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Using manufacturing industry firm-level census data from the period of 2000–2003 in China, this paper examines the impact of foreign direct investment on domestic firms' exports. After dealing with econometric problems of endogeneity and sample selection, we find that foreign direct investment in China has had a positive impact on domestic firms' export value through backward industrial linkages and a positive impact on domestic firms' export propensities in the same industry through demonstration effects. In particular, non-exporting FDI firms and FDI firms producing homogeneous products are more likely to generate the positive export spillovers to domestic firms through industrial linkages while exporting FDI firms and FDI firms producing heterogeneous products are more likely to generate positive export spillovers to domestic firms through demonstration effects in the same industry.

[Key Words]
Foreign Direct Investment, Export Spillovers, Industrial Linkage

JEL Classifications: F14, F23

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1 Introduction

China's international trade has experienced a dramatic expansion in the last three decades. During the period 1978 to 2008, China's total international trade increased from US$20.6 billion to US$2,563.3 billion at an annual growth rate of 17.4 per cent. China's exports increased even more rapidly than its total trade, rising from US$9.8 billion in 1978 to US$1430.7 billion in 2008 at an annual growth rate of 18.1 per cent. Consequently, China has become the largest exporting nation in the world. The dramatic increase in international trade, particularly in exports, has contributed significantly to China's economic growth. According to the International Monetary Fund (IMF, 2009), China's exports were estimated to contribute around 30–45 per cent of the growth rate of China between 2001 and 2008 — a striking figure for an economy of her size — up from 15 per cent in the 1990s.

Foreign direct investment (FDI) in China has also increased dramatically in the last three decades. Foreign firms have been attracted by the huge domestic market and pool of relatively well-educated, low-cost labour. By the end of 2009 China attracted a stock of US$760 billion FDI (at constant 1990 US dollar prices), making it the largest recipient among the developing countries.

FDI has contributed greatly to China's international trade. Exports and imports by FDI firms have accounted for nearly 60 per cent of China's total international trade. What, however, are the impacts of FDI on China's domestic firms' exports? This question is important because it is expected that export spillovers are some of the main benefits generated by FDI to host economies. These not only help domestic firms improve productivity, promote specialisation and increase exports, but also can help host countries improve resource allocation and play to their comparative advantage in international trade (Dunning, 1993).

Chinese domestic firms' exports have experienced a significant increase in terms of both the total export value and the average export propensity. Between 1980 and 2008 the

value of exports from domestic firms has increased from US$18.1 billion to US$640.2 billion at an annual growth rate of 13.6 per cent. In 1998 the total number of domestic exporting firms was 20,537 and their average export value was US$25.24 million with the average export propensity of 8.80 per cent. By 2007 the total number of domestic exporting firms reached 41,872 and their average export value reached US$74.52 million (both were more than twice the value of 1998) and the average export propensity increased to 9.58 per cent. In particular in some industries, such as plastic products, metal products and electrical machinery, domestic firms' average export value increased by around three times. The interest in this paper is the contribution of FDI to this performance.

FDI can reduce domestic firms' export costs through knowledge spillovers such as learning by doing (demonstration effects), research and development, human resource movement, training courses, technical assistance, and technology transfer (Dunning, 1993; Caves, 1996; Aitken et al., 1997; Barrios et al., 2003; Gorg and Greenaway, 2004; Greenaway et al., 2004; Javorcik, 2004; Kneller and Pisu, 2007). These various effects can be combined into three main channels by which FDI may promote domestic firms' export activities. First, FDI can generate positive spillovers to domestic firms in productivity, which may improve domestic firms' competitiveness in the international market. Second, FDI can strengthen domestic industrial linkages through buying and supplying parts and components, which will encourage domestic firms in the upstream and downstream industries to be involved in international production specialisation, thus enhancing those firms' ability to export. Third, FDI can pass information between international markets and domestic firms, facilitating domestic firms' exports. This effect will depend on whether the FDI firm is oriented to the domestic market of the host economy or the international market, and will also depend on the types of products or services sold by the FDI firm, such as the extent of differentiation of those items.

Empirical studies of the impact of FDI on domestic firms have mainly focused on productivity spillovers or technology transfers from FDI. There are few empirical studies of other forms of export spillovers from FDI (Gorg and Greenaway, 2004). Moreover,

most studies of export spillovers only investigate the intra-industry or horizontal impact of FDI on the export activities of domestic firms. FDI could also affect export activities of domestic firms in the upstream and downstream industries through vertical linkages and information flows. Therefore, further empirical analysis of how FDI can affect domestic firms' exports is valuable. China, with huge FDI inflows and fast growth in international trade in the last three decades, provides a valuable case study for such research.

Studies at the firm level need to isolate the effects of interest. Using the firm-level census data of Chinese manufacturing industries during the period 2000–2003, this paper carries out a series of regressions to investigate the impacts of FDI on China's domestic firms' export performance both in terms of the export value and the export propensity, which is the ratio of exports to total sales. In searching for the export spillovers from FDI firms to domestic firms, we not only examine the horizontal impact but also investigate the impact through vertical industrial linkages between FDI firms and domestic firms. In addition, to identify the impact of information flows, we also examine the impact of different FDI firms, in terms of the market orientation and product differentiation, on domestic firms' exports.

After controlling for firm characteristics, such as productivity, capital-to-labour ratio, R&D activities, scale, age, and indirect foreign investment of domestic firms, and dealing with some econometric problems of endogeneity and sample selection, our empirical regressions reveal the following three main findings.

First, FDI has a positive impact on domestic firms' export value through the backward and forward industrial linkages, and this positive impact is mainly generated by non-exporting FDI firms and FDI firms producing homogeneous products.

Second, FDI, in particular high-exporting FDI firms and FDI firms producing heterogeneous products, will increase domestic firms' export propensity in the same industry through demonstration effects.

Third, positive export spillovers from FDI firms are mainly to domestic non-state-owned enterprises both in terms of export value and export propensity.

Two contributions are made to the previous literature. First, in addition to intra-industry impacts of FDI on domestic firms' exports through demonstration effects, our analysis points out that industrial linkages can be another important channel through which FDI can promote domestic firms' exports activities. Second, we distinguish FDI firms by their different characteristics, such as market orientation and product differentiation, in order to reveal how different types of FDI firms may have different impacts on domestic firms' exports, which can help to provide some useful policy implications.

The paper is arranged as follows. Section 2 presents the literature review. Section 3 specifies the empirical model specifications for investigating the impact of FDI variables (i.e., horizontal, backward and forward FDI) on domestic firms' export value and export propensity. In particular, a Heckman two-step procedure regression has been combined with the first differencing regression technique to deal with the endogeneity problem associated with firms' fixed effects and the sample selection problem due to domestic firms' non-random selection between exporting and non-exporting behaviours. Section 4 documents the data sources and variable definitions. Section 5 discusses the estimation results. Finally, Section 6 makes the conclusion.

2 Evidence of export spillovers from FDI: a literature review

The literature on export spillovers from FDI is relatively limited compared to that on productivity spillovers (Gorg and Greenaway, 2004; Kneller and Pisu, 2007). Aitken et al. (1997) were pioneers in exploring externalities associated with FDI. Using plant-level cross-section data for Mexican manufacturing industries for 1986 and 1989, they investigate the role of geographic and multinational spillovers on the export decisions of local firms. They estimate a probit model using export activity by multinationals in the

industry and region as a proxy for export information externalities. They argue that proximity to multinational activity reduces the cost of access to foreign markets and find evidence that export activities by multinational firms in a sector positively affect the probability of a firm in the same sector and region being an exporter.

Kokko et al. (2001) investigate the decision to export by domestic firms in Uruguay using cross-sectoral firm-level data for 1998. They distinguish between the presence of multinational firms in import-substituting and export-oriented industries and find evidence only for spillovers from export-oriented multinational firms.

Greenaway et al. (2004), using firm-level panel data for the United Kingdom for 1992–96 and a two-step Heckman selection model, estimate the probability of exporting and identify the factors that affect a firm's export ratio. Their results suggest that multinational firms' exports have a positive effect on domestic firms' probability of exporting but do not affect their export ratio. They also find that the presence of multinational firms in the sector positively affects the decision to export and the export ratio.

Barrios at al. (2003) focus on export information externalities and on demonstration effects through R&D spillovers. Using firm-level panel data for Spanish manufacturing for 1990–98, they estimate a probit model to explain why firms export and a tobit model to estimate what determines a firm's export ratio. They find no evidence that either R&D activity or export activity by multinational firms in a sector affects the probability that domestic firms export. The tobit estimations, however, find evidence for positive effects of multinational firms' R&D activities on export activities on domestic firms' export ratios, but no spillovers from multinational firms' export activities on domestic firms.

Ruane and Sutherland (2005) concentrate on finding evidence of export spillovers from foreign enterprises on the export decision and intensity of domestic enterprises in countries that promote themselves as export platforms for FDI. By using firm-level data for the manufacturing sector in Ireland for the period 1991–98, they find that the decision

by host-country enterprises to enter the export market is positively associated with the presence of foreign enterprises in their sector. However, they find that the export intensity of foreign enterprises is negatively associated with the export decision and export intensity of domestic enterprises in Irish manufacturing.

Empirical studies on export spillovers from FDI firms to domestic firms in China are even more limited. For example, Zheng et al. (2004), using panel data at the regional level for the period of 1985–99, examine the impact of FDI on the export performance of domestic Chinese firms. They find that FDI has some positive effects on domestic firms' export performance, but the influence is less than that on all firms (foreign and domestic). Similarly, Ma (2006), using panel data at the provincial level for the period of 1993–2000, examines whether exports by multinational firms increase the probability of exporting by Chinese domestic firms. Ma finds that FDI firms funded by overseas-Chinese investors do not increase the probability of exporting by local firms, while FDI firms from the OECD countries positively influence the export decisions of local firms, particularly in the processing trade.

Buck et al. (2007), using firm-level panel data for the period 1998–2001, investigate export spillovers from FDI firms to Chinese domestic firms. By using a two-step modelling strategy, their estimations show that multinational firms in China positively affect local Chinese firms' exports. Sun (2009) uses pooled firm-level data to assess the impact of FDI on China's domestic firms' exports in the cultural, educational and sporting product manufacturing industry between 2000 and 2003. After dealing with the sample-selection bias, he finds that there are some positive effects of FDI on domestic firms' exports in this industry although the impacts are asymmetric across regions and differ among types of firms.

Kneller and Pisu (2007) provide one of the few studies of spillovers from foreign firms to domestic firms through horizontal, backward and forward linkages. Using a firm-level dataset of United Kingdom manufacturing industries from 1992 to 1999 they use the Heckman selection process and model the two decisions of whether to export or not, and

how much to export, separately. They find that the export decision of domestic firms does not seem to be affected by contacts they may have with multinational enterprises. Except for backward spillovers (which are positive and significant) they did not find any evidence of forward and horizontal spillovers. In addition, the horizontal spillovers seem to depend on the export orientation of foreign firms. Both export-oriented and domestic market-oriented multinational enterprises appear to generate positive and significant export spillovers, but the export-oriented foreign firms seem to be the source of stronger export spillovers. With regard to vertical spillovers, they find significant negative forward export externalities and significant positive backward externalities.

This review finds mixed results and little study of the impact of FDI in China on domestic firms' exports. This paper proceeds by examining four questions. First, do FDI inflows affect domestic firms' export value and export propensity through horizontal or vertical channels? Second and third, do different types of FDI, in terms of a) market orientation and b) product differentiation, have different impacts on domestic firms' exports? And fourth, do FDI inflows have different impacts on the export of domestic firms of different ownership types?

3 Data collection and variable definitions

We use firm-level data from the annual enterprise census conducted by the National Bureau of Statistics (NBS) of China. The census covers the population of all state-owned enterprises (SOEs) and non-state-owned enterprises with annual sales value above RMB5 million yuan in the manufacturing industries across all provinces (except for Taiwan). The sample is an unbalanced dataset at the firm level for the manufacturing industries (China Industry Classification Code: 13-42), which spans a period of four years from 2000 to 2003. The total number of firms covered varies from 134,130 in 2000 to 169,810 in 2003. To control for firms' entry and exit and their possible impact on the relationship between FDI and domestic firms' exports, we restrict the sample used for regressions to those domestic firms that at the least appeared in two consecutive years (for the sample

period) and use the neighbourhood matching technique to sort out unmatched domestic firms with the same exporting behaviour between each consecutive two years.[2] The sample used contains 250,868 observations.

To distinguish between domestic firms and FDI firms, we use both firms' ownership type information from the China Enterprise Registration Code (CERC) and their capital composition: domestic firms are defined as the currently operating firms with a foreign capital share of less than 25 per cent of the total registered capital (or CERC 100-190) and FDI firms are defined as the currently operating firms with a foreign capital share of more than or equal to 25 per cent of the total registered capital (or CERC 200-340).[3] Based on these definitions, we choose both domestic firms' export value (at constant price) and average export propensity as the dependent variables. Domestic firms' export value (at constant price) is defined as domestic firms' export revenue divided by the firm-level output price index (calculated by using the constant price output value and the current price output value), while domestic firms' average export propensity is defined as the domestic firms' export revenue divided by their total sales revenue.

For the variables of FDI spillovers at the industry level, we follow Javorcik (2004) to account for both the relative importance of FDI in firms' capital stock and FDI firms' scale in the sector. Specifically, the variable for horizontal spillovers is defined as the weighted sum of foreign capital share, with the weight being each firm's share in the sector's output ($Horizontal_{jt}$):

$$Horizontal_{jt} = (\sum_{i \in j} ForeignShare_{it} * Y_{it}) / (\sum_{i \in j} Y_{it}), \quad (1)$$

[2] For details of the neighbourhood matching technique please see Imbens and Angrist (1994) and Hahn et al. (2001). The related results are available from the authors upon request.
[3] China's regulations define FDI as a foreign capital share of at least 25 percent of the total registered capital.

where $ForeignShare_{it}$ denotes the share of foreign capital in FDI firms at time t and Y_{it} is the total output of the same FDI firm at the same time. The value of the variable increases with the output of FDI firms and with the share of foreign capital in these firms.

The variable of backward spillovers is defined as:

$$Backward_{jt} = \sum_{k \neq j} \alpha_{jk} Horizontal_{kt}, \quad (2)$$

where α_{jk} is the proportion of sector j's output supplied to sector k, taken from China's 2002 input–output table at the two-digit level based on the International Standard Industrial Classification (ISIC) Code. The greater the foreign presence in sectors supplied by industry j and the larger the share of intermediates supplied to industries with FDI presence, the higher the value of the variable.

The variable of forward spillovers is defined as:

$$Forward_{jt} = \sum_{m \neq j} \varphi_{jm} [[\sum_{i \in m} ForeignShare_{it} * (Y_{it} - EX_{it})] / [\sum_{i \in m} (Y_{it} - EX_{it})]], \quad (3)$$

where φ_{jm} is the share of inputs purchased by sector j from sector m in total inputs sourced by sector j. EX_{it} denotes the export value of FDI firm i at time t estimated with the output constant price.

In addition to FDI variables, we also control for some firm characteristics affecting domestic firms' export behaviour, including productivity, capital–labour ratio, R&D activities, operational scale, age, and indirect foreign investment. For domestic firms' productivity, we choose domestic firms' total factor productivity as an approximation, which is estimated by using the semi-parametric regression method following Levinsohn and Petrin (2003). All value variables used for the productivity estimation are calculated at year 2000 constant prices. Domestic firms' exports are controlled in the estimation in

order to deal with the possible reverse causality problem. Productivity is expected to have a positive impact on domestic firms' exports.

Firms' capital–labour ratio is defined as the log of net value of fixed assets at year 2000 constant prices divided by total number of employed workers. Domestic firms' average capital–labour ratio has increased during the period from 2000 to 2003, with the growth rate being 4.63 per cent. However, domestic exporting firms' capital–labour ratio has increased by only 2 per cent, which implies that domestic firms' exports are still primarily based on the comparative advantage in labour. Given China's comparative advantage in labour-intensive activities, the capital–labour ratio is expected to have a negative impact on domestic firms' exports.

Firms' R&D index is defined as the total revenue from new products divided by the total revenue. R&D activities can increase firms' competitiveness and therefore are expected to have a positive impact on domestic firms' exports.

Firms' age is based on their establishment year. In our sample, domestic firms' average age is 12.4 years. Firms' operational scale is a dummy variable, which takes one if the domestic firm is classified as the large and medium-sized firm and zero if not. We have no pre-judgement of the impact of these two variables on domestic firms' exports.

Finally, indirect foreign investment is the foreign equity share in total registered capital of domestic firms ranging from zero to less than 25 per cent. This variable controls the direct impact of foreign capital on domestic firms' exports and is expected to be positive.

Tables 1–3 show the descriptive statistics of domestic firms' basic information and export behaviour, and FDI in the same and in upstream and downstream industries.

Table 1. Major Economic Indicators of Domestic Firms: 2000-2003

	2000		2001		2002		2003		Total	
	Non-Exporting Domestic Firms	Exporting Domestic Firms	Non-Exporting Domestic Firms	Exporting Domestic Firms	Non-Exporting Domestic Firms	Exporting Domestic Firms	Non-Exporting Domestic Firms	Exporting Domestic Firms	Non-Exporting Domestic Firms	Exporting Domestic Firms
Number of Observation	88645	19401	97374	21136	99451	23839	109553	26347	395023	90723
Average output value (10,000 yuan)	26323	116143	28201	117195	31783	123749	35684	141766	30741	125759
	(88986)	(638757)	(103926)	(693802)	(135355)	(764732)	(135689)	(975163)	(118983)	(792419)
Average number of employed workers (person)	234	765	213	640	206	579	193	546	210	623
	(507)	(2671)	(504)	(2390)	(561)	(2091)	(439)	(2010)	(503)	(2277)
Net value of fixed assets (10,000 yuan)	6868	31888	6845	29766	6965	27252	6649	27441	6826	28884
	(43102)	(265715)	(54193)	(284308)	(59056)	(272385)	(43801)	(266796)	(50507)	(272210)
Average Intermediate Input Value (10,000 yuan)	20271	89672	21765	91458	24451	95696	27225	108933	23611	97216
	(70230)	(496880)	(84692)	(553411)	(109044)	(604997)	(107446)	(766945)	(95237)	(624804)
Firms' Productivity (ln(TFP) Index)	1.06	0.95	1.06	0.95	1.06	0.95	1.07	0.98	1.06	0.96
	(0.83)	(0.76)	(0.81)	(0.75)	(0.81)	(0.75)	(0.84)	(0.81)	(0.82)	(0.77)
K/L ratio (10,000 yuan/person)	27.2	25.0	29.5	24.7	29.7	24.6	30.7	25.1	29.4	24.9
	(107.1)	(88.8)	(101.6)	(53.4)	(60.8)	(48.5)	(60.7)	(62.8)	(84.1)	(64.1)

Note: Numbers in brackets are standard deviations.
Source: Authors' own calculation.

Table 2. Intra-sector FDI Firms' Output Share and Inter-sector FDI Impact: 2000–2003 (Unit: %)

	2000			2001			2002			2003			Total		
Sectors	Hori_ FDI	Down stream FDI	Upstre am_F DI	Hori_ FDI	Down stream FDI	Upstre am_F DI	Hori_ FDI	Down stream FDI	Upstre am_F DI	Hori_ FDI	Down stream FDI	Upstre am_F DI	Hori_ FDI	Down stream FDI	Upstre am_F DI
Processing of Food from Agricultural Products	15.1	4.5	1.7	17.0	4.8	1.8	16.9	4.6	1.7	17.2	4.6	1.8	16.6	4.7	1.7
Manufacture of Food	28.7	0.8	6.6	32.6	0.9	7.1	30.4	0.9	7.0	30.2	1.0	7.3	30.6	0 9	7.0
Manufacture of Beverage	19.5	0.3	6.1	21.3	0.4	6.4	23.1	0.4	6.3	25.0	0.4	6.4	22.3	0.4	6.3
Manufacture of Tobacco	0.1	0.0	1.4	0.3	0.0	1.3	0.2	0.0	1.4	0.2	0.0	1.3	0.2	0.0	1.4
Manufacture of Textile	13.3	8.6	3.7	14.2	8.8	3.3	14.7	8.8	3.7	16.4	9.1	3.5	14.8	8.8	3.5
Manufacture of Textile Wearing Apparel, Footware, and Caps	31.9	1.1	9.3	32.5	1.2	9.3	32.0	1.2	9.5	33.4	1.3	10.1	32.6	1.2	9.6
Manufacture of Leather, Fur, Feather and Related Products	41.7	2.3	5.8	40.1	2.4	6.1	39.3	2.4	6.0	38.8	2.6	6.4	39.8	2.5	6.1
Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm, and Straw Products	17.8	7.2	3.7	16.6	7.6	3.9	16.1	7.9	4.0	18.8	8.3	4.2	17.3	7.8	4.0
Manufacture of Furniture	32.5	1.4	10.6	35.0	1.5	10.6	36.2	1.5	9.8	39.5	1.5	10.3	36.2	1 5	10.3
Manufacture of Paper and Paper Products	22.3	12.6	5.0	23.3	13.4	5.2	24.7	13.5	5.3	23.6	13.9	5.4	23.6	13.4	5.2
Printing, Reproduction of Recording Media	20.5	3.3	10.8	22.0	3.6	11.0	22.4	3.6	11.3	22.8	3.8	11.2	22.0	3.6	11.1
Manufacture of Articles For Culture, Education and Sport Activity	45.9	0.5	13.7	47.4	0.5	13.9	47.7	0.5	13.7	49.9	0.5	13.9	48.0	0 5	13.8

Table 2. Continued

Sectors	2000			2001			2002			2003			Total		
	Hori_ FDI	Down stream _FDI	Upstre am_F DI	Hori_ FDI	Down stream _FDI	Upstre am_F DI	Hori_ FDI	Down stream _FDI	Upstre am_F DI	Hori_ FDI	Down stream _FDI	Upstre am_F DI	Hori_ FDI	Down stream _FDI	Upstre am_F DI
Processing of Petroleum, Coking, Processing of Nuclear Fuel	3.9	4.1	1.3	3.7	4.4	1.4	6.9	4.6	1.4	6.1	4 9	1.5	5.3	4 5	1.4
Manufacture of Raw Chemical Materials and Chemical Products	14.7	13.5	3.4	16.1	13.7	3.5	16.7	13.7	3.8	18.6	14.3	3.9	16.7	13.9	3.7
Manufacture of Medicines	11.2	0.1	4.5	10.5	0.1	4.7	11.4	0.1	4.7	11.3	0.2	4.9	11.1	0 1	4.7
Manufacture of Chemical Fibers	17.8	13.2	7.5	14.3	13.8	7.8	13.9	14.1	7.9	11.8	15.1	8.6	14.1	14.1	8.0
Manufacture of Rubber	25.1	10.2	5.8	25.3	11.0	5.8	28.3	11.1	6.0	27.0	12.1	6.3	26.5	11.2	6.0
Manufacture of Plastics	31.5	13.1	8.4	31.2	14.2	8.7	30.4	14.4	8.9	32.3	15.4	9.7	31.4	14.4	9.0
Manufacture of Non-metallic Mineral Products	11.6	5.3	5.2	12.6	5.9	5.3	12.5	6.0	5.5	11.5	6.4	5.7	12.1	6.0	5.4
Smelting and Pressing of Ferrous Metals	3.6	9.3	3.6	4.2	9.7	3.7	4.4	10.0	4.1	5.1	10.7	4.1	4.4	10.0	3.9
Smelting and Pressing of Non-ferrous Metals	7.2	14.5	3.3	7.6	15.1	3.4	7.3	15.4	3.6	8.5	16.3	3.6	7.7	15.4	3.5
Manufacture of Metal Products	26.1	8.0	5.7	25.2	8.7	5.6	25.8	8.9	5.5	25.3	9.5	6.0	25.6	8 9	5.7
Manufacture of General Purpose Machinery	13.5	5.9	7.6	13.7	6.6	7.8	15.8	6.6	7.6	17.8	7.3	8.0	15.4	6.7	7.8
Manufacture of Special Purpose Machinery	9.8	1.8	9.1	13.0	1.9	9.4	12.7	1.9	9.5	14.7	2.1	10.2	12.7	1.9	9.6

Table 2. Continued

Sectors	2000			2001			2002			2003			Total		
	Hori_ FDI	Down stream _FDI	Upstre am_F DI	Hori_ FDI	Down stream _FDI	Upstre am_F DI	Hori_ FDI	Down stream _FDI	Upstre am_F DI	Hori_ FDI	Down stream _FDI	Upstre am_F DI	Hori_ FDI	Down stream _FDI	Upstre am_F DI
Manufacture of Transport Equipment	16.5	1.1	6.1	18.3	1.2	6.2	18.2	1.3	6.4	21.9	1.3	6.8	18.9	1 2	6.4
Manufacture of Electrical Machinery and Equipment	23.8	8.7	10.9	24.1	9.9	11.1	24.7	10.1	10.9	26.4	10.9	11.3	24.9	10.0	11.1
Manufacture of Communication Equipment, Computers and Other Electronic Equipment	47.1	2.5	5.2	54.7	2.7	5.4	55.0	2.8	5.3	59.3	2 9	5.4	54.7	2.8	5.3
Manufacture of Measuring Instruments and Machinery for Cultural Activity and Office Work	52.1	4.3	18.1	57.9	4.6	19.6	57.7	4.7	18.5	59.8	5 1	19.3	57.3	4.7	18.9
Manufacture of Artwork and Other Manufacturing	31.7	5.7	5.8	31.8	6.0	5.8	33.9	6.2	5.9	30.8	6.6	6.0	32.1	6 2	5.9
All Manufactures	20.3	6.2	6.2	21.5	6.6	6.3	22.1	6.7	6.4	23.1	7.2	6.7	21.9	6.7	6.4

Source: Authors' own calculation.

Table 3. Domestic Firms' Exports Behaviour by Sectors: 2000–2003

Sectors	Items	2000	2001	2002	2003	All Firms
Processing of Food from Agricultural Products	Average Export Proportion (%)	51.9	53.0	52.0	52.8	52.4
	Number of Exporting Firms	813	790	885	987	3,475
Manufacture of Food	Average Export Proportion (%)	55.0	55.0	53.4	54.3	54.4
	Number of Exporting Firms	371	371	400	431	1,573
Manufacture of Beverage	Average Export Proportion (%)	39.9	41.4	44.0	42.9	42.1
	Number of Exporting Firms	189	193	213	232	827
Manufacture of Tobacco	Average Export Proportion (%)	5 9	5.5	3.7	3.8	4.6
	Number of Exporting Firms	38	34	44	43	159
Manufacture of Textile	Average Export Proportion (%)	55.4	56.3	55.8	57.6	56.3
	Number of Exporting Firms	2,736	3,026	3,231	3,503	12,496
Manufacture of Textile Wearing Apparel, Footware, and Caps	Average Export Proportion (%)	82.7	83.4	81.8	82.0	82.4
	Number of Exporting Firms	1,896	2,196	2,698	2,850	9,640
Manufacture of Leather, Fur, Feather and Related Products	Average Export Proportion (%)	79.1	77.0	77.7	79.7	78.4
	Number of Exporting Firms	711	906	1,033	1,224	3,874
Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm, and Straw Products	Average Export Proportion (%)	66.5	67.4	64.8	67.9	66.7
	Number of Exporting Firms	259	334	371	420	1,384
Manufacture of Furniture	Average Export Proportion (%)	66.4	66.8	66.7	69.5	67.7
	Number of Exporting Firms	161	181	240	323	905
Manufacture of Paper and Paper Products	Average Export Proportion (%)	42.6	40.2	37.0	35.7	38.8
	Number of Exporting Firms	248	247	264	266	1,025
Printing, Reproduction of Recording Media	Average Export Proportion (%)	29.4	31.5	39.4	37.1	35.0
	Number of Exporting Firms	68	70	87	112	337
Manufacture of Articles For Culture, Education and Sport Activity	Average Export Proportion (%)	73.9	77.8	76.1	78.1	76.7
	Number of Exporting Firms	462	552	662	736	2,412
Processing of Petroleum, Coking, Processing of Nuclear Fuel	Average Export Proportion (%)	36.6	23.9	29.4	18.0	28.7
	Number of Exporting Firms	106	52	128	64	350
Manufacture of Raw Chemical Materials and Chemical Products	Average Export Proportion (%)	34.2	34.0	32.5	39.7	35.3
	Number of Exporting Firms	1,387	1,398	1,482	1,722	5,989
Manufacture of Medicines	Average Export Proportion (%)	35.7	35.6	34.7	34.8	35.2
	Number of Exporting Firms	500	528	539	571	2,138

Table 3. Continued

Sectors	Items	2000	2001	2002	2003	All Firms
Manufacture of Chemical Fibreers	Average Export Proportion (%)	19.4	24.6	25.3	23.4	23.3
	Number of Exporting Firms	60	70	75	70	275
Manufacture of Rubber	Average Export Proportion (%)	41.6	37.4	38.3	39.9	39.3
	Number of Exporting Firms	244	233	256	260	993
Manufacture of Plastics	Average Export Proportion (%)	53.9	55.7	54.5	56.7	55.3
	Number of Exporting Firms	590	617	756	870	2,833
Manufacture of Non-metallic Mineral Products	Average Export Proportion (%)	47.8	49.7	50.0	51.6	49.9
	Number of Exporting Firms	845	927	991	1,171	3,934
Smelting and Pressing of Ferrous Metals	Average Export Proportion (%)	35.8	32.3	33.6	31.3	33.3
	Number of Exporting Firms	259	239	246	265	1,009
Smelting and Pressing of Non-ferrous Metals	Average Export Proportion (%)	34.3	28.6	33.3	34.6	33.2
	Number of Exporting Firms	245	193	275	407	1,120
Manufacture of Metal Products	Average Export Proportion (%)	62.7	63.8	65.6	66.0	64.7
	Number of Exporting Firms	1,143	1,289	1,473	1,645	5,550
Manufacture of General Purpose Machinery	Average Export Proportion (%)	38.4	40.0	41.1	42.5	40.7
	Number of Exporting Firms	1,486	1,622	1,779	2,041	6,928
Manufacture of Special Purpose Machinery	Average Export Proportion (%)	22.0	23.4	23.5	25.8	23.7
	Number of Exporting Firms	809	748	813	847	3,217
Manufacture of Transport Equipment	Average Export Proportion (%)	31.7	35.1	33.5	36.0	34.2
	Number of Exporting Firms	732	734	888	989	3,343
Manufacture of Electrical Machinery and Equipment	Average Export Proportion (%)	40.6	45.8	49.1	51.7	47.4
	Number of Exporting Firms	1,019	1,195	1,382	1,579	5,175
Manufacture of Communication Equipment, Computers and Other Electronic Equipment	Average Export Proportion (%)	45.1	45.7	42.1	45.0	44.4
	Number of Exporting Firms	542	592	661	734	2,529
Manufacture of Measuring Instruments and Machinery for Cultural Activity and Office Work	Average Export Proportion (%)	41.0	40.9	42.8	51.7	44.8
	Number of Exporting Firms	284	320	330	441	1,375
Manufacture of Artwork and Other Manufacturing	Average Export Proportion (%)	82.0	84.0	83.2	83.7	83.3
	Number of Exporting Firms	1,198	1,479	1,637	1,544	5,858
All Manufactures	Average Export Proportion (%)	52.8	55.1	55.2	56.7	55.1
	Number of Exporting Firms	19,401	21,136	23,839	26,347	90,723

Source: Authors' own calculation.

4 Methodology and model specification

To examine whether FDI may affect domestic firms' exports through either intra-sector or inter-sector channels, we start with a basic specification to explain the response of domestic firms' export value to the horizontal, upstream and downstream FDI presence at the industry level.

$$\begin{aligned}\ln \exp ort_{ijrt} = {} & \beta_0 + \beta_1 Horizontal_{jt} + \beta_2 Backward_{jt} + \beta_3 Forward_{jt} \\ & + \sum \alpha_r D_r + \sum \alpha_j D_j + \sum \alpha_t D_t + u_{ijrt}\end{aligned}, \tag{4}$$

where $\ln \exp ort_{ijrt}$ denotes the logarithm of export value of domestic firm i operating in sector j and region r at time t. $Horizontal_{jt}$ measures the export spillovers generated by FDI presence in the same sector j at time t, and $Backward_{jt}$ and $Forward_{jt}$ measure the export spillovers generated by FDI presence in the downstream and upstream sectors, respectively. Since all three variables are estimated with the data on firm-level capital stock (registered capital), no lags of those variables are required to be included in Equation (4). Finally, three groups of dummy variables, $\sum \alpha_r D_r$, $\sum \alpha_j D_j$ and $\sum \alpha_t D_t$, are used to control the regional, sectoral and time-specific effects, and u_{ijrt} is used to capture the random errors.

The problem is that the results of estimating Equation (4) would be biased because many firm level factors affect domestic firms' export behaviour and at the same time correlate with the industry-level FDI variables. For example, domestic firms with relatively higher productivity or lower capital–labour ratio are more likely to export their products to the international market (Melitz, 2003) while FDI is more likely to enter domestic firms with high productivity or lower capital–labour ratio through joint venture, merger and acquisition — the cherry-picking effect (Brambilla et al., 2009) — thus raising the industry-level FDI stock. Not considering the impact of those factors may lead to the

overestimation of the impact of FDI on domestic firms' exports. To deal with this problem, we introduce some control variables, so that Equation (4) can be written as Equation (5):

$$\begin{aligned}\ln \exp ort_{ijrt} &= \beta_0 + \beta_1 Horizontal_{jt} + \beta_2 Backward_{jt} + \beta_3 Forward_{jt} \\ &+ \beta_4 \Pr od_{ijrt} + \beta_5 \ln(K/L)_{ijrt} + \beta_6 \mathrm{OpenYear}_{\mathrm{ijrt}} + \beta_7 \mathrm{D_Scale}_{\mathrm{ijrt}} + \beta_8 RnD_{ijrt}, \quad (5) \\ &+ \beta_9 IFI_{ijrt} + \sum \alpha_r D_r + \sum \alpha_j D_j + \sum \alpha_t D_t + u_{ijrt}\end{aligned}$$

where $\Pr od_{ijrt}$ denotes domestic firms' total factor productivity (estimated by using the LP method as explained in Section 3), which is used to control the possible impact of productivity disparity across firms on their exporting behaviour (Melitz, 2003). $\ln(K/L)_{ijrt}$ denotes the log of capital–labour ratio at the firm level, which is used to control the impact of comparative advantage disparity across firms on their exporting behaviour (H–O model). $\mathrm{OpenYear}_{\mathrm{ijrt}}$, $\mathrm{D_Scale}_{\mathrm{ijrt}}$, RnD_{ijrt} and IFI_{ijrt} are firms' open year, a dummy variable for firms' scale, R&D index representing domestic firms' innovation ability, and indirect foreign investment, respectively.

The pooled OLS regression method can be applied to estimate Equation (5), but the estimated results could be biased due to two further econometric problems.

The first is that of endogeneity. It is widely believed that many unobserved time-invariant firm-specific factors, such as firms' entrepreneurship, local transportation and communication facilities, government policies and so on, affect domestic firms' export behaviour as well as affecting FDI inflows into the same, upstream and downstream sectors. Without considering these factors, the pooled OLS regression may lead to biased estimation of the impacts of FDI on domestic firms' export behaviour, even after controlling for firms' characteristics, such as productivity, capital–labour ratio and R&D. To deal with this problem, we adopt the first-differencing regression technique (FD) to eliminate the time-invariant firm-specific factors from the OLS regression and re-

examine the impact of FDI on domestic firms' export behaviour. Thus, Equation (5) can be re-arranged as:

$$\begin{aligned} d\ln export_{ijrt} &= \beta_0 + \beta_1 dHorizontal_{jt} + \beta_2 dBackward_{jt} + \beta_3 dForward_{jt} \\ &+ \beta_4 d\,\mathrm{Pr}od_{jrit} + \beta_5 d\ln(K/L)_{ijrt} + \beta_6 \mathrm{dD_Scale}_{\mathrm{ijrt}} + \beta_7 dOpenYear + \beta_8 dRnD_{ijrt}, \\ &+ \beta_9 dIFI_{ijrt} + \sum \alpha_r D_r + \sum \alpha_j D_j + \sum \alpha_t D_t + u_{ijrt} \end{aligned} \quad (6)$$

where $d(.)$ denotes the change of each variable over time and other variables are defined the same as in Equation (5).

The second econometric problem results from the truncated dependent variable. According to Melitz (2003), domestic firms choosing to export usually incur additional sunk costs, which are related to market research. Thus, domestic firms with exporting ability will not enter the international market if the profits from exporting behaviour cannot compensate for their loss. In China's manufacturing industries between 2000 and 2003, two-thirds of domestic firms were not exporting. Since those non-exporting domestic firms (i.e., their exports are all equal to zero) are not included in our regression, the change in their ability to export due to FDI inflows cannot be captured. Thus, both the OLS and FD regressions may underestimate the impact of FDI inflows on domestic firms' export behaviour. To deal with this sample selection problem, we adopt the Heckman two-step procedure (Wooldridge, 2002) to include the non-exporting domestic firms into our regression. The method is first to assume that domestic firms with similar characteristics may have similar exporting probabilities (although they may not do so owing to many other constraints), and then to estimate the inverse Mills ratio to capture the probability of both exporting and non-exporting firms choosing to export. Thus, FDI's impact on domestic firms' export behaviour can be estimated by regressing domestic exporting firms' exports with regard to the variables of FDI presence with the control of the Mills ratio. To fulfil this two-step procedure, a dummy variable representing whether domestic firms export or not in the base year (say, year 2000) — highly related to domestic firms' exporting choice but not related to their export amount — has been used in the first step to identify the two regressions. The above model is

summarised in Equation (7).

$$
\begin{aligned}
d\ln export_{ijrt} &= \beta_0 + \beta_1 dHorizontal_{jt} + \beta_2 dBackward_{jt} + \beta_3 dForward_{jt} \\
&+ \beta_4 d\ln(Prod_{ijrt}) + \beta_5 d\ln(KL_ratio)_{ijrt} + \beta_7 \mathrm{dD_Scale}_{ijrt} + \beta_8 dRnD_{ijrt} + \beta_9 dIFI_{ijrt}, \quad (7) \\
&+ \gamma dMills_{ijrt} + \sum \alpha_t D_t + v_{ijrt}
\end{aligned}
$$

where $Mills_{ijrt}$ is the Mills ratio, which has been estimated from the first-step probit model

$$
\begin{aligned}
P(y\,export_{ijrt} = 1 \mid export_{ijrt} > 0) &= \theta_0 + \theta_1 dHorizontal_{jt} + \theta_2 dBackward_{jt} + \theta_3 dForward_{jt} + \\
&\lambda D_Export_{ijr-t} + \theta_4 d\ln(Prod_{ijrt}) + \theta_5 d\ln(KL_ratio)_{ijrt} + \theta_7 \mathrm{dD_Scale}_{ijrt} + \theta_8 dRnD_{ijrt}, \quad (8) \\
&+ \theta_9 dIFI_{ijrt} + \sum \phi_t D_t + v_{ijrt}
\end{aligned}
$$

and D_Export_{ijr-t} is domestic firms' export status before year t used to identify the first-stage probit model for domestic firms' exports ($y\,export_{ijrt} = 0,1$) (Heckman, 1979; Wooldridge, 1995 and 2002; Christofides et al., 2003).

Equations (7) and (8) can provide consistent estimates on the impact of intra-sector and inter-sector FDI on domestic firms' export value, with the control of time-invariant firm-specific factors and the truncated dependent variable problems.

To investigate the impact of FDI on domestic firms' export propensity, we re-write Equations (5), (7) and (8) as:

$$
\begin{aligned}
\ln ratio_{ijrt} &= \beta_0 + \beta_1 Horizontal_{jt} + \beta_2 Backward_{jt} + \beta_3 Forward_{jt} \\
&+ \beta_4 Prod_{ijrt} + \beta_5 \ln(K/L)_{ijrt} + \beta_6 \mathrm{OpenYear}_{ijrt} + \beta_7 \mathrm{D_Scale}_{ijrt} + \beta_8 RnD_{ijrt} \quad (9) \\
&+ \beta_9 IFI_{ijrt} + \sum \alpha_r D_r + \sum \alpha_j D_j + \sum \alpha_t D_t + u_{ijrt}
\end{aligned}
$$

and

$$
\begin{aligned}
d\exp ratio_{ijrt} &= \beta_0 + \beta_1 dHorizontal_{jt} + \beta_2 dBackward_{jt} + \beta_3 dForward_{jt} \\
&+ \beta_4 d\ln(\Pr od_{ijrt}) + \beta_5 d\ln(KL_ratio)_{ijrt} + \beta_7 \mathrm{dD_Scale}_{\mathrm{ijrt}} + \beta_8 dRnD_{ijrt}, \\
&+ \beta_9 dIFI_{ijrt} + \gamma dMills_{ijrt} + \sum \alpha_t D_t + v_{ijrt}
\end{aligned}
\tag{10}
$$

where $Mills_{ijrt}$ is the Mills ratio, which has been estimated from the first-step probit model

$$
\begin{aligned}
P(y\exp ort_{ijrt} = 1 \mid \exp ort_{ijrt} > 0) &= \theta_0 + \theta_1 dHorizontal_{jt} + \theta_2 dBackward_{jt} + \theta_3 dForward_{jt} \\
&\lambda D_Export_{ijr-t} + \theta_4 d\ln(\Pr od_{ijrt}) + \theta_5 d\ln(KL_ratio)_{ijrt} + \theta_7 \mathrm{dD_Scale}_{\mathrm{ijrt}} + \theta_8 dRnD_{ijrt}, \\
&+ \theta_9 dIFI_{ijrt} + \sum \phi_t D_t + v_{ijrt}
\end{aligned}
\tag{11}
$$

and $\exp ratio_{ijrt}$ is domestic firm i's export propensity at time t and other variables are defined as the same as in Equations (7) and (8).

5 Empirical results: FDI and domestic firms' exports

We present the results under three headings — the impacts of FDI on all types on domestic firms export values and propensities, followed by results of the different effects of FDI firms according to their market orientation and extent of product differentiation.

The impact of FDI on domestic firms' export value and export propensity: all firms

Based on Equations (5) and (9), we use the OLS method with the adjustment for heteroscedasticity and cluster effects. As shown in Columns (1) and (3) of Table 4, FDI has a significant positive impact only on domestic firms' export value in the same sector. Only the elasticity with respect to the horizontal spillovers variable is significant at the 1 per cent level. In terms of export propensity, none of the elasticities of the spillovers variables are significant even at the 10 per cent level. Most of the estimated coefficients of the control variables are consistent with our expectations.

Table 4. Estimation Results for Domestic Firms' Export Value and Export Propensity: All Firms

	Export value		Export propensity	
	OLS	FD	OLS	FD
	(1)	(2)	(3)	(4)
Prod (TFP Index)	0.664***	0.117***	–0.016***	0.004***
	(0.137)	(0.031)	(0.003)	(0.001)
ln(K/L)	0.004	–0.035***	–0.010***	–0.003***
	(0.011)	(0.013)	(0.002)	(0.001)
Open Year	–0.870***	–	0.103***	–
	(0.065)	–	(0.005)	–
D_Scale	0.197***	–0.157***	0.126***	–0.023***
	(0.071)	(0.020)	(0.009)	(0.003)
RnD	0.012***	0.145**	–0.000	0.057***
	(0.001)	(0.065)	(0.000)	(0.007)
Inversed Mills Ratio	–0.600***	–0.249***	–0.229***	0.069***
	(0.022)	(0.030)	(0.011)	(0.007)
Within-firm FDI share	1.723***	1.218***	0.111***	0.102***
	(0.148)	(0.298)	(0.035)	(0.031)
Horizontal	2.074***	0.072	0.009	0.042***
	(0.610)	(0.247)	(0.083)	(0.013)
Backward	7.894*	0.927***	0.055	0.011
	(4.689)	(0.275)	(0.634)	(0.028)
Forward	0.930	0.196	0.188	–0.019
	(4.727)	(0.857)	(0.487)	(0.076)
Constant	–16.823***	0.053***	0.588***	0.004***
	(2.503)	(0.012)	(0.212)	(0.001)
Number of Observations	52,713	23,562	52,713	23,562
R^2	0.188	0.020	0.489	0.017

Note: For concision, regional, sectoral and time dummies are not reported, but they are controlled and jointly significant in each regression.
*** p<0.01, ** p<0.05, * p<0.1, and numbers in parentheses are standard error.
Source: Authors' own calculation.

OLS estimates are biased due to endogeneity. As we discussed in the previous section, there are many unobserved time-invariant firm-specific factors, which may positively relate to firms' export value, export propensity, and the horizontal, upstream and downstream FDI shares. To deal with this problem, we adopt the first differencing (FD) regression to eliminate the time-invariant firm-specific characteristics from our estimation. As shown in Columns (2) and (4) of Table 4, the estimated coefficients of FDI spillovers variables become smaller but most become more significant, which implies that the endogeneity problem does exist in our regression and tends to generate

overestimation. The negative significant coefficient of Mills ratio in the FD regression of domestic firms' export value and the positive significant coefficient of Mills ratio in the FD regression of domestic firms' export propensity also suggest that the sample selection problem does matter for the regression. Thus, the adjustment with the Heckman selection is appropriate.

After dealing with the endogeneity and the sample selection problems, our estimation results (Columns (2) and (4) of Table 4) show that FDI may raise domestic firms' export value in the upstream sector (i.e., a backward linkage). The estimated elasticity is 0.927 and is significant at the 1 per cent level. An explanation of this phenomenon is that the entry of FDI firms generates demand from the upstream industry, which in turn helps domestic firms improve and adjust production to be suitable to international markets. To secure high-quality inputs, downstream FDI firms may transfer technology to upstream domestic firms, thus improving the competitiveness of domestic firms and increasing export. However, FDI has no significant impact on domestic firms' export value in the same industry or in the downstream sector.

The impact of FDI on domestic firms' export propensity may only take place in the same sector but the magnitude of the impact is very small. The elasticity of domestic firms' export propensity to the horizontal spillovers variable is 0.042 and is significant at the 1 per cent level. The estimation results show that FDI has no significant impact on domestic firms' export propensity through backward and forward industrial linkages.

As for the control variables, domestic firms' export value and export propensity are negatively related to their capital–labour ratio and firms' operational scale. Domestic firms' export value and export propensity are positively related to firms' productivity and R&D activities, implying that FDI can also promote domestic firms' exports through their positive productivity spillovers. Finally, indirect foreign investment is a positive and statistically significant factor to both domestic firms' export value and export propensity.

The impact of FDI firms' market orientation on domestic firms' exports

One notable feature of FDI firms in China is the high propensity to export. During the period 2000 to 2003, the average export propensity of FDI firms was 42 per cent and in 10 of the 29 manufacturing industries FDI firms' export propensity exceeded 50 per cent. Therefore, it is important to investigate whether FDI firms' own export behaviour may affect domestic firms' exports.

We group FDI firms into non-exporting FDI firms (the current export revenue is equal to zero), exporting FDI firms (the current export revenue is more than zero), and high-exporting FDI firms (the export revenue is more than or equal to 50 per cent of the total revenue). Equations (1) to (3) are used to calculate the corresponding horizontal, backward and forward FDI spillovers variables for each group of FDI firms. The estimation results are shown in Tables 5 and 6.

The results show that non-exporting FDI is more likely to generate a positive impact on domestic firms' export value through a backward linkage than the exporting FDI and the high-exporting FDI. As shown in Table 5, the estimated elasticity of domestic firms' export value to the backward FDI spillovers variable for the non-exporting FDI is 6.085 and significant at the 1 per cent level, which is higher and more significant than those for the exporting FDI (1.653 and significant at the 10 per cent level) and the high-exporting FDI (2.579 and not significant at the 10 per cent level).

An explanation of this result is that FDI firms in China are highly engaged in the processing trade. In 2006, FDI firms accounted for 84 per cent and 85 per cent of China's total processing export and import, and processing export and import accounted for 80 per cent and 58 per cent of FDI firms' total export and import, respectively. The high-exporting FDI firms (with an export propensity of at least 50 per cent) are mainly engaged in processing export. They import almost all materials and intermediate inputs from overseas and export almost all the final products after processing and assembling in the special export-processing zones or duty-free zones specifically designed and created

for export-oriented FDI firms. As a result, they not only have no backward or forward industrial linkages with domestic firms but they also compete with domestic firms for the same products in the international markets. The ordinary exporting FDI firms, as more and more of them flow in, will increasingly source materials and intermediate inputs from domestic firms, which would improve productivity and adaptability of domestic firms in the upstream industry, thus improving their ability to export to the international markets.

Table 5. Estimation Results for Non-export, Export and High-export FDI on Domestic Firms' Export Value

	Non-exporting FDI		Exporting FDI		High exporting FDI	
	OLS	FD	OLS	FD	OLS	FD
Prod (TFP Index)	0.664***	0.121***	0.664***	0.114***	0.664***	0.115***
	(0.137)	(0.031)	(0.137)	(0.030)	(0.137)	(0.030)
ln(K/L)	0.004	–0.035***	0.004	–0.035***	0.004	–0.035***
	(0.011)	(0.013)	(0.011)	(0.013)	(0.011)	(0.013)
Open Year	–0.869***	–	–0.870***	–	–0.870***	–
	(0.065)	–	(0.066)	–	(0.066)	–
D_Scale	0.197***	–0.158***	0.199***	–0.157***	0.198***	–0.158***
	(0.071)	(0.020)	(0.071)	(0.020)	(0.071)	(0.020)
RnD	0.012***	0.146**	0.012***	0.145**	0.012***	0.145**
	(0.001)	(0.065)	(0.001)	(0.065)	(0.001)	(0.065)
Inversed Mills Ratio	–0.601***	–0.249***	–0.600***	–0.249***	–0.600***	–0.248***
	(0.022)	(0.029)	(0.022)	(0.030)	(0.022)	(0.029)
Within-firm FDI share	1.720***	1.219***	1.724***	1.215***	1.723***	1.219***
	(0.148)	(0.299)	(0.148)	(0.299)	(0.147)	(0.298)
Horizontal	–1.776	–0.558	1.072***	0.059	–1.363	0.021
	(1.306)	(0.795)	(0.312)	(0.272)	(2.459)	(1.303)
Backward	1.465	6.085***	3.049	1.653*	–4.204	2.579
	(10.530)	(2.173)	(3.746)	(0.869)	(10.486)	(5.451)
Forward	–6.374	1.329	35.946***	3.309	51.657***	10.688
	(6.435)	(1.970)	(6.446)	(4.107)	(6.749)	(8.209)
Constant	–15.961***	0.049***	–16.210***	0.053***	–16.083***	0.052***
	(2.590)	(0.014)	(2.524)	(0.012)	(2.524)	(0.013)
Number of Observations	52,713	23,562	52,713	23,562	52,713	23,562
R^2	0.187	0.020	0.188	0.020	0.188	0.020

Note: For concision, regional, sectoral and time dummies are not reported, but they are controlled and jointly significant in each regression.
*** p<0.01, ** p<0.05, * p<0.1 and numbers in parentheses are standard error.
Source: Authors' own calculation.

Exporting FDI and high-exporting FDI are more likely to generate positive impacts on domestic firms' export propensity in the same industry than are non-exporting FDI. As

shown in Table 6, the estimated elasticity of domestic firms' export propensity to the horizontal FDI spillovers variable for the high-exporting FDI is 0.248 and significant at the 5 per cent level, which is higher than for the exporting FDI (0.062 and significant at the 1 per cent level) and for the non-exporting FDI (–0.110 and not significant at the 10 per cent level).

Table 6. Estimation Results for Non-export, Export and High-export FDI on Domestic Firms' Export Propensity

	Non-exporting FDI		Exporting FDI		High-exporting FDI	
	OLS	FD	OLS	FD	OLS	FD
Prod (TFP Index)	–0.016***	0.005***	–0.016***	0.004***	–0.016***	0.004***
	(0.003)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)
ln(K/L)	–0.010***	–0.003***	–0.010***	–0.003***	–0.010***	–0.003***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Open Year	0.103***	–	0.103***	–	0.103***	–
	(0.005)	–	(0.005)	–	(0.005)	–
D_Scale	–0.126***	–0.023***	–0.127***	–0.023***	–0.126***	–0.023***
	(0.009)	(0.003)	(0.009)	(0.003)	(0.009)	(0.003)
RnD	–0.000	0.057***	–0.000	0.057***	–0.000	0.057***
	(0.000)	(0.007)	(0.000)	(0.007)	(0.000)	(0.007)
Inversed Mills Ratio	–0.229***	0.069***	–0.229***	0.069***	–0.229***	0.069***
	(0.011)	(0.007)	(0.011)	(0.007)	(0.011)	(0.007)
Within-firm FDI share	0.111***	0.101***	0.111***	0.102***	0.110***	0.101***
	(0.035)	(0.031)	(0.034)	(0.031)	(0.034)	(0.031)
Horizontal	0.452***	–0.110	–0.117***	0.062***	0.027	0.248**
	(0.141)	(0.068)	(0.039)	(0.018)	(0.257)	(0.122)
Backward	–0.620	0.308	–0.332	0.017	–3.244***	0.797
	(1.045)	(0.198)	(0.508)	(0.059)	(1.154)	(0.655)
Forward	0.735	0.559*	0.789	–0.057	1.115	1.874**
	(0.703)	(0.290)	(0.721)	(0.492)	(0.844)	(0.755)
Constant	0.566***	0.003***	0.605***	0.004***	0.599***	0.002**
	(0.212)	(0.001)	(0.214)	(0.001)	(0.214)	(0.001)
Number of Observations	52,713	23,562	52,713	23,562	52,713	23,562
R^2	0.489	0.018	0.489	0.018	0.489	0.018

Note: For concision, regional, sectoral and time dummies are not reported, but they are controlled and jointly significant in each regression.
*** p<0.01, ** p<0.05, * p<0.1 and numbers in parentheses are standard error.
Source: Authors' own calculation.

There is some evidence of a positive impact on domestic firms' export propensity from high-exporting FDI and non-exporting FDI through forward industrial linkages. The estimated elasticity of domestic firms' export propensity to the forward FDI spillovers

variable for the high-exporting FDI is 1.874 and significant at the 5 per cent level and for the non-exporting FDI it is 0.559 and significant at the 10 per cent level. The results suggest that the positive impact of FDI on domestic firms' export propensity is mainly in the same industry through the demonstration effects, although there is some evidence of positive impacts of FDI on domestic firms' export propensity through forward industrial linkages.

The impact of FDI firms' product differentiation on domestic firms' exports

To investigate the impact of FDI firms' product differentiation on domestic firms' exports, based on Rauch (1999) we classify FDI firms into two categories: FDI firms producing homogenous (organised exchange) products and FDI firms producing heterogeneous (differentiated) products.[4] Equations (1) to (3) are used to calculate the corresponding horizontal, backward and forward FDI spillovers variables for the two groups of FDI firms. In doing so, we matched between the Chinese Industrial Classification Code (CICC) (for FDI firms) and the SITC Revision 2 (for Rauch's classification) by using Rauch's conservative classification in the concordance table (obtained from Jon Haveman's International Trade database http://www.macalester.edu/research/economics/page/haveman/trade.resources/tradedata.html#Rauch). According to this concordance table, each product at the 4-digit level SITC Revision 2 is linked to one of the two categories, including the products traded on an organized exchange (homogeneous products) and the differentiated products (heterogeneous products).

Generally, it might be expected that FDI firms producing heterogeneous products are more likely to generate positive spillovers to upstream and downstream industries. However, since most FDI firms in China producing heterogeneous products are also engaged in the processing trade, the empirical results can be ambiguous.

[4] We dropped the category of reference priced products in Rauch's classification from our regression exercise.

As shown in Table 7, FDI firms producing heterogeneous products generally have no significant impact on domestic firms' export value in either the same industry or in upstream and downstream industries (although they are positive), while FDI firms producing homogeneous products may have a positive and significant impact on domestic firms' export value in the downstream industry (forward linkage). This is because most FDI firms producing heterogeneous products are concentrated in the processing industries and are engaged in the processing trade, which purchases materials and intermediate inputs from overseas and sells its products to the international markets, thus having little industrial linkages with domestic firms.

Table 7. Impacts of FDI Producing Homogenous and Heterogeneous Products on Domestic Firms' Export Value

	Homogenous products		**Heterogeneous products**	
	OLS	**FD**	**OLS**	**FD**
Prod (TFP Index)	0.664***	0.113***	0.664***	0.115***
	(0.137)	(0.031)	(0.137)	(0.031)
ln(K/L)	0.004	–0.035***	0.004	–0.035***
	(0.011)	(0.013)	(0.011)	(0.013)
Open Year	–0.869***	–	–0.870***	–
	(0.065)	–	(0.066)	–
D_Scale	0.196***	–0.156***	0.198***	–0.158***
	(0.071)	(0.020)	(0.071)	(0.020)
RnD	0.012***	0.144**	0.012***	0.145**
	(0.001)	(0.065)	(0.001)	(0.065)
Inversed Mills Ratio	–0.601***	–0.250***	–0.600***	–0.247***
	(0.022)	(0.029)	(0.022)	(0.029)
Within-firm FDI share	1.721***	1.215***	1.723***	1.220***
	(0.148)	(0.299)	(0.148)	(0.298)
Horizontal	–0.370	0.697	0.164	0.020
	(0.539)	(0.480)	(0.108)	(0.065)
Backward	–9.201	–1.285	0.379	0.517
	(8.599)	(4.328)	(0.996)	(0.726)
Forward	7.429	3.961*	3.716***	0.659
	(4.530)	(2.157)	(0.759)	(0.661)
Constant	–16.063***	0.055***	–16.091***	0.049***
	(2.525)	(0.012)	(2.524)	(0.015)
Number of Observations	52,713	23,562	52,713	23,562
R^2	0.187	0.020	0.188	0.020

Note: For concision, regional, sectoral and time dummies are not reported, but they are controlled and jointly significant in each regression.
*** p<0.01, ** p<0.05, * p<0.1 and numbers in parentheses are standard error.
Source: Authors' own calculation.

As for the impact of FDI firms producing different products on domestic firms' export propensity, as shown in Table 8, FDI firms producing heterogeneous products are more likely to generate a positive impact on domestic firms' export propensity in the same industry through demonstration effects while FDI firms producing homogeneous products are more likely to generate a positive impact on domestic firms' export propensity through backward linkages.

Table 8. Impacts of FDI Producing Homogenous and Heterogeneous Products on Domestic Firms' Export Propensity

	Homogenous products		**Heterogeneous products**	
	OLS	**FD**	**OLS**	**FD**
Dependent variable: lnexport				
Prod (TFP Index)	–0.016***	0.005***	–0.016***	0.005***
	(0.003)	(0.001)	(0.003)	(0.001)
ln(K/L)	–0.010***	–0.003***	–0.010***	–0.003***
	(0.002)	(0.001)	(0.002)	(0.001)
Open Year	0.103***	–	0.103***	–
	(0.005)	–	(0.005)	–
D_Scale	–0.126***	–0.023***	–0.126***	–0.023***
	(0.009)	(0.003)	(0.009)	(0.003)
RnD	–0.000	0.057***	–0.000	0.057***
	(0.000)	(0.007)	(0.000)	(0.007)
Inversed Mills Ratio	–0.229***	0.069***	–0.229***	0.069***
	(0.011)	(0.007)	(0.011)	(0.007)
Within-firm FDI share	0.111***	0.101***	0.111***	0.101***
	(0.035)	(0.031)	(0.034)	(0.031)
Horizontal	0.042	0.008	–0.007	0.028***
	(0.088)	(0.032)	(0.016)	(0.005)
Backward	4.045***	1.549**	–0.179	0.083
	(1.389)	(0.604)	(0.125)	(0.056)
Forward	–0.028	–0.206	0.181*	0.002
	(0.503)	(0.261)	(0.108)	(0.043)
Constant	0.589***	0.004***	0.597***	0.002*
	(0.212)	(0.001)	(0.214)	(0.001)
Number of Observations	52,713	23,562	52,713	23,562
R^2	0.489	0.017	0.489	0.018

Note: For concision, regional, sectoral and time dummies are not reported, but they are controlled and jointly significant in each regression.
*** p<0.01, ** p<0.05, * p<0.1 and numbers in parentheses are standard error.
Source: Authors' own calculation.

The impact of firm ownership on export spillovers from FDI

The last question is what ownership type of domestic firms is more likely to receive export spillovers from FDI firms. To answer this question, we divide our sample of domestic firms into two categories based on their ownership: one is the state-owned enterprises (SOEs) (defined as the share of capital owned by state and collective groups being more than 50 per cent) and the other is the non-state-owned enterprises (non-SOEs). The estimated results are shown in Tables 9 and 10.

Table 9. Impact of FDI on Domestic Firms' Export Value: SOEs vs. Non-SOE Firms

	SOEs		Non-SOEs	
	OLS	**FD**	**OLS**	**FD**
Prod (TFP Index)	0.757***	0.099**	0.594***	0.125***
	(0.139)	(0.040)	(0.144)	(0.035)
ln(K/L)	0.005	–0.028	0.005	–0.039***
	(0.020)	(0.027)	(0.010)	(0.012)
Open Year	–0.838***	–	–0.900***	–
	(0.072)	–	(0.066)	–
D_Scale	0.690***	–0.087**	–0.004	–0.171***
	(0.123)	(0.034)	(0.065)	(0.025)
RnD	0.011***	0.038	0.011***	0.179***
	(0.002)	(0.146)	(0.001)	(0.068)
Inversed Mills Ratio	–0.590***	–0.224***	–0.609***	–0.250***
	(0.035)	(0.051)	(0.023)	(0.035)
Within-firm FDI share	1.481***	1.277**	1.839***	1.174***
	(0.284)	(0.516)	(0.178)	(0.376)
Horizontal	4.101***	0.309	1.074*	0.018
	(0.995)	(0.464)	(0.640)	(0.275)
Backward	9.453	0.348	3.755	1.134***
	(6.115)	(1.072)	(4.475)	(0.243)
Forward	5.077	–0.197	1.568	0.131
	(5.686)	(1.732)	(3.264)	(0.943)
Constant	–15.211***	–0.013	–13.555***	0.072***
	(3.431)	(0.018)	(2.306)	(0.014)
Number of Observations	14,317	6,495	38,395	17,067
R^2	0.224	0.011	0.179	0.023

Note: For concision, regional, sectoral and time dummies are not reported, but they are controlled and jointly significant in each regression.
*** p<0.01, ** p<0.05, * p<0.1 and numbers in parentheses are standard error.
Source: Authors' own calculation.

Comparing the estimation results from the two datasets, we find that the impact of FDI on domestic non-SOEs is much stronger than on domestic SOEs. The estimated backward impact of FDI to domestic firms' export value and the horizontal impact of FDI to domestic firms' export propensity for the two groups are 1.134 and 0.05 (significant at the 5 per cent level) for non-SOEs, which are larger than 0.348 (not significant at the 10 per cent level) and 0.03 (significant at the 10 per cent level) for SOEs, respectively. This result implies that FDI's impact on domestic firms' exports is mainly transferred through their impact on domestic private firms.

Table 10. Impact of FDI on domestic firms' export propensity: SOEs vs. non-SOE firms

	SOEs		Non-SOEs	
	OLS	**FD**	**OLS**	**FD**
Prod (TFP Index)	–0.008***	0.005***	–0.021***	0.003
	(0.002)	(0.001)	(0.004)	(0.002)
ln(K/L)	–0.003***	–0.002**	–0.013***	–0.003***
	(0.001)	(0.001)	(0.002)	(0.001)
Open Year	0.079***	–	0.111***	–
	(0.005)	–	(0.004)	–
D_Scale	–0.101***	–0.019***	–0.134***	–0.024***
	(0.011)	(0.003)	(0.009)	(0.003)
RnD	–0.000***	0.026**	0.000	0.070***
	(0.000)	(0.012)	(0.000)	(0.008)
Inversed Mills Ratio	–0.176***	0.057***	–0.257***	0.077***
	(0.010)	(0.007)	(0.012)	(0.008)
Within-firm FDI share	0.124***	0.132*	0.114***	0.088**
	(0.039)	(0.070)	(0.043)	(0.045)
Horizontal	0.029	0.030*	0.004	0.050**
	(0.068)	(0.016)	(0.087)	(0.020)
Backward	–0.175	0.029	–0.016	–0.006
	(0.514)	(0.033)	(0.678)	(0.036)
Forward	–0.306	–0.025	0.531	–0.037
	(0.502)	(0.066)	(0.530)	(0.106)
Constant	1.121***	–0.000	0.219	0.006***
	(0.188)	(0.001)	(0.250)	(0.001)
Number of Observations	14,317	6,495	38,395	17,067
R^2	0.444	0.018	0.508	0.019

Note: For concision, regional, sectoral and time dummies are not reported, but they are controlled and jointly significant in each regression.
*** p<0.01, ** p<0.05, * p<0.1 and numbers in parentheses are standard error.
Source: Authors' own calculation.

6 Conclusion

Using the firm-level census data of manufacturing industries during the period 2000 to–2003, this paper examines the impact of FDI on domestic firms' export in China. Spillovers to productivity from FDI has been studied in some depth in the literature but there is less work done on the effects of FDI on export performance.

We find that FDI firms have a positive impact on the export value of domestic firms in the upstream industries through backward linkages and a positive impact on the export propensity of domestic firms in the same industry through demonstration effects.

We further find that the positive impact on the export value of domestic firms through backward linkages is mainly from the non-exporting FDI firms and is mainly to domestic non-state-owned enterprises.

The positive impact on the export propensity of domestic firms in the same industry through demonstration effects is mainly from the exporting FDI firms and FDI firms producing heterogeneous products and is also mainly to domestic non-state-owned enterprises.

We also find that FDI firms producing homogeneous products generate positive export spillovers to domestic firms in the downstream industries through forward linkage, meaning that domestic firms can get intermediate inputs of good quality and at low prices from upstream FDI firms producing homogeneous products. Thus, domestic firms can reduce their production costs, improve competitiveness and increase export.

Our study does not find significant evidence that high-exporting FDI firms and FDI firms producing heterogeneous products generate export spillovers to domestic firms through either backward or forward industrial linkages. An explanation is that FDI firms with high export propensity and producing heterogeneous products are mainly engaged in the

processing trade. Because they are concentrated in the special processing zones and the import duty-free zones specifically designed for export-oriented FDI firms and they import almost all their materials and intermediate inputs from overseas and export the processed and assembled products abroad, they have no or at most marginal backward and forward industrial linkages with domestic firms. We note that governments sometimes promote FDI flows in order to have spillover benefits to domestic firms. Our finding is that if the concern is export performance, then not all FDI has the same impact.

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Appendix Table 1, Estimation Results from the Probit Model in the First Stage: 2001–2003

	2001	2002	2003
Dependent variable: D_Export			
Prod (TFP Index)	0.134***	0.042*	0.059***
	(0.029)	(0.021)	(0.016)
ln(K/L)	–0.033***	–0.051***	–0.066***
	(0.007)	(0.006)	(0.005)
Open Year	0.002**	0.006***	0.011***
	(0.001)	(0.001)	(0.001)
D_Scale	–0.374***	–0.300***	–0.421***
	(0.024)	(0.022)	(0.021)
RnD	0.606***	0.628***	0.550***
	(0.055)	(0.046)	(0.047)
Firm FDI Share	1.728***	1.659***	1.416***
	(0.239)	(0.219)	(0.223)
Previous Exporting Experience (ID Variable)	2.672***	3.092***	3.476***
	(0.018)	(0.020)	(0.023)
Constant	–5.180***	–13.313***	–23.651***
	(1.181)	(1.093)	(1.138)
Sector Dummies	Yes	Yes	Yes
Region Dummies	Yes	Yes	Yes
LR Chi2(61)	43972.27	52173.04	55188.1
Pseudo R-squared	0.630	0.572	0.568
Number of Observations	70076	88519	70076

Note: For concision, regional, sectoral and time dummies are not reported, but they are controlled and jointly significant in each regression.
*** p<0.01, ** p<0.05, * p<0.1 and numbers in parentheses are standard error.
Source: Authors' own calculation.