Field: International Economics

Spillover Effect and Market Selection Effect of FDI—Evidence from China

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Abstract

High economic growth rate or productivity can be the result of FDI spillover effect and other mechanisms such as market selection. Empirical researches dealt mainly with intra and inter- industry FDI spillover effects. This paper contributes to measure both the FDI spillover effect and market selection quantitatively. Further, account for the tendency of FDI to the high productivity industries. Based on 27 manufacturing industries in China between 2001 and 2006, our results indicate market selection is significant but domestic large firms confront more competition from FDI than the small firms. We also find that both intra and inter- industry FDI spillover effects are positive and significant, and there is gravitation of MNCs to locate in more productive sectors.

JEL Classification Code:
Key words: spillover effect, FDI, market selection

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1. Introduction

A large body of literatures tries to measure the spillover effect of FDI on recipient countries. Earlier literatures (Findaly, 1987; Das, 1987) assume superior technology as “public goods” in nature, thus technology spillover effects can occur automatically among inter-industries. However, evidences give little support for these horizontal technology externalities. Haddad and Harrison (1993) first found the negative effect on spillovers from FDI by the firm-level panel data of Morocco. Followed by some other researchers using different micro-level datasets, Kokko, A (1996), Aitken and Harrison(1999) and Djankow and Hoekman(2000) all cast doubt on the positive spillover effects from horizontal FDI.

Wang and Blomstrom(1992) argued technology transfer through FDI can emerge as endogenous. It depends on strategic interaction between subsidiary of Multinational Corporation and host country. As Javoricik(2004) pointed out earlier researches on FDI intra-industry spillover may go wrong direction since multinationals have an incentive to prevent information linkage but at the same time may benefit from transferring knowledge to local suppliers. That is, inter-industry spillovers are more likely taken place than intra-industry spillovers. Resent literatures emphasize inter-industry spillover via linkages and found very consensus evidences that inter-industry spillover effect is more prevalent than intra-industry spillover effect. Schoors and van der Tol (2002) found positive and significant backward linkage and negative forward linkage using cross-section dataset of Hungarian firms from 1997-1998. The results claimed inter-industry spillover effect outweighed intra-industry spillover. Blalock and Gertler(2003) examined the diffusion of technology brought with FDI using Olley-Pakes methods for Indonesian manufacturing establishments from 1988 to 1996. They found strong evidence that vertical supply chains were a channel for technology transfer. Girma(2004) measured productivity spillovers from FDI using firm-level panel data of U.K. manufacturing industries from 1992-1999. The results showed there were substantial differences in spillover benefits between export oriented FDI and domestic market oriented FDI. Javorick’s study(2004), based on firm-level data from Lithuania, produced evidence of positive productivity spillovers from FDI through contacts between foreign affiliates and their local suppliers in upstream sectors using the Olley-Pakes method. Relied on industry-level panel data from 1994 to 2003 and robust cluster test on firm level pooled data, Liu and Lin (2004) focused on the backward linkages of FDI in the manufacturing sectors in China. They found positive and robust evidence of technology spillovers took place through backward linkage to supplier in China. Harris and Robinson(2004) also found that inter-industry spillovers are generally more prevalent than intra-industry spillovers based on the data of U.K. manufacturing industries from 1974-1995 by the method of GMM. Kugler (2005) estimation on the basis of the Colombian manufacturing Census yielded the sector pattern of FDI spillover, which displayed knowledge promotion between but not within industries. The findings revealed outsourcing relationships of MNCs with local upstream

suppliers as the channel of diffusion.

While literature focus on spillovers, market selection is almost ignored with the exception in Aitken and Harrison(1999) (A&H hereafter) paper. Where they put forward a "market-stealing" hypothesis and argued that "while FDI may promote technology transfer, foreign-invested firms gain market shares at the expense of domestic firms and force the latter to produce smaller outputs at higher average costs". The mechanism is that FDI inflows can force less productive domestic firms to exit and /or of multinationals increasing their share of host country market, both of which would raise the average productivity in the industry. This idea is in line with the pioneering work done by Richard E.caves(1974), while quantitative is little known about the spillover effect and market selection separately from FDI inflow. Few researcher put market selection in the FDI spillover model. This paper fills this gap by examining the relative importance of FDI technology spillover and market selection at the same time. It also has an important policy implication, as the different results lead to different attitude for FDI. That is, when FDI spillover outweighs the market selection effect, policy for FDI will be more open, while when selection effect outweighs FDI industry spillover effect, policy for FDI will be more conservative.

II. Model and data description

(1) Model

A. Baseline model

Standard production function based on the approach of Cobb-Douglas production function which takes the following form:

$$Y_i = A_i L_i^{\alpha} K^{\beta}{}_i \qquad (1)$$

Where, Y_i is value-added; K_i is capital stock; L_i is labor. Power of α and β is the elasticity of labor and capital, respectively. A_i is the technology factor. Following A&H (1999) , A_i can be specified as:

$$A_i = B_i FI^{\gamma}{}_i FI\_S^{\theta} \qquad (2)$$ ①

Where B_i represents exogenous technical factor; FI_i is the ratio of foreign capital to total capital invested in industry i; FI_S is the weighted average of foreign equity participation across different industries. Both of them will be defined in more detail below.

Inserting Eq.(2) into Eq.(1), we can specify our baseline econometric panel estimation in log forms as follows:

① A&H(1999) examined FDI and FDI in firm/ industry level. Here we examined in industry level.

$$\ln Y_{it} = \ln B_i + \alpha \ln L_{it} + \beta \ln K_{it} + \gamma \ln FI_{it} + \theta \ln FI\_S_t + u_{it} \quad (3)$$ [①]

Where, the coefficient γ denotes the intra-industry spillover effect. If an increase in foreign equity participation within the same industry benefits the growth rate of the industry[②], then we'll expect γ is positive. The coefficient θ indicates the inter-industry spillover effect across the manufacturing industries. If an increase in foreign equity participation across different industry promotes the productivity of the industry, the coefficient θ will be positive, otherwise θ will be negative.

B: The extended model

Following A&H(1999), we include an interaction term $FI_{it} * FI\_S_t$ in the model (3). The interaction term allows us to capture whether a given industry with foreign ownership benefits from other industries with foreign participation. If the industry gains from other industries spillover, this coefficient should be positive. Otherwise, it could be negative.

$$\begin{aligned} \ln Y_{it} &= \ln B_i + \alpha \ln L_{it} + \beta \ln K_{it} + \gamma \ln FI_{it} \\ &\quad + \theta \ln FI\_S_t + \varphi \ln FI_{it} * FI\_S_t + u_{it} \end{aligned} \quad (4)$$

It is always arguable that FDI may gravitate to the more productivity industries; the coefficient estimated by the above model would be overestimated. To account for this possibility, we extend model (4) by adding industry initial labor productivity of 2000(LP_00_i), one year earlier than the beginning of our sample.

$$\begin{aligned} \ln Y_{it} &= \ln B_i + \alpha \ln L_{it} + \beta \ln K_{it} + \gamma \ln FI_{it} + \theta \ln FI\_S_t \\ &\quad + \varphi \ln FI_{it} * FI\_S_t + \lambda \ln LP_i\_00 + u_{it} \end{aligned} \quad (5)$$

The positive and significant sign of the parameter λ indicates foreign investment is attracted to more productive sectors.

Aside from FDI investment industry bias, A&H(1999) emphasized productivity could be the result of spillover and competition effect. We can't infer from the above estimation result that technology improvement is more from the spillover or from competition effect? According to Melitz(2003) heterogeneous model, with the different productivity of firms, market selection from competition causes low productivity firm exit, thus, market share allocates to higher productivity firms, average firm size increase and sector productivity increase. We extend model (5) by

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① For convenience, we assume B_i is different across the industries by our intuition. We will test them by econometrics in later part.

② Note that $TFP_{it} = \ln Y_{it} - \alpha \ln L_{it} - \beta \ln K_{it}$, model (3) can change to TFP forms $TFP_{it} = \ln B_i + \gamma \ln FI_{it} + \theta \ln FI\_S_t + u_{it}$. In TFP form, γ represents the spillover effect on productivity in industry itself.

adding one more interaction term $FI_{it} * Size_{it}$ to examine the effect of FDI on market size.

$$\ln Y_{it} = \ln B_i + \alpha \ln L_{it} + \beta \ln K_{it} + \gamma \ln FI_{it} + \theta \ln FI\_S_t + \varphi \ln FI_{it} * FI\_S_t + \lambda \ln LP\_00_i + \eta \ln FI_{it} * Size_{it} + u_{it} \quad (6)$$

Where, the parameter η gives evidence on the extent to which FDI effect on the different firm size. Positive η denotes the selection from FDI is somewhat lower when typical firm is large and vice verse.

(2) Data description

The dataset includes 27 manufacturing industries from the period of 2001-2006[①]. The sector-level data information of value added(Y_{it}) in current prices, number of enterprise(N_i), annual average employed persons(L_i), original value of fixed assets in 1998(K_{i0}), paid-in capital(PK_{it}), foreign-owned capital(FDI_{it})[②] and labor productivity in 2000(LP_i_00), all come from the China Industrial Economic Statistics yearbook of 2001-2007[③]. We get above-mentioned data of 2004 from the China Statistic Yearbook 2005[④] and have to generate Y_i and FDI_i in 2004 by averaging corresponding figures from 2003 and 2005. Other Figures of Ex-factor price indices of industries products by sector (preceding year =100), GDP per capital, consumer price index(CPI) and road transportation are from China Statistics Yearbook from 2001-2007.

Capital stock (K_{it}) in the model is calculated based on the perpetual inventory method (PIM) as follows:

$$K_{it} = (1-\delta) * K_{i0} + I_{it} \quad (7)$$

Where K_{it} is nominal capital stock, δ is depreciation rate, here we assume δ is

① We drop the industries where FDI is ignorable and also drop the industries which were not included in the new Industry classification from 2003 or newly added industries since 2003. Comparable 27 industries are listed in appendix table 1.

② Foreign-owned capital contain two parts, one comes from China's special areas of Hong Kong, Tai and Macao; the other is from other foreign countries.

③ With some unknown reason, China Industrial Economic Statistics yearbook 2005 was not available

④ sector- level Value added and FDI are not available in China Statistic Yearbook 2005.

10%[①]; K_{i0} is the initial capital stock. As the earliest possible sector-level data in the new industry classification began from 1998, we set original value of fixed assets in 1998 as the K_{i0}; I_{it} is newly added fixed assets in each year which we construct by the original fixed asset at year t netting previous year's figure.

Market size is proxy by average domestic firm size[②]

FI_i is the ratio of FDI_{it} to PK_{it} invested in industry i. A detail distribution of FI_{it} within the 27 two-digit manufacturing sectors averaging during 2001-2006 in China is presented in appendix table A1. As the figures in table A1 illustrate that the largest share of investment inflow into three industries: Articles for Culture, Education and Sport Activities; Communication Equipment, Computers and Other Electronic Equipment; Leather, Fur, Feather and Related Products. The share of FDI in Plastics; Furniture; Rubber; Measuring Instruments and Machinery for Cultural Activity and Office Work; and Foods followed. Manufacture of Production and Supply of Electric Power and Heat Power attracts the lowest of receiving FDI in the 27 manufactures

FI_S_t is the average share of foreign equity participation across different industries weighted by employment[③].

$$FI\_S_t = \frac{\sum_{i=1}^{27} FI_{it} * L_{it}}{\sum_{i=1}^{27} L_{it}} \qquad (8)$$

All the nominal variable above are then deflated by Ex-factor price indices of industries products by sector, except that GDP per capital is deflated by consumer price index (CPI_t).

Appendix Table A2 presents summary statistics of the key variables used in the empirical models.

III: Methodologies and Estimation results

A. Methodologies

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① We also check for different δ, results are no difference

② $Size_{it} = Y_{it} / N_{it}$, where Y_{it} and N_{it} are domestic firms' value added and the number of enterprises, respectively. Due to lack of market share information, average domestic firm size could be a direct albeit imperfect proxy of market selection.

③ We have tried capital- weighted FI_S_t, the results are no difference.

Before turning to the estimation results, there are several econometric concerns need to be addressed in the analysis.

The first concern is the model estimation selection. For panel data estimation, there are three different estimation selections: Pooled least square, fixed effect and random effect model. Hausman test is widely used for such choices.

Hausman statistics for testing the fixed effect vs. random effect for model (4)[①], the test statistic is 53.97.The critical value from the chi-squared table with six degree of freedom at 5% significant level is 12.59,which is far lower that the test value. We reject the null hypothesis at the individual effects are uncorrelated with the other regressors in the model. The F test statistics for testing the fixed effect vs. OLS is 14.15, which is larger than the critical value of 12.59. So it is reasonable we choose fixed effect estimation for model (4) to model (6). It makes sense as fixed effect panel estimation of model (4) to model (6) can be better capture the time-invariant information among industries.

The second issue is for possible heteroskedasticity and autocorrelation. When heteroskedasticity and/or autocorrelation exist, the variance will be biased, which cause t or F test invalid. We perform panel heteoskedasicity and autocorrelation test for model (4), respectively. The result of likelihood-ratio test for heteoskedasicity is 89.32. We also use Wooldridge test for autocorrelation. The test result of F-statistics is128.46[②]. Both of test show we cannot reject the null hypothesis of no heteroskedasticity and no autocorrelation at 5% significant level. We correct heteroskedasticity across panels and autocorrelation within panels in the following estimations of extended model (4) to (6).

Another more complex issue is the potential problem with FDI / FI increasing endogenously with higher output. Even we apply the appropriate control variable (LP_00) to deal with the possible high productivity industry bias of FDI; it is still arguable that FDI and productivity would be correlated with industry-specific error term. We apply IV variables techniques to deal with possible simultaneity bias. Huge domestic market demand and good infrastructure are always two key factors to attract FDI inflow in China. GDP per capital and road transportation are two widely used proxies for domestic demand capacity and infrastructure, respectively. They are determinants of FDI but not highly correlated with value added. Besides GDP per capital and road transportation, we also add one lag of FI, the total number of firms in each manufacturing industry as IV. All these IV variables choice are in line with the principle of IV[③].

B. Estimation results

Table 1 presents the estimated coefficients from fixed-effect regression for

① As model (5) and model(6) are based on model (4), we only do Hausman test for model (4), the same as the heteroskedasticity and autocorrelation tests.

② F(1, 26) =132.099, where the first degree of freedom is 1, the second degree of freedom is 26. the critical value table from F-statistics at 5% significant level is 4.23

③ IV needs to satisfy two conditions: (a) it has to be correlated with the endogenous variable ,and (b) it has to be uncorrelated with error term

extended model (4)-(6).

Table 1: the estimated coefficients from fixed-effect regression

Variables	Model (4)	Model (5)	Model (6)
K	0.5876***	0.3713 ***	0.3809***
	(0.0429)	(0.0396)	(0.0369)
Labor	0.3983***	0.51677***	0.5187 ***
	(0 .0399)	(0.0363)	(0.0333)
FI	2.7654 ***	2.0284 ***	2.2775***
	(0.7533)	(0.5937)	(0.5514)
FI_S	5.3431 ***	3.8747***	3.6965***
	(0.9120)	(0.6549)	(0.58928)
FI*FI_S	-6.7744***	-5.0427***	-4.5362**
	(2.1297)	(1.6672)	(1.5277)
FI*Size	---	---	-3.2845 ***①
			(1.2284)
LP_00	--	0.43525 ***	0.5567***
		(0.0397)	(0.0579)
constant	-1.1718***	1.0833***	1.3063***
	(0.3596)	(0.3155)	(0.2989)

Notes: Standard errors are presented in parentheses. All the regression results in the table 1 are corrected by heteroskedasticty and autocorrelation.
***: significant at the 10-percent level
**: significant at the 5-percent level
*:significant at the 10-percent level

The estimated coefficient on FI_S for model (4) to model (6) are all positive and significant, suggesting that there are inter-industry productivity gain associated with an increase in foreign equity participation across the industries and very robust no matter when we add some thus items in model (5) and model (6).

The coefficient of FI in model (4) is positive and significant, indicating that foreign equity participation promotes the industry productivity itself. When we consider the initial productivity industry difference in model (5), we get positive and significant λ which indicate there are FDI industry bias.

As far as the interaction term of FI*FI_S, we get negative and significant parameters for model (4) to model (6). The result is very robust. It denotes that the gains from foreign investment are not captured by foreign participation in other industries. Evidence from China suggest this may be the case as FDI flow in China chasing more for the cheap labors with less strategic cooperation between FDI across industries.

① We also replace average domestic firm size by average all firm size. The sign now is still negative but only significant on 10-percent level, which shows domestic firms confront more serious competition than foreign firms do from FDI inflow.

In model (6), the negative and significant sign of interaction term FI*Size denotes small domestic size firm benefit from FDI. Many researchers find FDI in China are vertical FDI instead of horizontal FDI. Small size firms get better chance to become suppliers when more FDI enter. Estimation of model (6) tells that small enterprise are beneficial from FDI than the large firms are in China.

In order to get consistent parameters, we test of model (4) to model (6) by IV regression again. Results are presented in table (2)

Table 2: the estimated coefficients from fixed-effect regression from IV regression

Variables	Model (4)	Model (5)	Model(6)
K	0.6282***	0.4273***	0.4380***
	(0.0608)	(0.0683)	(0.0683)
Labor	0.2689***	0.3211***	0.3569 ***
	(0.0628)	(0.0596)	(0.0607)
FI	2.4885***	3.9884***	4.8538***
	(1.1312)	(1.0052)	(1.0245)
FI_S	5.1060***	5.3844***	5.2685***
	(1.0061)	(0.8745)	(0.8607)
FI*FI_S	-6.1420**	-9.5243***	-9.6406***
	(2.8990)	(2.495)	(2.4324)
LP_00	---	0.4811***	0.6399***
		(0.077)	(0.0954)
FI*Size	---	---	-3.9923***
			(1.3655)
constant	-0.6184	1.1203	1.1000*
	(0.5312)	(0.61597)	(0.6060)

Note: Standard errors are presented in parentheses. Since FI_S is an average measure over all manufacturing industries, it is always not correlated with the industry-specific error term, so here we treat FI as endogenous, and use one lag of FI, the number of enterprises (N), GDP per capital and road transportation as the instrumental variables.
*: significant at the 10-percent level
***: significant at the 1-percent level

The IV results appear in table 2 generally are similar to what we obtain from table 1. The economic implication of parameters in Table 1 is appropriate for table 2.

IV. Conclusions

In contrast to earlier literature, which only focused on FDI spillover effect, this study first examines both the FDI spillover effect and market selection quantitatively. Further, we also account for the tendency of FDI to the high productivity industries. Based on 27 manufacturing industries in China between 2001 and 2006, we compare the three extended models from model (4) to model (6). Model (4) tests only FDI intra and inter- spillover effect similar to previous literature. We adjust the model (4) accounting for possible FDI gravitation to high productivity sectors by adding the initial labor productivity of industries. In model (6) we further both analyze the spillover effect and market section.

Our main conclusions are as follows: (1) both intra and inter FDI spillover effects are positive and very significant. (2) There is gravitation of MNCs to locate in more productive sectors. (3) Our empirical results demonstrate market selection is significant but large domestic firms confront more competition from FDI than the small firms in China.

Overall, Inter-industry spillover effect is greater than the intra spillover effect and spillover effects outweigh the market selection effect in China. The net impact of FDI on the manufacturing industries is still very significant. For further research, we need to examine the FDI spillover effect and market selection for the subgroups of different ownerships. Due to the different operation mechanism for different ownerships in China, we conjecture there might be some difference. However we only focus on the market selection in FDI spillover effect model in this paper, which is the basic but important job for further studies.

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Appendix tables

Table A1: sample averages of FI in different industries across china from 2001-2006

Industries	Average of FI	industries	Average of FI
Processing of Food from Agricultural Products	0.2527	Manufacture of Rubber	0.4496
Manufacture of Foods	0.4466	Manufacture of Plastics	0.4747
Manufacture of Beverages	0.3835	Manufacture of Non-metallic Mineral Products	0.2255
Manufacture of Textile	0.3114	Smelting and Pressing of Ferrous Metals	0.0847
Manufacture of Textile Wearing Apparel, Footwear and Caps	0.4684	Smelting and Pressing of Non-ferrous Metals	0.1277
Manufacture of Leather, Fur, Feather and Related Products	0.5418	Manufacture of Metal Products	0.3957
Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm and Straw Products	0.3017	Manufacture of General Purpose Machinery	0.2813
Manufacture of Furniture	0.4695	Manufacture of Special Purpose Machinery	0.2112
Manufacture of Paper and Paper Products	0.3939	Manufacture of Transport Equipment	0.2405
Printing, Reproduction of Recording Media	0.2824	Manufacture of Electrical Machinery and Equipment	0.3768
Manufacture of Articles For Culture, Education and Sport Activities	0.6514	Manufacture of Communication Equipment, Computers and Other Electronic Equipment	0.6050
Manufacture of Raw Chemical Materials and Chemical Products	0.2310	Manufacture of Measuring Instruments and Machinery for Cultural Activity and Office Work	0.4494
Manufacture of Medicines	0.1972	Production and Supply of Electric Power and Heat Power	0.0701
Manufacture of Chemical Fibers	0.2883	Average for all industries	0.3412

Table A2: summary statistics of the key variables

Variable		Mean	Std. Dev	Min	Max	Observations
	overall	6.9741	0.9336	4.7671	9.0008	162
Y	between		0.8565	5.4723	8.3509	27
	within		0.4009	6.2414	7.8905	6
	overall	7.0313	1.025006	4.7452	10.1071	162
Capital	between		1.00855	5.3040	9.5936	27
	within		0.2550	6.3120	7.6524	6
	overall	5.0824	0.7716	3.3955	7.8005	162
Labor	between		0.7324	5.3040	6.2683	27
	within		0.2750	4.3945	6.8720	6
	overall	0.3411	0.1499	0.0481	0.6925	162
FI	between		0.1491	.07009	0.6513	27
	within		0.0307	0.2439	0.4287	6
	overall	0.3299	0.0462	0.2799	0.4177	162
FI_s	between		0	0.3299	0.3299	27
	within		0.0462	0.2799	0.4177	6
	overall	7621.302	267.374	885	25345	162
N_firm	between		4919.094	1082	17714	27
	within		2073.454	2147.302	15427.3	6

Note: Y, Capital and K are in logarithms.