Comparison between Spillovers from Different Sources of FDI on the Chinese Manufacturing Sector

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Abstract

The purpose of this study is to assess the impact of foreign direct investment (FDI) on the labor productivity and technical efficiency for a cross-provincial sample of Chinese industrial sectors, with a special focus on different FDI sources. After considering some econometric issues, such as heteroscedasticity, simultaneity, collinearity, model misspecification, and normality, through some related hypotheses testing this study concludes that different sources of FDI might lead to contrasting effects on local firms in Chinese industries. Investments from Taiwan, Hong Kong, and Macao (THM) seem to improve their technical efficiency in production, whereas investments from other foreign countries (OFC) primarily affect industrial production of China's regions in terms of enhancing labor productivity.

Keywords: Chinese industry, foreign direct investment, spillover effect, technical efficiency

JEL Classifications: D24; F13; F15; L60

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I. INTRODUCTION

The emergence of China as the most important destination for foreign direct investment (FDI) has been witnessed in recent years,[1] as China has been the largest FDI recipient of the developing world. This can be manifested by the fact that, according to official Chinese statistics, the amount of actual used FDI was US$ 52.74 billion in 2002.[2] As a matter of fact, FDI in China originates from Taiwan, Hong Kong, and Macao (THM) and other foreign countries (OFC) including all other countries,[3] notably the U.S.A., Japan, and South Korea, and Western Europe. According to Table 1, THM-FDI presented more than 60% of the total actually used FDI in the first half of the 1990s. Investments from Hong Kong shared most of the THM-FDI, and its share was still more than 80% of overall THM-FDI in 2002. In addition, the share of Taiwanese investment to THM-FDI was 17.81% in 2002. While the importance of THM-FDI was decreasing during the 1990s, OFC-FDI has become the primary source of the total actually used FDI since 1998. In 2002, OFC-FDI accounted for as much as 57.72% of the total actually used FDI in China. Despite a gradual decline in FDI in China

[1] Foreign direct investment in China can be in four forms: joint ventures, cooperative developments, cooperative operations, and foreign enterprises. The objectives behind providing foreign enterprises with incentives to invest in China are fivefold: to develop a diversified industrial base; to introduce and transfer new technology; to stimulate economic growth; to upgrade managerial and labor skills; and to increase exports, particularly of manufactured goods.

[2] In 2002, China was the second largest FDI recipient in the world, next to Luxembourg, attracting FDI as much as US$ 126 billion. The third largest FDI recipient was France in 2002.

[3] According to *China Statistical Yearbook*, enterprises with funds from THM refers to all industrial enterprises registered as the joint-venture, cooperative, sole (exclusive) investment industrial enterprises and limited liability corporations with funds from THM. In addition, foreign funded enterprises refers to all industrial enterprises registered as the joint-venture, cooperative, sole (exclusive) investment industrial enterprises and limited liability corporations with foreign funds from OFC.

TABLE 1: Total Actually Used Foreign Direct Investment by Sources

(USD 10,000)

Year	Total Amount	THM Share (%)	Taiwan	Hong Kong	Macao	OFC Share (%)
1990*	348711	61.25	10.41	89.59	0.00	38.75
1991	4366340	58.02	1.84	94.94	3.22	41.98
1992	1100751	79.58	11.99	85.70	2.31	20.42
1993	2751495	76.32	14.95	82.26	2.79	23.68
1994	3376650	69.79	14.39	83.45	2.16	30.21
1995	3752053	63.06	13.36	84.78	1.86	36.94
1996	4172552	59.27	14.05	83.60	2.35	40.73
1997	4525704	53.73	13.53	84.85	1.62	46.27
1998	4546275	48.05	13.34	84.73	1.93	51.95
1999	4031871	47.80	13.49	84.91	1.60	52.20
2000	4071481	44.56	12.66	85.43	1.91	55.44
2001	4687759	42.70	14.89	83.51	1.60	57.30
2002	5274286	42.28	17.81	80.09	2.10	57.72

Sources: *China Statistical Yearbook* (1991-2003).
Note: The share of Hong Kong included FDI from Macao in 1990.

from THM, these overseas economies have remained the major source of investment in recent years.

Well documented by Dees (1998) is the fact that the resulting growth in FDI is undeniably a primary component of China's current success. The influence of FDI on industrial productivity in China has therefore become a lengthy issue of discussion and a topic of a great deal of industrial economic research. The "so-called" spillover effects of FDI might exist, because FDI may bring new products and technologies to the host country, while indigenous firms may also stand to benefit from FDI through personnel turnover, demonstration effects, and knowledge spillovers. In the long run, the increased competition induced by the presence of FDI in domestic industries may force inefficient locally-owned

firms to exit and surviving firms to improve their performance in production.

Since many economists subscribe to the notion that FDI facilitates technology spillover, as discussed by Thompson (2003), technology can perhaps be better defined as the knowledge whereby economic efficiency can be improved. If this suggestion is acceptable, then technology includes not only the "hard" aspects of production, such as the specifications of goods and the mechanistic details of their manufacturing, but also the "soft" aspect of business process, such as organization, marketing, and other types of managerial knowledge and skills. The transfer of the former technology to local firms from FDI might increase the productivity of local firms, whereas the transfer of the latter technology might improve the efficiency of local firms.

As a matter of fact, it is suggested that the impact of foreign technology on local development is dependent upon the level of domestic technological competence, and the ability of recipient firms to absorb information from foreign affiliates might be very important in the magnitude of the spillovers. The "soft" aspect of technology transfer might need more interaction between FDI firms and indigenous firms than the "hard" aspect, and thus the local firms' competence of communicating with FDI firms should play an important role in the magnitude of the spillovers resulting from the "soft" technology transfer. In this regard, Chinese local firms should more easily absorb information from THM-FDI than from OFC-FDI due to the former having advantages of language and culture. However, as

stressed by Luo (1999), OFC-FDI is superior to THM-FDI in product and process innovation and in technological development and has transferred more technologies to local firms. Based upon the above discussion, it is reasonable to propose the contrasting effects of THM-FDI and OFC-FDI on China's domestically-owned firms.

As China is the largest FDI recipient in the developing world, the issue of influence of FDI on China has attracted many economists' research attention. This study most closely relates to Huang (2004) and uses an extended period of data and technical efficiency instead of total factor productivity (TFP) measuring the spillovers. The purpose of this study is to investigate the contrasting impact of different sources of FDI on the productivity and technical efficiency in production of Chinese domestic firms. Furthermore, a comparison between spillovers from these two sources of FDI is also explored in this study. Therefore, the conclusions made in this study could be a supplement to the existing literature in this regard.

The rest of the paper is organized into five further sections. Section 2 reviews related literature regarding spillovers from FDI in a host country, particularly China. In Section 3 a description of and a preliminary comparison between FDI from different home countries are provided. Section 4 introduces the empirical models and data used in this study. In Section 5 the existence and magnitude of impact of FDI on the productivity and efficiency of domestic firms are examined. Moreover, the primary issue regarding whether THM-FDI has

a different impact on domestic Chinese firms than OFC-FDI is also analyzed. Finally, Section 6 presents and discusses the conclusions drawn from this study.

II. LITERATURE REVIEW

The influence of FDI on a host economy can theoretically be categorized into two parts -- the direct effect and the indirect effect. The direct effect of FDI has been discussed in classical international economics and endogenous growth theory. According to the former, factor and output movement leads to factor price equalization, a process that enhances the efficiency of resource allocation for the countries involved. MacDougall (1960) demonstrated that capital movement across nations and industries narrows the gap in the marginal productivity of capital and thus improves the total output of capital. In addition, based upon the endogenous growth model constructed by Grossman and Helpman (1990), an economy or a particular industry may benefit from any designated FDI that jump-starts a sustainable learning-by-doing process.

In addition to the direct effect of FDI, the indirect effects from the so-called spillovers have important implications on a host country. With regard to spillovers, Globerman (1979) reported that FDI contributes a number of potential indirect (or “spillover”) economic benefits to a host country. FDI, for example, results in a greater efficiency throughout the economy by increasing competition in the industries of a host country. Foreign firms also train and transfer their skills to workers and managers who may later be employed by local firms.

Other spillover economic benefits of FDI include a faster adoption of new technology by local firms, improved management practices throughout the host country's economy, and an increased mobility of resources, particularly financial capital, in the host country. Furthermore, Haddad and Harrison (1993) added that other benefits from FDI are increased capital flow, higher employment, and new technology brought in by foreign firms. Technology transfer, in fact, occurs in many different ways: new technology is sold directly through licensing agreements; it is included in imported inputs and capital goods; and it is transferred to exporters who learn about new technology from their foreign buyers.[4]

Although a number of empirical studies have attempted to directly measure the spillover effects of FDI, the conclusions they reach with respect to the significance of spillovers are inconsistent. On the one hand, several studies of aggregate manufacturing, such as those of Cave (1974), Globerman (1979), Blomström and Persson (1983), Kokko (1994), and Chuang and Lin (1999), have found that a foreign presence has a positive impact on the productivity of local firms and therefore have concluded that spillovers are generally significant and important. Some studies, such as those of Haddad and Harrison (1993), Kokko et al. (1996), and Tsou and Liu (1997), on the other hand, have deduced that spillovers are insignificant and unimportant and that, in some industries, they may not even exist.

As mentioned earlier, Chinese policy towards FDI since 1979 has been predicated upon

[4] Mansfield and Romeo (1980) suggested that the technology transferred via multinationals is more up-to-date than that sold through licensing agreements.

appropriating western technology, either directly or indirectly, and the issue regarding the existence of the indirect route has become a primary topic in recent industrial economic research. Zhao (1995) suggested that increased imports of technology have expedited the development of indigenous technology both in the dimension of technology generation (R&D and innovation) and technology utilization (output of and exports of the capital good industries). Zhu and Lu (1998) found that the spillovers from FDI have a greater impact and are more effective in promoting labor productivity than in boosting TFP. To cite another example, Chuang and Hsu (2001) used plant-level data from the National Census of the People's Republic of China in 1995 to examine spillovers in China, and their main finding provided evidence of the positive impact of FDI on Chinese industries.[5]

Zhu and Tan (2000) adopted pooled city-level data set, consisting of 2032 observations from 11 consecutive years to confirm the existence of feedback effects between per capita FDI intensity and labor productivity. Li et al. (2001) confirmed the existence of positive spillovers and further indicated that spillovers occur that varies with different types of ownership of local firms and FDI. Liu (2002) found that FDI has large and significant spillover effects in raising both the level and growth rate of productivity of manufacturing industries.[6] Liu and Wang (2003) proved a positive effect of FDI on TFP as evidence which indicates that the FDI inflow is not merely a source of capital, but also a conduit for

[5] Moreover, they found that while positive spillovers exist in both high and low technology gap sectors, spillovers are greater in low technology gap sectors than in high technology gap sectors.

[6] Liu (2002) adopted data on 29 manufacturing industries over the period from 1993 to 1998 in the Shenzhen Special Economic Zone of China.

technology transfer. To sum up, all these observations equally support the existence of spillovers from FDI on China's economy.

Regarding the issue of the differential productivity impact of THM-FDI and OFC-FDI on Chinese domestic firms, there are three studies that have tried to provide answers to this issue. The first evidence provided by Hu and Jefferson (2002) uses 1995 to 1999 firm-level data on China's electronics and textile industries drawn from the Survey of Large and Medium Size Enterprises that the National Bureau of Statistics (NBS) of China conducts each year. After pooling over domestic and FDI-receiving firms and estimating an FDI-augmented production function, they concluded that OECD-FDI has a significant negative effect on firm productivity, whereas in neither electronics nor textile industries does THM-FDI have any impact on firm productivity. Spillovers are generally measured as the impact of the presence of FDI on productivity in a domestic firm, however, the sample adopted by Hu and Jefferson (2002) does not narrow itself to domestic firms.[7]

Buckley et al. (2002) employed industry level data from the Third Industrial Census in 1995 published by the NBS of China in 1997 to explore the possibility that different types of ownership advantage of multi-national enterprises (MNEs) from THM and from OFC might lead to contrasting effects on local firms of China. They demonstrated that THM-FDI does not have a statistically positive impact on the productivity of Chinese firms, while OFC-FDI

[7] As discussed in Buckley (2002), the improvements in TFP might be largely a result of the growth within the industry of the foreign sector itself.

does. Moreover, they also found that THM-FDI impedes the productivity of state-owned enterprises (SOEs) in China due to crowding-out SOEs, particularly in industries where their products compete directly.

The other study dealing with the same issue is conducted by Huang (2004). He adopted cross-provincial data on Chinese industries for 1993, 1994, and 1997 and regressed two empirical models with labor productivity and TFP as the dependent variable, respectively. The primary conclusions of Huang (2004) are that the impact of investment differs depending upon its source, with that from those overseas Chinese enterprises contributing to the spillover effect in regions with a high technology gap, whereas that from other foreign enterprises tending to improve productivity and TFP primarily in regions with a low technology gap. However, the TFP measured by Huang (2004) is the exponential value of the residuals of production function which in fact do not account for the possible influence of measurement errors and other noise upon the production function as discussed similarly by Coelli et al. (1998).

For the purpose of providing more solid evidence as to whether THM-FDI and OFC-FDI have contrasting effects on Chinese manufacturing, this study sheds light on the issue using more extended periods of data and technical efficiency instead of TFP as the dependent variable in the empirical model. Moreover, all regional statistics in this study will be confined to domestic firms which are more suitable for discussing the issue regarding the

spillovers from FDI on domestic firms.

III. AN OVERVIEW OF DIFFERENT SOURCES OF FDI IN CHINA

Without a doubt, THM-FDI and OFC-FDI in Chinese industries have distinct characteristics. According to the official data provided by the *China Statistical Yearbook*, THM have played a more important role in terms of FDI in China than have OFC. The FDI originating from Hong Kong, traditionally the major investor in China, accounts for 59% of the realized FDI during the 1991-1995 period compared to 44% during the1996-1998 period and 37% during 1999-2002.[8] Taiwan began to invest heavily in China from the early 1990s onwards, becoming the second most important source of foreign capital in China during 1991-1995, with a 10% share of all realized FDI inflow. However, this share has decreased to 6.67% during the period of 1999-2002.

With regard to realized FDI from other foreign countries, the United States was the third largest investor in the same sub-periods (1991-1995 and 1996-1998), with a realized share of FDI inflow of 7.4% and 7.8%, respectively, and became the second largest investor during 1999-2002, with a share of 10.2%. Japan became the fourth most important investor in China, with a 6.9% share of actual FDI inflow during 1991-1995. Japan was elevated to the second most important investor with a share of 8.11% during 1996-1998. However, during 1999-2002, Japan was the third largest investor with a share of 8%. Western Europe, the

[8] Dees (1998) pointed out that FDI from Hong Kong becomes overvalued, because of a substantial share of its domestic capital "round-tripping" its way through Hong Kong and back to China, thus benefiting from tax privileges made available to foreign investors in Hong Kong.

world's main source of international direct investment, does not as yet play a major investment role in China, with a relatively small share of realized FDI inflow into China.[9]

With regard to the geographical and industrial distribution of FDI, according to the official data provided by the *China Industrial Economic Statistical Yearbook*, the shares of value-added output of THM-FDI and OFC-FDI by region in 1993, 2001, and 2002 are presented in Table 2.[10] It is illustrated that Guangdong Province was the most favorable province for both THM-FDI and OFC-FDI. It enjoyed the largest share of both THM-FDI's and OFC-FDI's value-added output not only in 1993, but also in 2001 and 2002. It is also found that THM-FDI seemed to be much more concentrated in Guangdong than that from OFC-FDI. In addition, THM enterprises also preferred Fujian, Jiangsu, Shanghai, and Zhejiang than other regions. OFC enterprises seem to have more favorable locations than their THM counterparts, such as Guangdong, Fujian, Jiangsu, Shanghai, Zhejiang, Tianjin, Shandong, and Beijing.[11]

The description concerning the industrial distribution is provided by Lee and Cheong (1999). They presumed that 54.3% of total investment by ethnic Chinese was in textile and

[9] Among all Western European countries, the largest investor in China is the United Kingdom, whose share of FDI stock was, however, just 1.65% during 1991~1995, and 3.05% during 1996~1998. However, its share decreased to 2.3% during 1999-2002, and the largest European investor changed to Germany with a share of 2.5%.

[10] Due to lack of regional distribution of these two FDI sources, this study employs the shares of value-added output instead of the share of investment to discuss this. The conclusion found in this study is quite similar to the finding in Lee and Cheong (1999) who employed the share of investment amount based upon their survey sample data.

[11] As pointed out by Zhang (2000), nearly 80% of US-FDI in China is located in either metropolitan cities, such as Beijing, Shanghai, and Tianjin, or in the coastal area. Lee and Cheong (1999) also indicated that 44.32% of South Korea-FDI was located in Shandong during 1979-1996.

TABLE 2: Share of Value-Added and Real Average Sales Revenues of Firms by Sources

(Unit: %, million RMB)

Regions	Industrial Value-Added Output (%)						Real Average Sales Revenues of Firms					
	THM			OFC			THM			OFC		
	1993	2001	2002	1993	2001	2002	1993	2001	2002	1993	2001	2002
Beijing	4.39	2.58	2.08	8.50	5.41	4.25	6.92	115.86	100.72	16.39	158.10	138.01
Tianjin	1.94	1.39	1.09	4.19	7.10	7.22	10.80	49.14	57.37	23.59	124.94	143.93
Hebei	1.98	2.00	1.83	2.28	1.48	1.86	5.03	48.06	56.88	7.19	38.67	50.53
Shanxi	0.69	0.31	0.35	0.46	0.40	0.59	15.45	43.76	60.97	5.40	58.26	91.18
Inner Mongolia	0.18	0.17	0.46	0.29	0.38	0.37	6.83	43.14	71.36	5.08	64.98	74.07
Liaoning	2.97	2.09	2.31	5.07	4.37	4.02	9.19	49.30	56.34	13.86	70.26	72.48
Jilin	0.09	0.71	0.69	1.68	2.51	2.38	2.28	57.86	93.32	17.36	177.43	221.48
Heilongjiang	0.29	0.50	0.55	1.00	0.53	0.75	6.71	42.43	53.23	5.93	37.19	51.89
Shanghai	7.13	8.65	7.65	18.65	18.98	17.61	15.15	68.57	75.97	53.18	137.95	158.04
Jiangsu	8.73	8.62	9.05	12.35	14.22	15.08	12.15	51.53	59.59	18.75	104.74	112.03
Zhejiang	5.21	5.11	5.49	5.58	5.12	5.52	14.52	49.82	56.25	10.93	64.81	69.82
Anhui	0.26	0.95	1.01	0.58	1.22	1.43	4.09	60.89	55.57	10.13	90.45	110.78
Fujian	6.36	10.05	11.67	7.12	4.34	5.33	8.52	50.51	56.32	13.73	74.59	93.86
Jiangxi	0.33	0.29	0.29	0.67	0.51	0.48	3.57	21.22	22.89	8.53	98.89	98.03
Shandong	2.36	3.97	3.71	4.17	7.74	7.96	11.12	43.62	44.86	10.87	59.00	58.95
Henan	0.43	1.86	1.47	1.74	0.70	0.71	5.97	47.61	53.45	18.34	37.13	47.19
Hubei	1.91	1.25	1.39	1.73	2.42	1.93	4.48	45.47	53.25	7.13	130.20	134.41
Hunan	0.24	0.49	0.58	1.03	0.70	0.61	2.93	26.56	33.21	17.38	68.24	72.04
Guangdong	49.63	45.70	45.10	19.45	17.72	17.72	15.19	69.39	76.37	24.40	207.28	244.53
Guangxi	0.47	0.46	0.47	0.75	0.77	1.08	5.54	32.32	36.32	6.04	76.18	143.53
Hainan	0.57	0.17	0.13	0.41	0.13	0.17	3.73	23.28	24.55	7.50	47.24	74.49
Sichuan[a]	2.72	1.46	1.39	0.35	1.78	1.64	5.62	63.92	76.44	7.43	95.40	94.02
Guizhou	0.27	0.06	0.04	0.39	0.12	0.03	9.55	12.75	16.05	5.83	33.84	47.47
Yunnan	0.09	0.30	0.31	0.16	0.32	0.29	1.61	31.55	30.25	6.14	47.10	52.39
Tibet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.59	0.48
Shaanxi	0.54	0.51	0.58	1.03	0.79	0.69	13.22	57.58	70.34	16.18	93.49	85.55
Gansu	0.05	0.23	0.19	0.12	0.08	0.07	3.05	59.37	57.78	10.04	41.35	58.92
Qinghai	0.00	0.03	0.04	0.00	0.00	0.00	0.00	37.41	31.83	1.57	14.97	24.33
Ningxia	0.10	0.05	0.02	0.02	0.12	0.15	4.69	27.26	26.89	2.50	56.71	70.32
Xinjiang	0.07	0.05	0.06	0.23	0.06	0.05	6.64	23.02	37.24	14.57	16.72	16.63
Total	100	100	100	100	100	100						

Sources: National Bureau of Statistics (NBS) of China (1994, 1995, 1998, 2002, 2003), *China Industry Economy Statistical Yearbook*, Beijing: China Statistics Press and NBSC (1994, 1995, 1998, 2002, 2003), *China Statistical Yearbook*, Beijing: China Statistics Press.

Note: In this study, all information for Sichuan in 1997 includes that for Chongqing which became the 4th municipality in 1997.

apparel, precision machinery, chemical, rubber and plastics industry, stone, clay, and glass, and iron and steel during 1979-1996.[12] However, OFC-FDI has a different preference in industrial distribution, for example, 65.3% of total investment by South Korea was in the ordinary equipment and machinery industry. Simply put, as far as spatial and sectoral preferences for FDI goes, clear-cut distinctions between THM-FDI and OFC-FDI are evident.

Of particular interest too, based on a sample survey of foreign enterprises in China conducted by Kao et al. (1994), is that compared with THM enterprises, OFC firms have a greater potential for higher profits in China, a conclusion also supported by Kao (1996).[13] Furthermore, Lee and Cheong (1999) found that investment size from ethnic Chinese has a smaller size orientation than overall. Table 2 illustrates the average scale of FDI firms by these two FDI sources. It is shown that the average scale of THM investment is smaller than that of OFC investment as shown in Table 2. In most regions, particularly for those favored by both FDI sources, the real average sales revenue of OFC firms is larger than that of THM firms. The difference between their average scales was even larger in 2001 and 2002 than that in 1993. For example, the average scale of OFC firms was as large as three times that of THM firms in 2002, but only 1.5 times in 1993.

For the propensity of cooperating with local firms, FDI from Taiwan, for instance, is

[12] The sample data used in Lee and Cheong (1999) included 7,174 cases, about 4,000 of which were classified as ethnic Chinese source including those from THM as well as from Singapore, Indonesia, Thailand, and the Philippines.

[13] In this new survey, which began in 1993, annual interviews were carried out in 1,066 foreign enterprises over a five-year period.

more likely to be in the form of wholly-owned firms, unlike that of foreign countries.[14] Joint ventures exhibit higher levels of productivity than their domestic counterparts, thus implying that FDI in joint ventures as opposed to wholly-owned firms is more likely to produce positive spillovers. The cross- regional sample used in this study also supports the above arguments. According to Table 3, the average labor productivity -- defined as the value-added output per employee -- is much higher for each region in OFC than in THM enterprises.[15] This is true for most regions. Furthermore, Huang et al. (2003) also found that, after controlling other explanatory variables, the technical efficiency of OFC-FDI was better than that of THM-FDI in 1994.[16] It is thus concluded that THM-FDI and OFC-FDI took on different forms of investment behavior and performance in 1993, 1994, and 1997. Additionally, in the scope of cooperative operations, THM enterprises have a tendency to prefer to cooperate with collectively-owned and town/village enterprises, whereas OFC enterprises tend to prefer to cooperate with Chinese SOEs.

The FDI firms' willingness to transfer technology to local firms should be an important issue when discussing the spillovers from FDI. Young and Lan (1997) employed a postal survey of 361 responses out of a random sample of 500 FDI firms in Dalian to conclude that Western investors are regarded as combining high capability with a willingness to supply

[14] Haddad and Harrison (1993) recognized that a major benefit often attributed to FDI is the knowledge transferred from foreign to local firms. The transfer of technology from foreign to local firms is more likely to take place if FDI is in the form of joint ventures rather than in the form of wholly-owned firms.

[15] Chuang and Hsu (2001) also provided a similar conclusion based on the industrial aspect.

[16] However, there is no difference in technical efficiency between THM and OFC in 1993 and 1997. This result also implies that the cultural factor did not help the technical efficiency of THM to be better than that of OFC. This result is quite different with the conclusion of Cheng (2001).

TABLE 3: Real Value Labor Productivity by Ownerships

(Unit: 1,000 RMB)

Regions	THM			OFC			Local Firms		
	1993	2001	2002	1993	2001	2002	1993	2001	2002
Beijing	28.02	107.00	102.47	52.25	147.28	136.25	14.43	53.29	66.35
Tianjin	23.48	46.38	42.31	39.06	120.07	134.91	9.41	45.42	50.53
Hebei	16.65	64.43	65.76	21.74	30.44	65.18	10.59	37.34	43.49
Shanxi	15.10	39.73	39.34	26.18	73.97	94.98	9.22	20.68	25.07
Inner Mongolia	8.66	32.35	83.75	13.64	51.66	62.67	7.06	26.46	33.87
Liaoning	27.10	65.00	75.66	37.40	66.78	66.77	11.20	35.13	41.95
Jilin	10.20	72.44	155.94	31.54	186.44	210.29	8.99	35.82	46.14
Heilongjiang	15.14	39.89	46.06	15.42	44.76	55.21	9.84	38.40	43.92
Shanghai	31.06	88.59	89.45	75.03	146.41	154.21	19.53	78.76	90.14
Jiangsu	24.69	61.40	66.68	34.80	94.46	107.45	14.98	45.23	53.40
Zhejiang	27.21	48.65	55.21	26.44	72.57	76.83	14.23	53.21	61.86
Anhui	13.06	74.39	91.72	25.96	72.37	109.08	11.50	31.97	38.06
Fujian	15.24	50.44	63.81	21.55	65.10	79.82	12.15	50.97	60.49
Jiangxi	19.53	30.14	28.69	29.24	56.45	52.26	9.68	24.88	31.40
Shandong	19.22	51.35	52.29	25.84	56.27	57.08	17.23	46.55	51.88
Henan	10.93	68.46	68.32	25.43	48.82	54.40	9.96	27.06	31.98
Hubei	21.27	64.66	71.72	56.89	114.11	151.55	13.72	41.08	48.36
Hunan	7.47	42.26	58.24	45.35	68.19	65.44	7.64	28.82	36.04
Guangdong	24.16	56.34	59.03	40.62	107.09	114.58	19.07	67.60	75.32
Guangxi	17.57	34.17	42.39	15.82	83.29	125.04	14.39	32.64	38.11
Hainan	37.82	50.00	41.08	80.30	51.86	107.53	13.39	46.73	52.57
Sichuan[a]	42.62	75.01	83.45	39.35	106.83	115.67	10.04	35.23	47.07
Guizhou	36.24	20.94	24.37	40.27	37.14	10.14	12.83	30.25	36.40
Yunnan	13.28	44.53	58.23	17.64	70.23	75.71	18.01	53.50	62.05
Tibet	NA	NA	NA	7.26	2.45	2.42	9.45	16.11	18.65
Shaanxi	50.86	75.02	115.94	76.74	149.93	194.93	10.59	29.51	35.92
Gansu	9.75	40.89	45.90	41.25	52.83	54.69	11.15	21.79	27.28
Qinghai	0.00	60.47	103.87	2.41	29.35	56.38	11.66	29.69	34.85
Ningxia	21.51	55.39	35.63	8.91	38.27	57.22	8.92	24.44	27.26
Xinjiang	5.35	23.37	26.76	15.59	54.90	45.30	10.10	42.94	47.75

Sources: Same as in Table 2.

Notes: 1. NA indicates data is not available.

2. All real values are calculated in 1990 price level.

technology. However, Japanese investment is primarily low cost oriented, with a conservative approach to the management of the local operation. Japanese investments appear to transfer far less technology than they control. Finally, most of the projects founded by THM were of low technology content, and 10% of these investments did not possess any technology advantage.

Regarding the motives of investing in China, Buckley et al. (2002) indicated that THM-FDI is primarily export-oriented, implying they were encouraged by China's cheap labor and incentive policies and by THM enterprises' advantages in labor intensive production. By contrast, OFC-FDI tends to be local market oriented, motivated by China's potentially huge market, by external trade barriers, and by western attempts to internationalize technological advantage. From the suggestion made by Anand and Delios (1996) that superior technology and management inflows accompany export-oriented FDI, it is reasonable to suspect that the productivity spillovers from THM-FDI should be different from those of OFC-FDI.

To sum up, investments from THM and from OFC indeed have heterogeneous properties, namely pertaining to firm scale, location preference, labor productivity, cooperative operation, profitability, motivation, and technological level. Moreover, THM-FDI has some advantages of cooperating and interacting with local firms, such as language and culture, when compared

to their foreign counterparts.[17] In light of these findings, this study is confident to state that the distinct properties of the two investors might very well bring about different effects on domestic Chinese firms. The data and methodology used in this study to investigate the possibly different spillovers on Chinese domestic firms from THM and OFC investments are explained in the following.

IV. METHODOLOGY AND DATA

As mentioned earlier, two issues are examined in this study: whether FDI increases Chinese productivity; and the differences, if any, between the spillovers from THM investment and that from OFC investment during 1993 to 2002. Empirical approaches are required to find answers to the questions at hand.[18] This study first adopts labor productivity as one dependent variable in order to investigate the primary issues. However, as discussed by Zhu and Lu (1998), labor productivity may not reflect the overall effects of spillover efficiency. Liu and Wang (2003) also argued that labor productivity is a partial productivity in which only one factor, labor, is considered.[19] Another alternative is TFP which is adopted by Huang (2004) to explore a similar issue. TFP reflects not only technology efficiency, but also the so-called "X-efficiency" in the production process. However, using the exponential

[17] Lee and Cheong (1999) also stressed that the biggest advantage ethnic Chinese firms had over South Korean firms was affinities in culture and language.

[18] Tsou and Liu (1997) indicated that, generally, two alternative empirical models can be used to directly estimate the spillover effect of FDI on a host country's industries. One involves the use of industrial labor productivity in the host country as the dependent variable in the regression; the other uses estimated industrial technical efficiency.

[19] Liu and Wang (2003) pointed out that it is difficult to distinguish between labor productivity being high in a sector/region, because of a high degree of technological efficiency or because of a large stock of physical capital, given that labor productivity fails to capture all of the influences on productivity.

value of residuals derived from estimating the production function as with TFP does not consider the possible influence of measurement errors and other noise upon the production function.[20]

4.1 Empirical Models

This study employs the stochastic frontier production function developed by Aigner et al. (1977) and Meeusen ans van den Broeck (1977) independently to investigate the primary issues. A random error accounts for measurement errors and other random factors, such as the effects of weather, strike, luck, etc., on the output variable, together with the combined effects of unspecified input variables in the production function. The stochastic frontier production to be estimated in the present study is in the spirit of Battese and Coelli (1995) and is specified as follows:

$$\ln(Y_{it}) = \beta_0 + \beta_1 \ln(K_{it}) + \beta_2 \ln(L_{it}) + + V_{it} - U_{it}, \qquad (1)$$

where *ln* represents the natural logarithm; Y_{it} denotes the real value added at the t^{th} observation (t = 1993, 1994, 1997, 2001, 2002) for the i^{th} industry (i = 1, 2, …, 30); K is the real annual average balance of the net value of fixed assets; L_{it} is the number of employees; βs are unknown parameters to be estimated; $V_{it}s$ are assumed to be iid $N(0, \sigma_v^2)$ random errors, independently distributed of the $U_{it}s$; and $U_{it}s$ are non-negative random variables, associated with technical inefficiency of production, which are assumed to be independently distributed,

[20] The TFP index is measured using the standard growth accounting approach initially proposed by Solow (1957) and also adopted by Jefferson et al. (2000). First, this study estimates the separate Cobb-Douglas production function of Chinese industries for each year. The estimated output elasticity of input is then used to calculate the weight of each input and the TFP index

such that U_{it} is obtained by a truncation (at zero) of the normal distribution.

The technical inefficiency effects, $U_{it}s$, are assumed to be a function of a set of explanatory variables and unknown coefficients. The technical inefficiency effect U_{it} could be thus specified as follows.

$$U_{it} = \delta_0 + \sum_{k=1}^{K-1} \delta_k Z_{itk} + W_{it}, \qquad (2)$$

where δs are unknown parameters to be estimated; the random variable, W_{it}, is defined by the truncation of the normal distribution with zero mean and variance, σ^2. Let the right-hand side of equation (2) be defined as $Z_{it}\delta + W_{it}$; the mean and variance of U_{it} are $Z_{it}\delta$ and σ^2, respectively; and the truncated point of W_{it} is $- Z_{it}\delta$, i.e., $W_{it} \geq - Z_{it}\delta$.[21]

The method of maximum likelihood is adopted to estimate the parameters of the stochastic frontier and of the technical inefficiency effect model simultaneously. Battese and Coelli (1993) constructed the likelihood function and its partial derivatives with respect to the parameters. The likelihood function is expressed in terms of the variance parameters, $\sigma_s^2 \equiv \sigma_v^2 + \sigma^2$ and $\gamma \equiv \sigma^2 / \sigma_s^2$, where γ has a value between 0 and 1.[22] A null hypothesis of no technical inefficiency effects in the production can be conducted by the generalized likelihood-ratio (LR) test. The null hypothesis is as follows.

[21] As discussed in Battese and Coelli (1995), this model setting does not require the W random variables to be identically distributed nor are they required to be non-negative. Furthermore, the mean of the normal distribution, which is truncated at zero to obtain the distribution of U_{it}, is not required to be positive for each observation. These features are the primary differences between Battese and Coelli (1995) and Reifschneider and Stevenson (1991).

[22] The technical efficiency of production for the i^{th} industry at the t^{th} period is thus defined as follows. $Technical\ Efficiency_{i,t} = \exp(-U_{i,t}) = \exp(-\delta_0 - \sum_{k=1}^{K-1} \delta_k Z_{itk} - W_{i,t})$.

$$H_0: \gamma=\delta_0=\delta_1=\ldots=\delta_{K-1}=0. \quad (3)$$

Another issue regarding whether the vast majority of residual variation is due to the inefficiency effect, u_{it}, can be also answered by testing the null hypothesis of $\gamma=1$. If the null hypothesis of $\gamma=1$ cannot be rejected, then it implies no random error in the production function.

4.2 Data and Variables

As mentioned earlier, this research examines the spillovers of FDI from different sources on the Chinese manufacturing sector. The official Chinese 1993, 1994, 1997, 2001, and 2002 cross-provincial data adopted in this research cover 30 regions and are sourced from various annual editions of the *China Industrial Economic Statistical Yearbook* and the *China Statistical Yearbook*. All variables were measured for industrial enterprises with independent accounting systems at the township and above levels for 1993-1997 and all state-owned and non-state-owned industrial enterprises above a designated size for 2001 and 2002.[23] The reasons for limiting the discussion of the spillover effects exclusively to 1993, 1994, 1997, 2001, and 2002 is that the definitions of some of the variables have been changed since 1993, and the information on THM and OFC investments in all Chinese industrial sectors is currently only complete for those five years.

To make the empirical results comparable across years, all information on Sichuan has

[23] According to the *China Statistical Yearbook*, all state-owned and non-state-owned industrial enterprises above a designated size refer to all state-owned and non-state-owned industrial enterprises with an annual sales income of over 5 million yuan.

included Chongqing since 1997.[24] The number of observations for each year is 30, representing the 30 regions in this study. This cross-provincial data provide the input, output, and other relevant information for Chinese domestic enterprises, the THM economy, and the OFC economy.[25] This study therefore follows Huang (2004) to further broaden the scope of related research by comparing the different spillover effects from the different sources of FDI for an extended period, and in so doing, provides a better understanding of the effects of these alternative sources of FDI on the Chinese manufacturing sector during 1993 to 2002.

This spillover effect from FDI on the Chinese manufacturing sector is reflected by improving labor productivity and technical efficiency. This study thus adopts two empirical models, the labor productivity function and the stochastic frontier production function, to cope with this issue. The labor productivity function is defined as follows.

$$\begin{aligned}\log LP_i = {} & \alpha_0 + \alpha_1 \log(KLR)_i + \alpha_2 SOE_i + \alpha_3 EXIM_i + \\ & \alpha_4 COAST_i + \alpha_5 \log(SCALE)_i + \alpha_6 OFC_i + \alpha_7 THM_i + \varepsilon_i\end{aligned} \tag{4}$$

Moreover, regarding the stochastic frontier production function, the technical inefficiency function shown in equation (2) is defined as follows.

$$\begin{aligned}U_i = {} & \delta_0 + \delta_1 SOE_i + \delta_2 EXIM_i + \\ & \delta_3 COAST_i + \delta_4 \log(SCALE)_i + \delta_5 OFC_i + \delta_6 THM_i + W_i\end{aligned} \tag{5}$$

In equation (4), *LP* denotes the labor productivity defined as the real value added per worker of total local firms and *KLR* denotes the real capital-labor ratio of total local firms in

[24] Information of Chongqing has been separated from that of Sichuan Province since 1997 due to it becoming China's 4th municipality in 1997.

[25] According to the *China Statistical Yearbook*, a foreign-funded economy includes Sino-foreign joint ventures, Sino-foreign cooperative enterprises, and foreign ventures exclusively with their own investment. An economy funded by entrepreneurs from THM, on the other hand, includes joint ventures and cooperative enterprises with the mainland as well as ventures exclusively with their own investment.

each of the 30 regions. In equation (5), *U* denotes the technical inefficiency of the local firms. In both equations (4) and (5), *SOE* is the share of the state-owned plants' real value added to the domestically-owned plants in each area. *EXIM* represents the openness of a region defined as the ratio of total amount of trade to the total domestic sales revenue in a specific region.[26] *COAST* is a dummy variable for coastal regions and *SCALE* is the average scale of the domestically-owned plants in each region. Finally, *THM* and *OFC* represent the spillover effect variables for FDI from THM and that from countries other than THM, respectively. Since all economic variables are in real terms (based year=1990), the price index is calculated by the method proposed by Chiu-Chen and Huang (1993) and Huang and Chiu-Chen (1999).[27] The definition of the variables and the expected sign of their estimated coefficients are discussed below and shown in Table 4.

In order to investigate the primary issue concerning spillovers from the different sources of FDI in the Chinese industries, this study defines two main explanatory variables representing the spillover effects from FDI as the THM enterprises' and OFC enterprises' shares of employment within each region as adopted in Cave (1974), Blomstorm and Persson (1983), Kokko (1994), Tsou and Liu (1997), Chuang and Hsu (2001), Li et al. (2001),

[26] Originally, *EXIM* is divided into two variables, *EX* and *IM*. The former and latter are defined as the ratio of exports and the ratio of imports to the total domestic sales revenue, respectively. However, *EX* is highly correlated with the primary independent variables, *THM* and *OFC*, in many years. Therefore, this study adopts *EXIM* instead of *EX* and *IM* as the independent variable in both empirical models.

[27] Chiu-Chen and Huang (1993) and Huang and Chiu-Chen (1999) developed a method to calculate the price index for each region or industry in China. In this method, as the *China Industrial Economic Statistical Yearbook* provides the gross output value at current prices and at 1990 constant prices for each region, the ratio of these two kinds of gross output value is calculated and used as the price index for each region (price index = 100 in 1990).

TABLE 4: Descriptions and Statistics of the Variables

Variable	Definition	Mean (Standard Deviation.)					Expected Sign
		1993	1994	1997	2001	2002	
Y	The real value added in domestically-owned plants in each area (in 1990 dollars, RMB 100 million).	332.38 (279.46)	340.36 (288.77)	437.01 (366.20)	611.32 (564.00)	718.59 (675.10)	
K	The real net value of fixed assets in domestically- owned plants in each area (in 1990 dollars, RMB 100 million).	427.45 (307.57)	476.86 (350.24)	886.09 (627.69)	1019.34 (693.65)	1382.13 (986.03)	
L	The total employment in domestically-owned plants in each area. (10,000 people)	265.78 (189.82)	267.57 (194.43)	238.09 (171.12)	150.08 (117.35)	148.88 (120.78)	
LP	The real value added per employee in domestically-owned plants in each area (in 1990 dollars, RMB).	12032.00 (3277.28)	12269.05 (4016.98)	17802.11 (5660.63)	38383.70 (14044.00)	45272.40 (15648.90)	
KLR	The real net value of fixed assets per employee in domestically-owned plants in each area (in 1990 dollars, RMB).	18048.98 (5923.30)	19094.00 (4445.40)	41241.69 (12936.86)	77857.90 (32487.00)	102809.00 (31369.30)	+
SOE	The state-owned plants' share of the real value added of the domestically-owned plants in each area (in 1990 dollars, %).	74.32 (13.69)	69.93 (14.71)	64.05 (14.89)	77.09 (19.14)	73.83 (18.57)	−
EXIM	The share of total trade (including exports and imports) to the total sales revenues of domestically-owned plants in each area (in 1990 dollars, %).	25.90 (53.53)	72.57 (209.11)	30.96 (44.58)	28.58 (43.65)	28.18 (39.02)	+
COAST	= 1 if coastal regions; = 0 if others.	0.40 (0.50)	0.40 (0.50)	0.40 (0.50)	0.40 (0.50)	0.40 (0.50)	+
SCALE	Average sales revenues of domestically-owned plants in each area (in 1990 dollars, RMB million).	6.77 (3.95)	6.35 (3.49)	8.78 (4.71)	38.39 (13.76)	43.76 (15.12)	+
OFC	The ratio of employment in OFC-owned plants to total employment of local firms in each area (%).	1.68 (2.47)	2.80 (3.80)	4.96 (5.77)	8.18 (10.79)	9.14 (12.51)	+
THM	The ratio of employment in THM-owned plants to total employment of local firms in each area (%).	2.15 (4.62)	3.12 (5.97)	5.28 (11.47)	10.49 (24.31)	11.12 (25.78)	+

Source: Same as in Table 2.

and Huang (2004). [28] If FDI from both THM and OFC has a spillover effect on the Chinese industries, then the signs of both coefficients of the spillover variables should be positive. On the basis of the estimated results, this study is indeed able to distinguish differences in the spillover effects from THM and from OFC investments in China.[29]

Wu (1995) concluded that China's SOEs, as opposed to other types of enterprises, have inferior levels of productive performance; thus, it could be stated that the higher the SOEs' share of total real domestic added value in a specific area is, the lower are its labor productivity and technical efficiency in production. The share of total trade to the total output of local firms should play an important role in the labor productivity and the technical efficiency. The influence of trade includes two parts: exports and imports. As pointed out by Chuang and Lin (1999) and Chuang and Hsu (2001), "trade-induced learning by doing" is an important means of improving productivity, management, and marketing technology among local enterprises as they attempt to overcome competition in the international market. Hence, if such a "trade-induced learning by doing" effect does exist in Chinese industries, then it follows that a region with a high share of exports in total real

[28] The other reason for using this definition is that according to the theory of spillover effect from FDI on the host country, the spillover effect is primarily transmitted by way of the labor mobility from foreign firms to local firms. More important reason for using this definition of variables representing the spillover effects is that using other definitions in the empirical model cause a serious econometric problem of collinearity among explanatory variables.

[29] As a matter of fact, attributing the spillover effects solely to FDI without controlling for domestic investment or at least fixed asset investment may be misleading. The domestic investment measured for all firms in each region is incompatible with all of the variables measured for only industrial enterprises with the independent accounting systems at the township and above levels. This inconsistency in the measurements across variables might have resulted in distortions in the estimations. The capital-labor ratio variable may have possibly conquered any shortcoming arising from the omission of the domestic investment in the regression model. In addition, adding the inconsistently-measured domestic investment into the model does not change the primary findings of this study.

domestic value added might have higher levels of productivity and efficiency. In addition, if locally-owned enterprises import mainly advanced production equipment, then their share of imports should have a potentially positive relationship with both labor productivity and technical efficiency.

The average scale of firms may also play an important role in both labor productivity and technical efficiency. The larger the scale of firms is, the higher are labor productivity and technical efficiency due to the economies of scale. Regarding the geographic factor, relative to other regions, coastal regions should find it is easier to obtain advanced production and management technology and, as a result, improve their productivity and efficiency.[30] Therefore, the sign of the coefficient of the dummy variable for coastal regions is expected to be positive. Finally, in labor productivity function, since the value added per worker includes the contributions from capital, according to Tsou and Liu (1997), the capital labor ratio is expected to have a positive influence on labor productivity.

V. EMPIRICAL RESULTS

Since 1998, the scope of statistics on the Chinese manufacturing sector has changed from including industrial enterprises with independent accounting systems at the township and above levels to including all state-owned and non-state-owned industrial enterprises with an

[30] These coastal regions include Bejing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Guangxi, and Hainan. In this study, Guangxi is classified as a coastal region in accordance with a standard way used in many other studies. To illustrate, Brun et al. (2002) classified Guangxi as a coastal province, and so did Zhang (2001). Although Guangxi is not one of the special economic zones, most studies classify Guangxi as a coastal region due to its coastal location.

annual sales income of over 5 million RMB. This study estimates empirical models for each year separately instead of pooling all observations and estimating a regression. As indicated in the previous section, two empirical models are conducted to analyze the spillovers from FDI in Chinese industries. The dependent variable in Model 1 is regional labor productivity in logarithmic form as shown in equation (4), while in Model 2 the dependent variable is regional technical inefficiency derived from stochastic frontier production function as shown in equation (5).

5.1 Labor Productivity Function

The estimating results of model 1 for five years consider econometric problems of heteroskedasticity and collinearity, and they are reported in Table 5.[31] It is worth noting that a diagnostic test, Jarque-Bera (JB) statistic,[32] with respect to residuals for econometric issues of normality has been conducted, indicating that residuals derived from the labor productivity regression distribute normally except for the year 1994. Moreover, in order to test for model misspecification, the Regression Specification Error Test (RESET) proposed by Ramsey (1969) is applied,[33] and suggests that the null hypothesis of no misspecification of the labor

[31] The correlation coefficient matrix of all variables for each year is available upon requests.

[32] As mentioned in Greene (2000), Jarque-Bera is a test statistic for testing whether the series is normally distributed. The test statistic measures the difference of the skewness and kurtosis of the series with those from the normal distribution. Under the null hypothesis of a normal distribution, the Jarque-Bera statistic is distributed as χ^2 with 2 degrees of freedom.

[33] RESET is a general test for the following types of specification errors: 1. omitted variables: empirical model does not include all relevant independent variables. 2. Incorrect functional form: some or all of the dependent and/or independent variables are transformed to logs, powers, reciprocals, or in some other way. 3. Correlation between independent variable(s) and ε, which may be caused by a measurement error in independent variable, simultaneous equation considerations, a combination of lagged of dependent variable values, and serially-correlated disturbances.

TABLE 5: Empirical Results of Labor Productivity Function

Variables	Model 1					Model 1' (lagged variables)	
	1993	1994	1997	2001	2002	1994	2002
CONS.	6.94*** (0.95)	9.01*** (1.16)	7.08*** (1.79)	9.01*** (1.39)	6.63*** (1.44)	7.95*** (0.87)	9.41*** (1.22)
Log (KLR_t)	0.25** (0.12)	-0.06 (0.15)	0.24 (0.18)	0.04 (0.14)	0.28* (0.14)	0.10 (0.11)	0.02 (0.12)
SOE_t	-0.01*** (3×10^{-3})	-1×10^{-3} (3×10^{-3})	-0.01*** (3×10^{-3})	-2×10^{-3} (3×10^{-3})	-4×10^{-3}* (2×10^{-3})	-0.01* (3×10^{-3})	-1×10^{-3} (3×10^{-3})
$EXIM_t$	9×10^{-4} (7×10^{-4})	6×10^{-4}*** (2×10^{-4})	3×10^{-3}*** (9×10^{-4})	1×10^{-3}* (7×10^{-4})	2×10^{-3}*** (5×10^{-4})	2×10^{-3}* (8×10^{-4})	2×10^{-3}** (6×10^{-4})
$COAST_t$	-0.02 (0.12)	-0.04 (0.12)	-0.17 (0.11)	0.11 (0.11)	0.04 (0.10)	-0.04 (0.14)	0.07 (0.11)
Log ($SCALE_t$)	0.27** (0.11)	0.57*** (0.14)	0.28** (0.13)	0.26*** (0.03)	0.26*** (0.03)	0.44*** (0.14)	0.27*** (0.03)
OFC_t	-2×10^{-4} (0.01)	0.03** (0.01)	0.01 (0.01)	0.01** (0.01)	0.01** (4×10^{-3})	0.04*** (0.01)	0.01** (5×10^{-3})
THM_t	3×10^{-3} (4×10^{-3})	-0.01 (0.01)	-5×10^{-3} (0.01)	8×10^{-4} (1×10^{-3})	2×10^{-4} (1×10^{-3})	-0.01** (5×10^{-3})	5×10^{-4} (1×10^{-3})
Observations	30	30	30	30	30	30	30
Adj. R^2	0.52	0.70	0.54	0.65	0.66	0.61	0.65
Log-Likelihood	13.51	16.67	9.32	8.35	10.49	12.97	9.86
F Statistics	5.52***	10.48***	5.95***	8.53***	9.21***	7.50***	8.71***
H_0: Normal distribution. JB=	2.62	22.75***	4.69	3.74	3.22	22.26***	2.31
H_0: No misspecification. *F* =	0.02	1.21	0.57	0.06	0.13	0.11	3×10^{-3}

Notes: 1. Numbers in parentheses are standard deviations. 2. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

productivity regression cannot be rejected for all years.

Regarding the spillover of FDI on the Chinese manufacturing sector, Table 5 stresses that the *THM* coefficient is statistically insignificant in all years. In other words, THM did not bring any spillover effect in terms of labor productivity to the Chinese industries. In sharp contrast, the coefficient of *OFC* is only not significant in 1993 and 1997. That is to say, the foreign countries' investment had spillover effects on the Chinese industries, particularly in 2001 and 2002. It is shown in Table 5 that the sign of the coefficient of most explanatory variables mirrors that which was originally expected. The significantly positive sign of the coefficient of *KLR* existed only in 1993 and 2002. It indicates that the capital-labor ratio does not significantly contribute to labor productivity. This might also be the result of over-investment in the Chinese industries and the policy of "limiting production to reduce inventory" during the period of the 1990s.

Except for 1994 and 2001, the output in regions with a high share of SOEs demonstrates low levels of labor productivity, a finding which is consistent with our expectation. Regarding the trade effect, the empirical results show that it existed in the Chinese industries in 1994, 1997, and 2002, which implies that the contribution of the trade effect has been an important factor to Chinese industrial productivity. Being consistent with what was anticipated, the average production scale has a significantly positive influence on Chinese domestic labor productivity. However, no significant differences in labor productivity are

found between coastal and non-coastal regions.

5.2 Stochastic Frontier Production Function

In order to further investigate the issue concerning whether the FDI improves the technical efficiency of local firms in the Chinese manufacturing sector, the maximum-likelihood estimates (MLE) of the parameters of the stochastic frontier and the technical inefficiency effect model are obtained using a computer program, FRONTIER 4.1 and its instruction is provided by Coelli et al. (1998). In order to test the robustness of the model specification, the generalized likelihood-ratio statistic λ for testing the absence of a technical inefficiency from the frontier is shown in the last row of Table 6.[34] It is shown that for years 1993, 2001, and 2002, the null hypothesis of no technical inefficiency effect in the regional production function as presented in equation (3) cannot be rejected,[35] and thus their empirical results are ignored in this study. In addition, the null hypothesis of γ=1 cannot be rejected in 1994 and thus implies no random error in the production function.

Regarding the spillover effect in terms of improving technical efficiency of the host country, Table 6 shows that the estimate coefficient of the *OFC* variable in the model for the inefficiency effect is significantly negative at the 10% level only in 1994. This weakly implies that the foreign countries' investment had spillover effects in the Chinese industries only in 1994. It is also suggested that investments from THM does not seem to facilitate the

[34] The likelihood-ratio test statistic, λ=--2×log[Likelihood (H_0)/ Likelihood (H_1)], has an approximately χ_n^2 distribution with n equal to the number of parameters assumed to be zero in the null hypothesis H_0.

[35] The values of λ for 1993, 2001, and 2002 are 8.71, 12.28, and 8.50, respectively.

TABLE 6: Estimation Results of the Stochastic Frontier Production Function

	Model 2		Model 2'
	1994	1997	2002
Stochastic Frontier Model:			
CONS	0.53***	-0.15	0.14
	(0.19)	(0.81)	(0.24)
$Log(K_t)$	-0.18	0.57	0.47***
	(0.26)	(0.89)	(0.17)
$Log(L_t)$	1.13***	0.50	0.63***
	(0.24)	(0.77)	(0.15)
Technical Inefficiency Model:			
CONS	0.84***	-0.16	0.37*
	(0.23)	(0.83)	(0.21)
SOE_t	9×10^{-4}	0.01**	2×10^{-3}
	(2.E-03)	(3×10^{-3})	(2×10^{-3})
$EXIM_t$	-3×10^{-4}**	-3×10^{-3}	-3×10^{-3}***
	(1×10^{-4})	(0.01)	(8×10^{-4})
$COAST_t$	0.04	0.12	0.01
	(0.04)	(0.11)	(0.06)
$Log(SCALE_t)$	-0.77***	-0.24	-0.16
	(0.20)	(0.69)	(0.10)
OFC_t	-0.02*	0.01	-7×10^{-4}
	(0.01)	(0.03)	(3×10^{-3})
THM_t	0.01	-0.01	-3×10^{-3}**
	(0.01)	(0.02)	(1×10^{-3})
Variance Parameters:			
σ_s^2	3×10^{-3}***	0.01	0.01***
	(1×10^{-3})	(0.01)	(1×10^{-3})
γ	1.00***	0.59	0.62***
	(0.05)	(0.71)	(0.12)
Observations	30	30	30
Log likelihood	44.93	32.93	39.65
Inefficiency effect LR λ=	35.82***	16.28**	19.97***

Notes: 1. The values in parentheses are standard errors.
2. Symbols ***, **, and * indicate significance at the 1 %, 5%, and 10% levels of the two-tailed test, respectively.
3. λ=--2×log[Likelihood (H_0)/ Likelihood (H_1)]~χ_n^2, where *n* is the number of parameters assumed to be zero in the null hypothesis H_0.

technical efficiency of local firms in China's manufacturing sector, which is inconsistent with the prior expectation, partly due to the econometric problem of simultaneity.

Other coefficients in the model for the inefficiency effect are either insignificant or have a sign which is consistent with our expectation. The trade effect and scale effect seem to improve the technical efficiency in 1994. The output in regions with a high share of SOE demonstrates low levels of technical efficiency in 1997.

5.3 Simultaneity Issues

So far this study has treated FDI from different sources and other factors as exogenous variables in two empirical models. As a matter of fact, it is arguable that, for example, the direction of causality may go from labor productivity or technical efficiency to the level of FDI. The same argument can be applied to other variables, such as *EXIM*, *SCALE*, etc. Moreover, it is also possible that the dependent variables and some independent variables might be simultaneously affected by certain omitted factors. Under these circumstances, the previous estimates would be inconsistent. This study applies an instrumental variable technique to deal with this possible simultaneity bias. The instrumental variables for these independent variables employed in this study are their lagged values. Models 1' and 2' use the lagged value variables as independent variables and their estimates are presented in Tables 5 and 6, respectively. However, both models can be estimated only for 1994 and 2002. Model 2' for 1994 is ignored due to a conclusion that no technical inefficiency effect exists in

the regional production function.

The empirical results of Models 1' and 2' provide more detailed and accurate information regarding the spillover from OFC-FDI and THM-FDI on the Chinese manufacturing sector. With respect to the labor productivity regression, it is shown in Table 5 that the coefficient of *OFC* is significantly positive in both 1994 and 2002. This result further supports the previous suggestion that the OFC-FDI had a spillover effect on China's labor productivity. However, the coefficient of *THM* shows a significantly negative sign in 1994, but not in 2002. This implies that in the early 1990s, like 1994, investments from THM might have damaged China's labor productivity; that is, incurring a negative spillover effect. However, as time goes by, this negative spillover brought by THM-FDI has been mitigated and the coefficient of *THM* became insignificant in 2002.

The absence of positive spillovers in terms of labor productivity from investments from THM is surprising and contradicts the general conclusions of earlier studies. Positive spillovers could have been cancelled out by negative spillovers. In addition to the reasons proposed by Globerman (1979),[36] the fact that all foreign enterprises provide higher payoffs might have been another factor producing negative spillovers.[37] In fact, in the early 1990s,

[36] The negative indirect economic benefit of foreign ownership comes about as a result of the centralization of substantive managerial decision-making in the parent firm, which possibly encouraged talented managers and technicians to relocate outside the host country, thereby reducing productivity throughout the economy as a whole. In addition, a further explanation for the negative spillovers is that FDI contributes to the fragmented structure of the host country's manufacturing industries. This fragmented structure refers to a condition whereby too many firms operate below optimal size, producing too diverse of an array of output, which therefore lowers productivity in both foreign- and locally-owned firms.

[37] According to the *China Statistical Yearbook*, for example, the average 1997 annual wages of staff and workers in a foreign-funded economy and in an economy funded by entrepreneurs from THM were 10,361 and 9,329

foreign enterprises from THM with their high payoff might be more likely to lure many local outstanding managers and technicians, especially young new workers, than those from OFC due to the similar culture and language among Taiwan, Hong Kong, Macao, and China. These local outstanding managers and technicians might further be motivated to switch their job choices from local firms to these THM-funded enterprises, eventually lowering domestic productivity. Undoubtedly, THM-FDI has improved Chinese productivity in some ways, but ironically, it has lowered Chinese productivity in others.

Although THM-FDI did not bring a positive influence on Chinese labor productivity, it is shown in Table 6 that THM-FDI contributed to the technical efficiency of the Chinese manufacturing sector. The coefficient of THM_{t-1} in the technical inefficiency function of Model 2' in 2002 is significantly negative. As mentioned before, according to Thompson (2003), technology can perhaps be better defined as the knowledge whereby economic efficiency can be improved. Hence, technology concludes not only hard technology but also relatively advanced soft managerial practices. The OFC-FDI transfers hard technology to Chinese industry and further improves local firms' labor productivity. However, the transfer of the advanced soft managerial practices from FDI to local firms primarily depends on the knowledge absorbency of the local firms. Therefore, language plays an important role in this knowledge transfer. For this sake, undoubtedly, THM-FDI can more easily transfer

RMB, respectively. However, it was only 6,747 and 4,512 RMB in state-owned and urban/collective-owned units, respectively.

relatively advanced managerial skills to Chinese local firms than OFC-FDI. Therefore, Table 6 concludes that THM-FDI improves the Chinese industry's technical efficiency, but this is not true for OFC-FDI.

VI. CONCULDING REMARKS

The primary issue investigated in this study is whether or not spillover effects from FDI on the Chinese manufacturing sector exist. Moreover, this study also provides answers to a rarely explored issue concerning the difference between spillovers from THM-FDI and OFC-FDI on China. This study utilizes official Chinese cross-provincial data from various years of the *China Industrial Economic Statistical Yearbook* and from the *China Statistical Yearbook* in 1993, 1994, 1997, 2001, and 2002 and estimates two specifications of the empirical models for each year to examine these issues.

After considering some econometric issues, such as heteroscedasticity, simultaneity, collinearity, model misspecification, and normality, and conducting some related hypotheses testing, this study concludes that investment from foreign countries other than from THM had spillover effects on the labor productivity of the Chinese industries. By contrast, FDI from THM did not have any spillover on the labor productivity of China's industries, except for 1994 with a negative spillover after taking simultaneity into account. Moreover, there was a positive spillover of THM-FDI on China's industries primarily in terms of technical efficiency in production in 2002 after considering the simultaneity issue. However, OFC-FDI might

not benefit from the technical efficiency of China's industries.

The different spillovers from THM and OFC are mainly due to the different comparative advantages of these two sources of FDI. The former has a comparative advantage in transferring the soft technology, which might improve economic efficiency, and the latter has a comparative advantage in transferring "hard" technology, which might improve labor productivity, to local Chinese firms. In addition, in the early 1990s, THM-funded enterprises might have more easily lured many local outstanding managers and technicians than those from OFC, and further brought a negative spillover in China's industries due to having a similar culture and language to China. However, in 2002 this scenario did not exist anymore.

This paper makes other contributions in this field. For one, it is found that the average scale of firms has a positive effect on productivity; moreover, it is demonstrated that the share of state-owned firms damaged the labor productivity of China's industries, however its negative impact disappeared in 2002. The trade effect had a positive influence not only on the labor productivity, but also on the technical efficiency. Finally, no significant differences in production performance are noted between coastal and non-coastal regions and the capital-labor ratio did not have any impact on the labor productivity.

The periods referred to in this study are limited to 1993, 1994, 1997, 2001, and 2002 on account of the paucity of data. This means that the findings of this study are only valid for

these years. Provided that the data for later years become available, the analyses here should be expanded to determine whether these conclusions are further supported. Nevertheless, this study provides preliminary conclusions to help us to better understand the spillover effects on Chinese industries from investment from THM and from OFC. In addition, each source of FDI plays a contributory role in improving China's industrial productivity in different ways. In line with the findings of this study, it is suggested that China might be better off if the government devises policies to attract more investment from both THM and OFC.

Apart from this, it is worth noting that the positive impact of FDI on the host country is not only in the enhancement of productivity and efficiency, but also in other aspects, like the increase in employment. Although this study concludes that the negative effects of spillovers on the labor productivity of Chinese industries as a whole from THM investment existed in 1994, the potential contribution of FDI to the development of the Chinese economy should not be ignored in that year.

A stronger recognition of the role of MNEs as "engines of growth" has more recently led to widespread policy liberalization. In the early stage of attracting FDI from foreign countries, China provided favorable treatments and tax exemptions to THM enterprises, partly for some political reasons. Indeed, these policies have attracted much FDI from THM, and THM-FDI has also produced spillover in terms of improving local firms' technical efficiency

in recent years. This study further suggests China's authorities to provide equal policies to both THM-FDI and OFC-FDI, because the latter is not merely a source of capital, but also produced spillovers to local firms in other ways. China's accession to the WTO (World Trade Organization) will create great opportunities that will further encourage FDI from both sources if foreign investors can be granted WTO's principle of national treatment. Therefore, a fully transparent system for regulating FDI will need to be established in the future.

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