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FDI TECHNOLOGY SPILLOVERS IN CHINA: IMPLICATIONS FOR DEVELOPING AREAS

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ABSTRACT
Using firm level data from China, this paper examines channels of FDI technology spillovers in different entry modes of MNCs, and draws policy implications for developing countries. Developing countries should encourage multinational corporations (MNCs) to enter their markets in the form of joint ventures rather than wholly foreign owned enterprises. In establishing joint ventures, moreover, they should encourage MNCs to invest in tangible assets, production of domestically-consumed products, promotion of traditional products, and employment and training of unskilled local workers. Furthermore, they should help domestic firms overcome the adverse effect of market stealing and skill stealing generated by wholly foreign owned enterprises.

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INTRODUCTION

Since the end of World War II, internationalization of production has accelerated and has brought more and more countries under the influence of foreign investment enterprises (FIEs) established by MNCs (MNCs). In recent decades, foreign direct investment (FDI) increasingly moved to developing countries. In particular, China has become the largest FDI recipient in the developing world since the mid-1990s. Many developing countries, including China, expect MNCs to bring in advanced technology through the investments they made directly in their countries, and adopt such preferential policies as tax holidays, tax reduction and tax rebate to attract FDI. A pressing task faced by these developing countries is to learn about the process by which technology spills over from FDI to domestic firms, and to adopt appropriate policies to facilitate the technology spillovers.

Unfortunately, the current literature on FDI technology spillovers can shed little light on how developing countries should achieve this task because it "largely avoids the (arguably difficult to answer) question as to how productivity spillovers actually take place, but focuses on the simpler issue of whether the presence of FDI affects productivity in domestic firms" positively or negatively (Görg and Strobl, 2001, p724; also Zhang, Li, Li & Zhou, 2010; Li et al, 2013; Zhang, Li and Li, 2014). This paper is intended to fill this vacuum. Differing from previous studies, the paper tries to unveil the complex process of FDI technology spillovers by identifying the individual channels through which FDI technology spillovers take place in different entry modes, and then draw practical implications for developing countries in making policies on MNC entry modes and investment priorities.

In what follows, we first review the literature on FDI technology spillovers and formulate testable hypotheses in section 2. We then describe the empirical model and data in section 3. In section 4, we present the empirical results. Section 5 discusses policy implications of the findings for developing countries and concludes the paper.

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LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

In theory, FDI may produce either a positive or a negative effect on the productivity of domestic firms in a developing country like China (Görg and Strobl, 2001; also Zhang, Li, Li & Zhou, 2010; Li et al, 2013; Zhang, Li and Li, 2014). The positive effect may come from competition. That is, FIEs forces domestic firms to increase their competitive capacity by reforming management styles and updating production technology. It may also come from linkage. That is, domestic firms benefit from the technical support, the demand and the supply provided by the FIEs with which they have an upstream or downstream relationship in business chains, and learn from observing these "linked" FIEs. It may further come from employment. That is, FIEs train their employees who may later move to domestic firms with acquired skills. The negative effect may occur because of a market stealing effect. That is, FIE competition, if too strong, could draw away demand from domestic firms and lead to a decline in productivity (Aitken and Harrison 1997, 1999). It may take place also due to a skill stealing e3ffect. That is, FIEs could attract the best workers away from domestic firms, leaving them with less skilled employees (Girma, Greenaway and Wakelin, 2001).

Both lines of arguments make sense, and gained empirical support. A positive effect was found in, for instance, Blomstrom (1986), Blomstrom and Persson (1983), Blomstrom and Wolff (1994), Caves (1974), Globerman (1979), and Kokko (1994, 1996). A negative effect was found in Aitken and Harrison (1999), Djankov and Hoekman (2000), and Kathuria (2000). The same mixed results are found in empirical studies on FDI technology spillovers in China. Positive FDI technology spillovers and/or negative FDI technology spillovers in China were found in Li, Liu and Parker (2001), Liu, Parker, Vaidya and Wei (2001), Buckley, Clegg and Wang (2002), Liu (2002), Hu and Jefferson (2002), Tian, Lin and Lo (2004), Tian (2007), Sun (2010), Lin, Lee & Yang (2011), Zhang, Li, Li & Zhou (2010), Wang, Wei, Liu, Wang & Lin (2014), and Zhang, Li and Li (2014). The mixed empirical results did not come as a surprise given the theoretical controversies on the issue.

We believe that the main problem in extant studies on FDI technology spillovers lies in methodology rather than in theory. Most of the studies used a single aggregate variable as a proxy for foreign presence to estimate the overall effect of FDI technology spillovers, ignoring detailed channels of FDI technology spillovers. These studies often used either the share of FIEs in capital, the share of FIEs in output, or the share of FIEs in employment to proxy for the presence of FDI in regression analyses, and interpreted the resulting estimates as if they represent the overall influence of FDI on the productivity of domestic firms. In fact, capital, output (product) and employment are actually three different channels by which FDI may influence the productivity of domestic firms, and the effects of technology spillovers through the three channels may differ dramatically. Besides, most of the studies fail to examine the possible difference between entry modes in technology spillovers. Jacorcik (2004) started to deal with the problem in a paper and found a marked difference in the spillover effect between joint ventures and wholly foreign owned enterprises. Jacorcik did not, however, go a step further to compare technology spillovers through capital, employment and output in different entry modes.

Being aware of the methodological shortcomings, we design a number of variables that represent different channels of FDI technology spillovers, and then examine the spillover effect of each of them for each of the entry modes under comparison. In terms of capital, for instance, tangible assets and intangible assets are considered as representing different sources of technology spillovers. In terms of products, new products are separated from traditional products and exported products are separated from domestically consumed products. In terms of employment, foreign investment enterprises with a higher level of average salary and skilled workers are separated from foreign investment enterprises with a lower level of average salary and skilled workers. All these variables represent, to an extent, investment priorities of MNCs and, as such, individual channels by which FDI may impact on the productivity of domestic firms. Meanwhile, we divide all foreign investment enterprises into three groups of entry mode: equity joint ventures, cooperative joint ventures and wholly foreign owned enterprises.[1] We develop some testable hypotheses about FDI technology spillovers through different channels and different entry modes.

With regards to channels of FDI technology spillovers, the effect of the three basic sources of FDI technology spillovers – capital, output (product) and employment, are dependent on the combined effects of individual components within each of them. In consideration of the complexity of the combined effects of these components, we do not attempt to make any *a priori* hypotheses about the possible directions of the effect of any of the three basic sources of FDI technology spillovers. We propose, however, some testable hypotheses about the possible directions of the effect of these individual components.

The direction of the effect of FDI technology spillovers through capital depends, for instance, on the combined effect of tangible and intangible assets of FIEs on the productivity of domestic firms. As tangible assets of FIEs, such as advanced equipments and production lines, are difficult to be protected from being observed and

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copied by domestic firms, they are likely to generate a strong positive effect of technology spillovers on the productivity of domestic firms. By contrast, intangible assets of FIEs, such as patents, copyrights, secret formula and ingredients, are normally well protected from being 'stolen' by domestic firms, and are thus unlikely to have much, if any, positive effect of technology spillovers on the productivity of domestic firms. On the basis of this observation, we propose hypothesis 1.

Hypothesis 1. Positive FDI technology spillovers are more likely to take place through tangible asset than intangible assets.

The direction of the effect of FDI technology spillovers through labour depends, to a certain extent, on the combined effect of FIEs with a higher level of average salary and FIEs with a lower level of average salary. Generally speaking, a higher level of average salary indicates a higher level of skilled workers or a higher level of human capital. It is likely that FIEs with a higher level of average salary draw away highly skilled employees from domestic firms. In this case, the negative skill stealing effect may be strong enough to offset the positive employment effect or even turn the total FDI spillover effect through labour negative. FIEs with a lower level of average salary are not, by contrast, in fierce competition with domestic firms for skilled workers; consequently, the negative skill stealing effect may not be strong enough to offset the positive employment effect. On the basis of these observations, we propose hypothesis 2.

Hypothesis 2. Positive FDI technology spillovers are more likely to take place through unskilled workers than skilled workers.

The direction of the effect of FDI technology spillovers through products depends, to a certain extent, on the combined effect of FIEs' exported products and domestically consumed products on the one hand, and FIEs' newly developed products and traditional products on the other. As FIEs' products that are sold and consumed within the host country can be easily observed and imitated by domestic firms, their positive spillover effect may be strong enough to offset the adverse market stealing effect. FIEs' products that are exported to international markets are, by contrast, relatively difficult to be observed and imitated by domestic firms, so their positive spillover effect may not be strong enough to offset the adverse market stealing effect. Similarly, the design of new products is normally treated as top secret and, therefore, is not easily observed and imitated by domestic firms, at least in the short run, so the positive spillover effect of newly developed products of FIEs may not be strong enough to offset the adverse market stealing effect. Over time, however, new products become traditional products, and domestic firms manage to observe and imitate them. Traditional products of FIEs may, therefore, have a positive effect of technology spillovers on the productivity of domestic firms. On the basis of these observations, we propose hypotheses 3 and 4.

Hypothesis 3. Positive FDI technology spillovers are more likely to take place through domestically-sold products than exported products.

Hypothesis 4. Positive FDI technology spillovers are more likely to take place through traditional products than new products.

As regards entry modes, there are marked differences in the organizational structure of different entry modes of MNCs, which are likely to lead to differences in the impact of FDI on the productivity of domestic firms. Equity joint ventures involve, for instance, the equity participation of both a MNC and a domestic firm and, therefore, entail close cooperation between the MNC and the domestic firm. The equity participation may be in the form of advanced equipments, and the cooperation may involve training of employees who operate these equipments. Within this organizational framework, it is very difficult for a MNC to prevent its technology from being learnt by its domestic partner and then being spread to other domestic firms. The same applies to cooperative joint ventures, which are similar to equity joint ventures in organizational structure. A cooperative joint venture differs from an equity joint venture mainly in the sense that the MNC and its domestic partner share the benefits and liabilities of the joint venture on the basis of an agreed contract rather than respective equity shares. As both the MNC and the domestic firm have to cooperate very closely in a cooperative joint venture, it is also difficult for the MNC to protect its technology and management know-how from being spread to domestic firms. In joint ventures (both equity joint ventures and cooperative joint venture), therefore, FDI is expected to generate positive technology spillovers, and the positive spillover effect may be strong enough to offset any negative spillover effects.

By contrast, wholly foreign owned enterprises present a completely different picture. As a MNC establishes a wholly foreign owned enterprise all on its own, without the involvement of a domestic partner, it can maintain a large degree of control over its technology and effectively prevent the technology from being "stolen" and spilling over to domestic firms. For this reason, MNCs with proprietary technology tend to prefer wholly foreign owned enterprise to joint ventures in order to protect their core technology competence. Coca-Cola has established, for example, more than a dozen bottling equity joint ventures in China, but has chosen to establish a wholly foreign owned enterprise producing the concentrates of its soft drinks in Shanghai in order to protect the formula of its soft

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drinks (Weisert, 2001). We would expect, therefore, little positive technology spillovers from wholly foreign owned enterprises. Without the positive offsetting the negative, negative FDI technology spillovers may prevail. On the basis of this observation, I propose hypotheses 5 and 6.

Hypothesis 5. Positive FDI technology spillovers, as assumed above, are more likely to take place in joint ventures than wholly foreign owned enterprises.

Hypothesis 6. Negative FDI technology spillovers, if any, are more likely to take place in wholly foreign owned enterprises than joint ventures.

In formulating these hypotheses, we should bear in mind that FDI technology spillovers through these channels may move in different directions depending on particular circumstances, and the direction of FDI technology spillovers is more an empirical than a theoretical question.

EMPIRICAL MODEL AND DATA

In the empirical estimation, we followed Aitken and Harrison (1999) to use basic log-linear production functions at the firm level in the form:

$$Y_{ijt} = C + \beta_1 FDI\_share_{jt} + \beta_3 X_{ijt} + \varepsilon_{ijt} \quad (1)$$

where log output *Y* for firm *i* in sector *j* at time *t* was regressed on a vector of inputs (***X***) and the presence of FDI in an industrial sector (*FDI_share*). On the basis of this benchmark model, we proceeded to compare the effects of FDI technology spillovers in the three entry modes of MNCs by dividing *FDI_share* into three separate components representing the presence of the three entry modes in an industrial sector, respectively. We thus rewrote Equation (1) as

$$Y_{ijt} = C + \beta_1 EJV\_share_{jt} + \beta_2 CJV\_share_{jt} + \beta_3 WFOE\_share_{jt} + \beta_4 X_{ijt} + \varepsilon_{ijt} \quad (2)$$

where log output *Y* for firm *i* in sector *j* at time *t* was regressed on a vector of inputs (***X***), the presence of equity joint ventures in an industrial sector (*EJV_share*), the presence of cooperative joint ventures in an industrial sector (*CJV_share*), and the presence of wholly foreign owned enterprises in an industrial sector (*WFOE_share*).

The ordinary least squares (OLS) approach was employed in the empirical estimation with White's correction for heteroscedasticity. Before running the regression, we needed to consider some econometric issues. The first issue was related to possible omission of unobserved variables, such as firm-specific, industry-specific and time-specific factors that are unknown to the econometrician but known to the firm. These factors may affect the estimated coefficient of FDI technology spillovers. Following Haskel, Preira and Slaughter (2002), we used first differencing as well as industry dummies and year dummies to address the problem. The second issue was related to possible endogeneity of the explanatory variables. The decision on capital and labour inputs was, for instance, likely to be made on the basis of productivity, so was the decision on entry mode. If this were the case, the estimated coefficient of FDI technology spillovers would be biased. Two approaches can be used to deal with the problem. We can employ the econometric techniques developed by Olley and Pakes (1996) that take into account productivity-led variations in inputs of individual firms.[2] Alternatively, we can use the lagged value of all the explanatory variables that are suspected of being endogenous in the regression analysis. As the endogeneity problem was not only with the inputs but also with the entry mode selection, we preferred to use the second approach to deal with the problem. The empirical model to be estimated was thus expressed as Equation (3).

$$\Delta Y_{ijt} = C + \beta_1 \Delta EJV\_share_{jt-1} + \beta_2 \Delta CJV\_share_{jt-1} + \beta_3 \Delta WFOE\_share_{jt-1} + \beta_4 \Delta X_{ijt-1} + \varepsilon_{ijt} \quad (3)$$

The data were obtained from the China National Bureau of Statistics. The Department of Industrial and Transportation Statistics of the China National Bureau of Statistics maintained a large database that contains the most comprehensive information about domestic and foreign enterprises in China's industrial and transportation sector. The China National Bureau of Statistics kindly provided the author with a randomly chosen sample of

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manufacturing enterprises in the period from 1996 to 1999.[3] The sample included 11324 firms in each year, of which 1166 are foreign investment enterprises: 904 equity joint ventures, 103 cooperative joint ventures, and 159 wholly foreign owned enterprises. The data of these foreign investment enterprises were used to produce variables representing the presence of the three entry modes in an industrial sector.[4] As the focus of the study was on the spillover effect of FDI on domestic firms, the 1166 foreign investment enterprises were excluded in the sample for regression analysis. Consequently, the sample included 10158 domestic firms only in each year. A number of observations were deleted because of missing information about the firm's output, capital or employment. The reduced sample included 9055 domestic firms each year, and 35610 domestic firms for the four year period. Information on the value of new products and exports were available only for the years of 1998 and 1999, so the sample size was cut by half in regressions on the two variables. The firms fell into 122 four-digit ISIC industrial sectors.

The data contained detailed information about firm-level output and input. We used the value added for output (Y). The vector of inputs, $\boldsymbol{X}$, included two variables: the log of capital input (K) and the log of labour input (L). We used the capital stock for capital input and the number of employment for labour input, respectively. The value added was deflated on the basis of the 1990 constant price. Furthermore, following Aitken and Harrison (1999), we deflated the capital stock by the GDP deflator. In addition, we included four-digit ISIC industry dummies to control for productivity differences across industries. We also included a variable, F/Dgap, to control for productivity gap between foreign investment enterprises and domestic firms, which was defined as the ratio of the average labour productivity of foreign investment enterprises in the relevant four-digit ISIC industry to the labour productivity of individual domestic firms in that industry. This variable was included because technology gap was found negatively related to the productivity of domestic firms in some empirical studies, and it should be controlled for (Blomstrom and Persson, 1983; Liu, Siler, Wang and Wei, 2000; Girma, Greenaway & Wakelin, 2001; Kokko, Tansini and Mario, 1996).

The focus of analysis was on the variables representing the presence of the three entry modes of MNCs in an industrial sector. Differing from previous studies, we did not use a single variable to proxy for foreign presence in an industry. Instead, we designed as many proxies as possible to obtain rich information about detailed channels of FDI technology spillovers in the three entry modes. As these proxies were highly correlated, we did not to include them in the same equation to avoid the problem of multicollinearity.

First, we used the share of each of the three entry modes in the total capital of an industrial sector to capture the effect of FDI technology spillovers on domestic firms through capital in each of the three entry modes. We also used the share of each of the three entry modes in the tangible assets and the intangible assets of an industrial sector to capture the effect of FDI technology spillovers on domestic firms through tangible and intangible assets in each of the three entry modes, respectively.

Then, we used the share of each of the three entry modes in the employment of an industrial sector to capture the effect of FDI technology spillovers on domestic firms through employment in each of the three entry modes. We used the employment share of equity joint ventures, cooperative joint ventures and wholly foreign owned enterprises with a higher level of average salary in an industrial sector to capture the effect of FDI technology spillovers on domestic firms through the employment of skilled workers in the three entry modes, respectively.[5] We also used the employment share of equity joint ventures, cooperative joint ventures and wholly foreign owned enterprises with a lower level of average salary in an industrial sector to capture the effect of FDI technology spillovers on domestic firms through the employment of less skilled workers in the three entry modes, respectively.

Lastly, we used the share of each of the three entry modes in the total value of sales of an industrial sector to capture the effect of FDI technology spillovers on domestic firms through products in each of the three entry modes. We also used the share of each of the three entry modes in exports, domestic sales, new products and traditional products of an industrial sector to capture the effect of FDI technology spillovers on domestic firms through exported products, domestically consumed products, newly developed products and traditional products in each of the three entry modes, respectively.[6] The summary statistics of these variables are reported in Table 1.

(Insert Table 1 about here)

REGRESSION RESULTS

Spillover effect via capital and labor inputs

We first estimated the effect of FDI technology spillovers on domestic firms through capital and labour inputs in the three entry modes, and reported the results in Table 2. As shown in column 1, the coefficient on the share of equity joint ventures in the capital of an industrial sector and the coefficient on the share of cooperative joint ventures in the capital of an industrial sector were both positive and statistically significant, indicating that domestic firms in

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industrial sectors with more foreign participation in capital in the form of equity joint ventures and cooperative joint ventures were significantly more productive than those in sectors with less foreign participation in capital in the form of equity joint ventures and cooperative joint ventures. By contrast, the coefficient on the share of wholly foreign owned enterprises in the capital of an industrial sector was positive but statistically insignificant, indicating that domestic firms in industrial sectors with more foreign participation in capital in the form of wholly foreign owned enterprises were not significantly more productive than those in sectors with less foreign participation in capital in the form of wholly foreign owned enterprises. The results supported hypothesis 5, and were consistent with what were found in Javorcik (2004).

(Insert Table 2 about here)

As shown in column 2, the coefficient on the share of equity joint ventures in the tangible assets of an industrial sector and the coefficient on the share of cooperative joint ventures in the tangible assets of an industrial sector were both positive and statistically significant, while the coefficient on the share of wholly foreign owned enterprises in the tangible assets of an industrial sector was positive but statistically insignificant. The results suggest that equity joint ventures and cooperative joint ventures both had a significantly positive effect of technology spillovers on domestic firms through tangible assets while wholly foreign owned enterprises had no significant spillover effect on the productivity of domestic firms through tangible assets. The results supported hypothesis 1, and further backed up hypothesis 5.

As shown in column 3, the coefficient on the share of equity joint ventures in the intangible assets of an industrial sector, the coefficient on the share of cooperative joint ventures in the intangible assets of an industrial sector and the coefficient on the share of wholly foreign owned enterprises in the intangible assets of an industrial sector were all positive but statistically insignificant. The result suggested that all the three entry modes of MNCs had no significant positive effect of technology spillovers on domestic firms through intangible assets. Hypothesis 1 thus gained additional support.

As shown in column 4, the coefficient on the share of equity joint ventures in the employment of an industrial sector and the coefficient on the share of cooperative joint ventures in the employment of an industrial sector were both positive but statistically insignificant, indicating that equity joint ventures and cooperative joint ventures both had no significantly positive effect of technology spillovers on domestic firms through employment. By contrast, the coefficient on the share of wholly foreign owned enterprises in the employment of an industrial sector was negative and statistically significant, indicating that wholly foreign owned enterprises had a significantly negative effect on the productivity of domestic firms through employment. The results supported hypothesis 6.

As shown in column 5, the coefficient on the employment share of equity joint ventures with a higher level of average salary in an industrial sector and the coefficient on the employment share of cooperative joint ventures with a higher level of average salary in an industrial sector were both negative but statistically insignificant, while the coefficient on the employment share of wholly foreign owned enterprises with a higher level of average salary in an industrial sector was negative and statistically significant. The results suggested that equity joint ventures, cooperative joint ventures and wholly foreign owned enterprises that hired skilled workers with high salary all had a negative effect of technology spillovers on domestic firms through employment, though the negative effect was statistically significant only for wholly foreign owned enterprises. The results supported hypothesis 2, and further backed up hypothesis 6.

As shown in column 6, the coefficient on the employment share of equity joint ventures with a lower level of average salary in an industrial sector and the coefficient on the employment share of cooperative joint ventures with a lower level of average salary in an industrial sector were both positive and statistically significant, while the coefficient on the employment share of wholly foreign owned enterprises with a lower level of average salary in an industrial sector was positive but statistically insignificant. The results indicated that equity joint ventures and cooperative joint ventures that hired less skilled workers with low salary had a significantly positive effect of technology spillovers on domestic firms through employment while wholly foreign owned enterprises that hired less skilled workers with low salary had no significantly positive effect on the productivity of domestic firms through employment. The results further supported hypothesis 2, and backed up hypothesis 5.

Spillover effect via products

We then compared the effects of FDI technology spillovers on domestic firms through products in the three entry modes, and reported the results in Table 3. As shown in column 1, the coefficient on the share of equity joint ventures in the total value of sales of an industrial sector and the coefficient on the share of cooperative joint ventures in the total value of sales of an industrial sector were both positive but statistically insignificant, while the coefficient on the share of wholly foreign owned enterprises in the total value of sales of an industrial sector was

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negative and statistically significant. The result suggested that equity joint ventures and cooperative joint ventures did not have a significantly positive effect of technology spillovers on domestic firms through product sales, while wholly foreign owned enterprises generated a significantly negative effect on the productivity of domestic firms through product sales. The results further backed up hypothesis 6.

(Insert Table 3 about here)

As shown in column 2, the coefficient on the share of equity joint ventures in the exports of an industrial sector and the coefficient on the share of cooperative joint ventures in the exports of an industrial sector were both negative but statistically insignificant, while the coefficient on the share of wholly foreign owned enterprises in the exports of an industrial sector was negative and statistically significant. The results indicated that equity joint ventures, cooperative joint ventures and wholly foreign owned enterprises all appeared to have a negative effect of technology spillovers on domestic firms through exported products, but the effect was statistically significant only for wholly foreign owned enterprises. The results support hypothesis 3, and further backed up hypothesis 6.

As shown in column 3, the coefficient on the share of equity joint ventures in the domestically consumed products of an industrial sector and the coefficient on the share of cooperative joint ventures in the domestically consumed products of an industrial sector were both positive and statistically significant, while the coefficient on the share of wholly foreign owned enterprises in the domestically consumed products of an industrial sector was negative and statistically insignificant. The results indicated that equity joint ventures and cooperative joint ventures had a significantly positive effect of technology spillovers on domestic firms through domestically consumed products, while wholly foreign owned enterprises had no significant effect on the productivity of domestic firms through domestically consumed products. The results further supported hypothesis 3, and back up hypothesis 5.

As shown in column 4, the coefficient on the share of equity joint ventures in the new products of an industrial sector and the coefficient on the share of cooperative joint ventures in the new products of an industrial sector were both positive but statistically insignificant, while the coefficient on the share of wholly foreign owned enterprises in the new products of an industrial sector was negative and statistically insignificant. The result supported hypothesis 4, indicating that equity joint ventures, cooperative joint ventures and wholly foreign owned enterprises all had no significant effect of technology spillovers on domestic firms through new products.

As shown in column 5, the coefficient on the share of equity joint ventures in the traditional products of an industrial sector and the coefficient on the share of cooperative joint ventures in the traditional products of an industrial sector were both positive and statistically significant, while the coefficient on the share of wholly foreign owned enterprises in the traditional products of an industrial sector was positive but statistically insignificant. The results suggested that equity joint ventures and cooperative joint ventures had a significantly positive effect of technology spillovers on domestic firms through traditional products, while wholly foreign owned enterprises had no significant effect on the productivity of domestic firms through traditional products. The results support hypothesis 4, and further backed up hypothesis 5.

DISCUSSION AND CONCLUSION

The empirical findings of the study show that FDI technology spillovers are a very complicated process that involves various entry modes and channels, and the effect of FDI technology spillovers differs significantly from one entry mode to another and from one channel to another. The findings confirm what was found by Javorcik (2004) about the difference between joint ventures and wholly foreign owned enterprises in technology spillovers and, most importantly, reveal marked variations in the spillover effect through capital (tangible and intangible), labor (skilled and unskilled) and product (exported product, domestically soled product, new product and traditional product) in different entry modes. These specific spillover channels have never been examined in the context of different entry modes, and the present paper fills an important vacuum in the study on FDI technology spillovers. The differentials in FDI technology spillovers found in the study enrich our understanding of the complicated process of FDI technology spillovers, and shed a great deal of light on how developing countries should deal with technology spillovers from FDI. On the basis of the empirical findings illustrated in the last section, we now proceed to draw some implications for developing countries in making policies on MNCs' entry modes and investment priorities.

The paper finds, first of all, that positive FDI technology spillovers are more likely to take place in joint ventures than in wholly foreign owned enterprises. Whenever possible, therefore, developing countries should encourage MNCs to enter their market in the form of joint ventures rather than wholly foreign owned enterprises. The Chinese government granted, for instance, more preferential tax treatments to joint ventures than wholly foreign owned enterprises, and allowed MNCs to enter some pillar industries only in the form of joint ventures. The paper also finds that positive FDI technology spillovers are more likely to take place through some channels than others in

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the form of joint ventures. In promoting joint ventures, therefore, developing countries may guide FDI into areas in which domestic firms can benefit most from FDI technology spillovers.

In terms of capital, for example, the paper finds that positive technology spillovers take place through tangible assets rather than intangible assets, implying that developing countries should encourage MNCs to invest in tangible assets. In terms of products, the paper finds that positive technology spillovers take place through domestically consumed products and traditional products rather than exported products and newly developed products, implying that developing countries should encourage MNCs to invest in production of home-consumed products and promotion of traditional products. In terms of employment, the paper finds that positive technology spillovers take place through employment of unskilled workers rather than skilled workers, implying that developing countries should encourage MNCs to invest in projects that require employment and training of unskilled local workers.

In addition, the paper finds strong evidence of a market stealing effect and a skill stealing effect generated by wholly foreign owned enterprises, that is, a negative effect of technology spillovers through the products that wholly foreign owned enterprises export abroad and a negative effect of technology spillovers through the skilled workers that wholly foreign owned enterprises employ with attractive salary. The finding suggests that developing countries should encourage domestic firms to increase the competitiveness of their products in international markets and improve the way skilled workers are rewarded in order to avoid or minimize the negative effect of market stealing and skill stealing. Obviously, all these policy implications are relevant to developing countries that are trying to catch up with developed countries in technology.

Despite the path-breaking approach, the interesting empirical findings and the important policy implications, the paper is limited in the scope of analysis and the depth of investigation. In the real business world, for instance, MNCs, particularly those with proprietary technology, are very cautious about possible technology spillovers to competing domestic firms in host countries and are not therefore willing to follow the guidance of the government of host countries. They may prefer wholly foreign owned enterprises to joint ventures, investment in intangible assets to investment in tangible assets, production of exported products to production of home-consumed products, development of new products to promotion of traditional products, and employment of skilled workers to employment of unskilled workers. Therefore, developing countries may have to make compromises with MNCs with proprietary technology in entry modes and investment areas. Further effort should be made to discuss how the compromises should be made.

In addition, there are pressing issues other than technology spillovers that developing countries have to take into consideration in making policies on FDI. To address these issues, they may have to compromise their concern over technology spillovers. They may have to encourage, for instance, MNCs to invest in production of export-oriented products in order to improve balance of payment despite the obvious market stealing effect generated in the exported products. In the real world, developing countries need to balance these pressing concerns with the concern over technology spillovers. Further effort should be made to discuss the conditions under which the policy implications of the study are valid and applicable in the real world.

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TABLES

TABLE 1. SUMMARY STATISTICS

Name of variables	Observation	Mean	Standard deviation	Minimum	Maximum
Log Y	35610	9.46	1.48	2.21	16.53
Log K	35610	11.12	1.18	2.88	17.74
Log L	35610	6.89	1.02	1.96	12.25
EJV share in capital	35610	0.12	0.10	0.00	0.64
CJV share in capital	35610	0.05	0.03	0.00	0.12
WFOE share in capital	35610	0.03	0.05	0.00	0.38
EJV share in tangible assets	35610	0.12	0.10	0.00	0.63
CJV share in tangible assets	35610	0.05	0.03	0.00	0.12
WFOE share in tangible assets	35610	0.03	0.05	0.00	0.39
EJV share in intangible assets	35610	0.15	0.13	0.00	0.87
CJV share in intangible assets	35610	0.06	0.16	0.00	0.18
WFOE share in intangible assets	35610	0.04	0.07	0.00	0.39
EJV share in sales	35610	0.14	0.11	0.00	0.59
CJV share in sales	35610	0.03	0.04	0.00	0.12
WFOE share in sales	35610	0.04	0.07	0.00	0.48
EJV share in exports	18110	0.21	0.24	0.00	0.95
CJV share in exports	18110	0.02	0.04	0.00	0.47
WFOE share in exports	18110	0.10	0.17	0.00	0.85
EJV share in domestic sales	18110	0.13	0.12	0.00	0.56
CJV share in domestic sales	18110	0.03	0.04	0.00	0.10
WFOE share in domestic sales	18110	0.02	0.05	0.00	0.40
EJV share in new products	18110	0.15	0.17	0.00	0.95
CJV share in new products	18110	0.02	0.07	0.00	0.55
WFOE share in new products	18110	0.01	0.03	0.00	0.36
EJV share in traditional products	18110	0.13	0.11	0.00	0.58
CJV share in traditional products	18110	0.03	0.04	0.00	0.12
WFOE share in traditional products	18110	0.05	0.08	0.00	0.64
EJV share in employment	35610	0.07	0.08	0.00	0.54
CJV share in employment	35610	0.01	0.02	0.00	0.42
WFOE share employment	35610	0.06	0.13	0.00	0.46
EJV share in skilled workers	35610	0.08	0.10	0.00	0.32
CJV share in skilled workers	35610	0.01	0.02	0.00	0.07
WFOE share in skilled workers	35610	0.06	0.14	0.00	0.58
EJV share in unskilled workers	35610	0.12	0.19	0.00	0.56
CJV share in unskilled workers	35610	0.06	0.11	0.00	0.41
WFOE share in unskilled workers	35610	0.01	0.01	0.00	0.16
F/D gap	35610	24.67	169.38	0.01	9312.91

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TABLE 2. SPILLOVER EFFECT VIA CAPITAL AND LABOR INPUTS

Variables	**Regressions**					
	Capital inputs			Labor inputs		
	(1) Capital	(2)Tangible assets	(3) Intangible assets	(4) Employment	(5) Skilled workers	(6) Unskilled workers
Constant	-0.64 (-1.33)	-0.66 (-1.35)	-0.67 (-1.35)	-0.72 (-1.41)	-0.73 (-1.46)	-0.69 (-1.41)
K	0.70 (94.66)***	0.71 (94.72)***	0.70 (94.74)***	0.70 (94.05)***	0.70 (94.72)***	0.70 (94.71)***
L	0.29 (33.26)***	0.28 (33.12)***	0.29 (33.21)***	0.29 (33..26)***	0.29 (33.19)***	0.29 (33.18)***
F/D gap	-0.0011 (-12.05)***	-0.0012 (-12.12)***	-0.0011 (-12.09)***	-0.0011 (-12.11)***	-0.0011 (-12.06)***	-0.0011 (-12.11)***
EJV share	0.53 (2.28)**	0.56 (2.36)**	0.15 (1.08)	0.26 (1.51)	-0.17 (-1.53)	0.26 (2.28)**
CJV share	0.56 (2.27)**	0.49 (2.14)**	0.19 (1.26)	0.27 (1.54)	-0.15 (-1.26)	0.42 (2.44)**
WFOE share	0.12 (0.27)	0.10 (0.22)	0.03 (0.08)	-0.41 (-1.74)*	-0.46 (-2.57)**	0.16 (0.97)
Adjusted R^2	0.56	0.55	0.55	0.55	0.53	0.54

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Notes: 1) All specifications include annual time dummies and four-digit ISIC industry dummies. Numbers in parentheses under the coefficient estimates are White heteroscedasticity consistent T ratios; 2) * $p < 0.10$; ** $p < 0.5$; and *** $p < 0.1$.

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TABLE 3. SPILLOVER EFFECT VIA PRODUCTS

Variables	**Regressions**				
	(1) Sales	(2) Exports	(3) Domestic sales	(4) New products	(5) Traditional products
Constant	-0.45 (-1.08)	-0.44 (-1.02)	-0.46 (-1.14)	-0.58 (-1.28)	-0.54 (-1.25)
K	0.70 (94.088)***	0.70 (94.19)***	0.70 (94.25)***	0.70 (94.15)***	0.70 (94.13)***
L	0.29 (33.24)***	0.28 (33.15)***	0.29 (33.23)***	0.28 (33.17)***	0.28 (33.18)***
F/D gap	-0.0013 (-12.15)***	-0.0011 (-12.05)***	-0.0013 (-12.14)***	-0.0011 (-12.07)***	-0.0013 (-12.13)***
EJV_share	0.21 (1.64)	-0.14 (-1.24)	0.35 (1.84)*	0.11 (1.12)	0.32 (1.88)*
CJV_share	0.22 (1.58)	-0.17 (-1..46)	0.43 (1.91)*	0.15 (0.84)	0.46 (1.94)*
WFOE_share	-0.30 (-1.83)*	-0.76 (-3.88)**	-0.18 (-0.72)	-0.07 (-0.21)	0.14 (0.82)
Adjusted R^2	0.56	0.55	0.56	0.55	0.56

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Notes: 1) All specifications include annual time dummies and four-digit ISIC industry dummies. Numbers in parentheses under the coefficient estimates are White heteroscedasticity consistent T ratios; 2) * $p < 0.10$; ** $p < 0.5$; and *** $p < 0.1$.

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Notes

[1] The division of entry modes was made on the basis of the data available. The study used firm level data from China, and the three entry modes accounted for more than 98% of total FDI in China in the last decade.

[2] Please also refer to Levinsohn and Petrin (2003) and Javorcik (2004).

[3] In obtaining the dateset, we asked the China National Bureau of Statistics 1) to choose firms randomly, and 2) select firms that appear in all the four years. For confidentiality reason, the China National Bureau of Statistics did not provide identifiers of the firms.

[4] The classification of industrial sectors in China is different from the International Standard Industrial Classification (ISIC). We grouped the 11324 firms in this sample into industrial sectors according to the ISIC, and they fell into 122 four-digit ISIC industrial sectors.

[5] All FIEs were classified into high-waged or low-waged groups according to the average level of annual salary of the employees, with the benchmark being the firm with the medium salary level. High wage was not, as a reviewer pointed out, a perfect proxy for high skill. As the data did not provide any information about the education level of employees, we did not have more appropriate proxies to use in the study. Further effort should be made to overcome the problem when data are available.

[6] The value of domestic sales was calculated as the total value of sales minus the value of exports, while the value of traditional products was calculated as the total value of sales minus the value of new products. According to the China National Bureau of Statistics, new products included 1) those that are produced using new technology and designs; 2) those with significant improvements in structure and materials over the previous products through introducing new technology and designs.

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