0407***	-0.0449***	-0.0279***	-0.0316***	-0.0279***	-0.0316***	-0.0230***	-0.0305***	-0.0230***	-0.0305***
	（0.0014）	（0.0014）	（0.0014）	（0.0015）	（0.0023）	（0.0025）	（0.0023）	（0.0025）	（0.0030）	（0.0032）	（0.0030）	（0.0032）
Observations	94325	79956	94325	79956	35463	25738	35463	25738	24864	20268	24864	20268
P>wald	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
R^2	0.18	0.19	0.18	0.19	0.14	0.17	0.14	0.17	0.16	0.18	0.16	0.18

Notes: The dependent variable is Ln*TFP*. Year and city dummy variables are included in the regressions. Robust standard errors are presented in parentheses. *, **, *** denote significance at the 0.1, 0.05, and 0.01 level, respectively.

a: regression sample include all firms (including domestic and foreign invested firms) in the industry;

b: regression sample include all domestic firms with zero foreign (total, including HMT shares) equity participation in the industry.

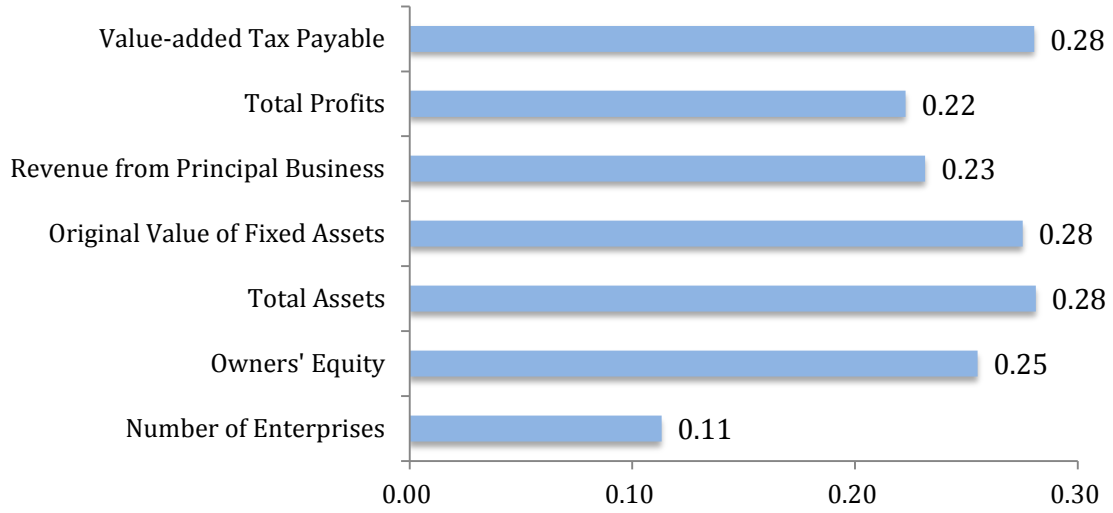

Figure 1. Proportion of foreign invested firms to all firms in the Chinese food industry on several indices, 2012

***Source*:** China Statistical Yearbook, 2013.

***Notes*:** The samples are all industrial enterprises with annual sales over 20 million Chinese Yuan.

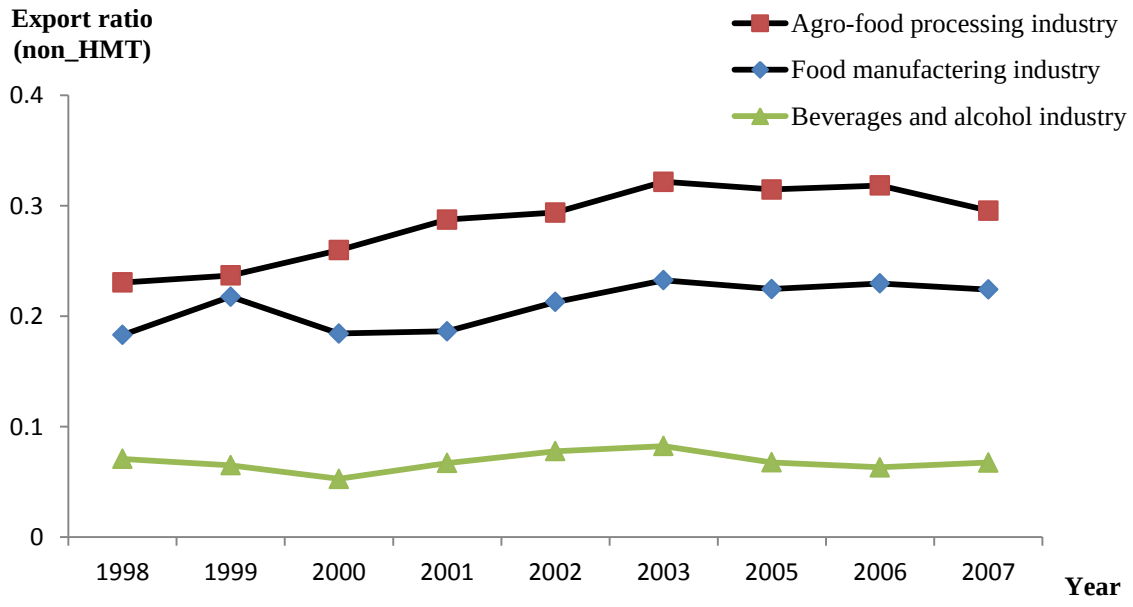

Figure 2. Mean export proportion of food firms with non-HMT foreign equity, 1998-2007

***Source*:** Calculated based on Annual Industrial Survey. Since the dataset lacks export data in 2004, the value of year 2004 is not included.

Appendix

Table A.1. Final sample of food firms

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Total
Original sample size	21440	20125	19120	18571	18602	19277	23832	23837	26505	29356	220665
Final sample size	12232	12694	12522	12991	13906	15788	20602	21776	24738	27290	174539
NO. of non-HMT foreign firms	1387	1421	1414	1500	1724	1937	2502	2585	2858	2720	20048
NO. of HMT firms	1109	1197	1174	1234	1244	1349	1677	1624	1765	1511	13884

Source: Annual Industrial Survey.

Notes: Foreign (except HMT) firms refer to firms with positive foreign participation in paid-in capital; HMT firms refer to firms with positive HMT participation in paid-in capital.

Table A.2. Estimated elasticity of input variables using the Olley-Pakes method

Industry	Agro-food processing industry	Food manufacturing industry	Beverages and alcohol industry
LnK	0.065*** （0.009）	0.046*** （0.005）	0.049*** （0.013）
LnL	0.063*** （0.003）	0.051*** （0.003）	0.069*** （0.004）
LnM	0.862*** （0.006）	0.893*** （0.006）	0.884*** （0.010）
LnTFP Mean (Standard deviations)	0.854 (0.362)	0.740 (0.331)	0.737 (0.363)

Notes: Bootstrap standard errors are presented in parentheses. The dependent variable is *LnY* (*Y* represents firm output); independent variables are *K* referring to fixed assets, *L* referring to workforce and *M* referring to intermediate input. *Y* and *M* are deflated values.

*** indicates significance at the 0.01 level.

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