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Research on How FDI Spillovers Effect Technology Contents of Manufacturing Exports-Firm-level Evidence from Listed Manufacturing Companies of China

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Abstract: The study explored the impact of spillovers from foreign direct investment (FDI) on technology contents of manufacturing exports using firm-level panel datasets from listed manufacturing companies of China covering 2000-2015 periods. The paper evaluated horizontal and vertical spillovers from FDI and constructed a panel data model to make an empirical analysis. The results show that the effect of horizontal spillovers on technological contents of manufacturing exports is weak and depressive, the effect of forward spillovers, backward spillovers and R&D investing ratio on technological contents of manufacturing exports are all positive. While that of capital labor ratio is significant negative. Listed manufacturing companies of China should pay more attention on high quality FDI and R&D investment.
Keywords: FDI horizontal spillovers, FDI vertical spillovers, Subindustry of China's manufacturing, Technology contents of manufacturing exports.

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1. INTRODUCTION

Foreign direct investment (FDI) has been one of the main ways of international capital flows driven by international companies with larger scope and quantities. Encouraging FDI engage in manufacturing industries has been widely utilized by listed companies of China in order to join in global production network and improve international competiveness. China's government encourages to import foreign capital for decades. Its amount of foreign capital actually utilized has been up to 126.27 billion dollars in 2015, increasing 6.4% compared to 2014. And manufacturing industry accounted for 31.3% of China's total amount (China's Ministry of Commerce, 2016). FDI makes a great impact on China's manufacturing industry. Spillovers from FDI may help host countries create a comparative advantage and enhance the competiveness of local companies.

FDI may affect exports competiveness of domestic firms. Firstly, it could strengthen the core competiveness of local companies by spillovers. There is an important precondition of

effective spillovers is that the companies are skill-intensive or technology (Sjoholm, 1999). Secondly, FDI could help a host country gain more revenue from foreign companies (the precondition is tax rate has no decrease) through economics of scale and externality. Especially for those local firms who take effective actions to enhance their competiveness (MacDougall, 1996). On the one hand, spillovers from FDI have positive effects. Foreign investing may help improve labor productivity of local firms by the way of improving allocative efficiency, technology efficiency and technology transfer (Cave, 1974). Empirical literature on manufacturing industries of Canada and Mexico shows that international companies have positive spillovers on host countries productivity, using industry data (Globerman, 1979; Blomsorm, Persson, 1983). There is a positive correlation between FDI and productivity of local small firms which accepted foreign capital in Venezuela (Aitken, Harrison, 1999). FDI may compel technology improvement of domestic firms through strengthen the competiveness (Zhang, 2005). Yang (2007) also finds that FDI through back-linkage positively promotes productivity of local suppliers using industry-level data from Guangdong Province of China. Similarly, spillovers from FDI could stimulus and promote productivity in the region as well as other relevant regions (Xie, Zhou, 2009; Wooster, Diebel, 2010; Zhong, 2010). Foreign R&D investing could positively promote indigenous innovation based on dynamic dataset that covers 30 Chinese provinces over the 1998-2008 period (Cao, Li, 2012).

But some other literatures based on different regions or methods have opposite conclusions. Inputting FDI didn't significantly improve technology of host countries, analyzing the relationship between FDI and international technology diffusion with data from 13 countries in 1970-1990 periods (Lichtenberg, Pottelsberghe, 1996). The effect of spillovers may relevant with form of foreign investing on the base of researching firm-level data of Czech's manufacturing. If the companies are invested by foreign and domestic capital, the spillovers are negative; if the companies are invested only by foreign capital, the spillovers are not significant (Djankov, Hoekman, 2000). Bao and Lai (2002) find FDI promote the technology development of host country but has no significant spillovers effects on local firms with growth model analysis. Eventually, Ping (2007) find large amount of foreign investing does not reduce gap between host firms with international companies but decrease indigenous innovation. Without considering effects caused by policy, the impact of FDI on total factor productivity of domestic enterprises is not significant or even negative (Jiang, Zhang, 2008).

As discussed earlier, there are no unified conclusions because of differences on methods, data, levels (firm, region, country and so on) and time, et al. The paper chooses representative listed companies which belong to core industry-manufacturing of China to confirm that how spillovers from FDI make effects on exports technology contents. The results would help most Chinese firms to find their right way to introduce foreign investing.

This paper is organized as follows. Section 2 makes a focus on evaluation of spillovers from FDI to research on its exit in manufacturing. Section 3 calculates exports technology contents. Section 4 makes an empirical discuss on the relationship between FDI spillovers and exports technology contents. Section 5 makes a summary and gives some feasible suggestions.

2. EVALUATION OF SPILLOVERS FROM FDI

2.1 Methodology

The paper sets three specific indexes - $HORI_{it}$, FOR_{it} & $BACK_{it}$ to calculate horizontal and vertical spillovers according to literatures on methods and indexes used to calculate FDI spillovers.

$HORI_{it}$ is data of horizontal spillovers, FOR_{it} means data of forward spillovers, $BACK_{it}$ means data of backward spillovers and i represents subindustry of manufacturing.

This paper use $HORI_{it}$ represents horizontal spillovers of industry i in the t year. Horizontal spillovers are spillovers from products transfer or labor movement in the same industry. That is to say, HORI could provide technology spillover condition of intra industries. The formula is as below:

$$\mathrm{HORI}_{\mathrm{it}} = FTC_{it} / TC_{it}$$

FTC_{it} means total foreign capital of industry i in the t year, TC_{it} means total capital of industry i in the t year.

The higher the HORI is, the higher of spillovers from FDI.

There may also be vertical spillovers within the supply chain when upstream industries provide better intermediate materials for their producer customers or when they transfer knowledge to their suppliers for better quality final products. Vertical spillovers include forward spillovers (FOR) and backward spillovers (BACK) because of different roles. Input-output table of China could help construct the two indexes.

FOR_{it} is used to evaluate spillovers created by upriver companies transfer high-quality products to downriver companies of host country. Reference to Schoors and Tool's (2002) method, FOR is defined sum of weighted-value of all foreign capitals which are from upriver industries. The equation is as shown below.

$$FOR_{it} = \sum_{l, l \neq i} \left(\alpha_{\mathrm{li}} \times HORI_{it} \right)$$

α_{li} is proportion of semi-products that downstream companies buy from upstream companies. It represents each unit output of downstream industry i consumes how many or how much semi-products provided by upstream industry l directly. Input-output table of China provides relevant data. Besides, horizontal spillovers covers intra industries' condition, so the progress needs to get rid of the condition that l=i. It means α_{li} rejects the condition that industry i/l buy semi-products in the same industry i/l. $HORI_{it}$ is proportion of foreign investing occupies in total capital. If FOR_{it} has positive effects on exports' technology contents, it will prove that significant forward spillovers exist in the industries which are researched.

$BACK_{it}$ is backward spillovers of FDI. It is used to evaluate spillovers that foreign capital of downstream industries caused to upstream industries. Reference to Blalock's (2001) definition,

it is a sum of weighted-value of foreign capitals which are from downstream industries. The equation is as follows.

$$BACK_{it} = \sum_{m,m\neq i} \left(\lambda_{im} \times \mathrm{HORI}_{mt} \right)$$

λ_{im} is output proportion that upstream industries supply to downstream industries. It represents each unit output of downstream industry m consumes how many or how much semi-products provided by upstream industry i directly. Input-output table of China supplies relevant data directly. As the same with FOR_{it}, the process need to get rid of condition that m=i. Apparently, higher foreign capital proportion of downstream industries is, higher proportion of semi-products provides by industry i, and bigger $BACK_{it}$ which means significant backward spillovers.

The coefficient λim of variable BACKit is a element in direct consumption coefficient matrix. The paper sets coefficient λim matrix as A. The coefficient α_{li} of variable FORit is element in transpose matrix of direct consumption coefficient matrix. The paper sets coefficient α_{li} as D. so D=AT. Getting rid of condition in intra industry, elements in diagonal of matrix A and D are all zero. Both backward spillovers and forward spillovers could show in matrix. As shown in the next two equations.

$$BACK = A \times HORI$$
$$FOR = D \times \mathrm{HORI} = \mathrm{A}^{\mathrm{T}} \times \mathrm{HORI}$$

2.2 Definition of Industry and Data

Considering data availability and research validation, all data is from Wind data-base. The paper use data of manufacturing companies listed in Shanghai and Shenzhen to research and all results are on the basic of this. The paper sets total market value of subindustry i on December 31th in year t as total capital of subindustry i in the year t and total market value of B share, Hongkong and foreign shares on December 31th in year t as foreign capital of subindustry i in the year t.

The paper assumes structures of manufacturing subindustries would have no large changes. It is the relationship among these subindustries has no change in the periods 2001-2015. We use "China's input-output direct consumption coefficient table of 2012" to create relationship among these subindustries. Table 1 shows classification of manufacturing subindustries.

Table 1. Subindustry Code and Name of Manufacturing

Code	Name
C0	Food , Beverages and Tobacco Manufacturing
C1	Textile, Apparel and Fur Manufacturing
C2	Wood and Furniture Manufacturing
C3	Papermaking and Printing Manufacturing
C4	Petroleum, Chemical and Plastic Manufacturing
C5	Electronic and Communication Manufacturing
C6	Metal and Non-metal Manufacturing
C7	Machinery, Equipment and Instrument Manufacturing
C8	Pharmaceutical and Biological Manufacturing
C99	Other Manufacturing

Data source: http://www.law-lib.com/law/law_view.asp?id=402067

Note: Before 2012, manufacturing covers 10 subindustries which is defined by China Securities Regulatory Commission (CSRC). After 2012, according to < Guidance on industry classification of listed companies (revised in 2012) > released by CSRC, manufacturing includes 31 subindustries, the same with Classification of National Economy. For consistency, the writer sort 31subindustries into 10 subindustries (the same with 2001-2012) to calculate.

2.3 Evaluation and Result of Spillovers of FDI

Table 2 shows statistical descriptions of variables HORI, FOR, BACK.

Table 2. Statistical Description

	N	Minimum	Maximum	Average	Standard deviation
HORI	135	.0088436	.5974117	.072673122	.0618912219
FOR	135	.0019582	.0917505	.029617525	.0228116135
BACK	135	.0016976	.0961758	.029241221	.0265932579
N validation(listed)	135				

Horizontal spillovers from FDI are calculated with data from Wind and showed in table 3.

Table 3 reports that spillovers among manufacturing subindustries are positive because of index above 0. However, the spillover is not significant as indexes are below 0.5 even below 0.1.

Year average shows that change extent is not very big in 2001-2015. The highest data is 0.1303 in 2008, and the lowest data is 0.0298 in 2015. There is a decline trend begins from 2015. The mainly reason is the growth speed of foreign investing lower than whole capital. Spillovers decrease because that listed manufacturing companies of China with little foreign investing increased quickly after 2008. By analyzing HORI and raw data of 2008, C99's index is relatively higher than other years and C99's total capital decrease largely but foreign investing

has no big change. Looking at data of subindustries, HORI of C3 is higher than others with a trend of decrease. Its HORI is above 0.1 in the period 2001-2009 and keep highest of all subindustries in 2001-2007. HORI of C8 is lower than others may because listed medicine manufacturing and biological manufacturing companies are rare provide products to each other.

The paper calculates forward and backward spillovers separately with the method discussed earlier. Specific data is shown separately in table 4 and 5. All the indexes are below 0.5, and most of them are below 0.1, what indicates that vertical spillovers of manufacturing subindustries are also indistinctive.

Table 3. 2001-2015 Horizontal spillovers from FDI (HORI)

	2001	2002	2003	2004	2005	2006	2007	2008
C0	0.0369	0.0397	0.0536	0.0585	0.0837	0.0653	0.0553	0.0661
C1	0.0872	0.0898	0.1063	0.0962	0.0993	0.0954	0.1069	0.0711
C3	0.1317	0.1455	0.1833	0.1677	0.1640	0.1236	0.1022	0.1402
C4	0.0566	0.0595	0.0855	0.0743	0.0773	0.0659	0.0472	0.0429
C5	0.0711	0.0592	0.0609	0.0787	0.0747	0.0706	0.0722	0.0633
C6	0.0805	0.0898	0.1063	0.1106	0.1203	0.1036	0.1124	0.1027
C7	0.0895	0.0885	0.0952	0.0902	0.0901	0.0938	0.0702	0.0760
C8	0.0343	0.0298	0.0259	0.0234	0.0272	0.0178	0.0171	0.0131
C99	0.0805	0.0700	0.0577	0.0966	0.1317	0.1063	0.0938	0.5974
AVG	0.0743	0.0747	0.0861	0.0885	0.0965	0.0825	0.0753	0.1303

(continued)

	2009	2010	2011	2012	2013	2014	2015	AVG
C0	0.0613	0.0541	0.0595	0.0466	0.0480	0.0378	0.0254	0.0528
C1	0.0612	0.0403	0.0372	0.0372	0.0485	0.0347	0.0230	0.0690
C3	0.1027	0.0847	0.0692	0.0587	0.0433	0.0401	0.0290	0.1057
C4	0.0396	0.0285	0.0243	0.0233	0.0190	0.0178	0.0131	0.0450
C5	0.0541	0.0275	0.0287	0.0238	0.0201	0.0175	0.0141	0.0491
C6	0.0976	0.1010	0.0912	0.0874	0.0839	0.0727	0.0560	0.0944
C7	0.0652	0.0581	0.0585	0.0665	0.0670	0.0586	0.0479	0.0744
C8	0.0133	0.0111	0.0088	0.0153	0.0157	0.0153	0.0107	0.0186
C99	0.2406	0.1541	0.2394	0.0913	0.0905	0.0773	0.0493	0.1451
AVG	0.0817	0.0622	0.0686	0.0500	0.0484	0.0413	0.0298	0.0727

Table 4. Forward Spillovers in 2001-2015 (FOR)

	2001	2002	2003	2004	2005	2006	2007	2008
C0	0.0057	0.0058	0.0071	0.0068	0.0072	0.0063	0.0059	0.0079
C1	0.0059	0.0055	0.0057	0.0071	0.0086	0.0072	0.0064	0.0250
C3	0.0109	0.0117	0.0146	0.0144	0.0156	0.0134	0.0127	0.0140
C4	0.0390	0.0384	0.0416	0.0456	0.0509	0.0443	0.0429	0.0918
C5	0.0605	0.0589	0.0618	0.0595	0.0626	0.0578	0.0479	0.0599
C6	0.0439	0.0402	0.0411	0.0454	0.0480	0.0437	0.0381	0.0719
C7	0.0530	0.0470	0.0479	0.0549	0.0563	0.0484	0.0486	0.0547
C8	0.0754	0.0708	0.0759	0.0819	0.0818	0.0792	0.0702	0.0802
C99	0.0096	0.0101	0.0119	0.0121	0.0132	0.0115	0.0116	0.0107
AVG	0.0338	0.0320	0.0342	0.0364	0.0382	0.0347	0.0316	0.0462

(continued)

	2009	2010	2011	2012	2013	2014	2015	AVG
C0	0.0054	0.0040	0.0042	0.0033	0.0033	0.0027	0.0020	0.0052
C1	0.0114	0.0079	0.0109	0.0054	0.0052	0.0045	0.0031	0.0080
C3	0.0117	0.0107	0.0101	0.0090	0.0085	0.0074	0.0056	0.0114
C4	0.0513	0.0383	0.0456	0.0299	0.0299	0.0253	0.0181	0.0422
C5	0.0463	0.0402	0.0406	0.0425	0.0425	0.0377	0.0294	0.0499
C6	0.0432	0.0301	0.0358	0.0270	0.0263	0.0232	0.0175	0.0384
C7	0.0418	0.0278	0.0285	0.0252	0.0235	0.0210	0.0157	0.0396
C8	0.0628	0.0468	0.0486	0.0459	0.0442	0.0386	0.0308	0.0622
C99	0.0099	0.0093	0.0086	0.0083	0.0081	0.0069	0.0053	0.0098
AVG	0.0315	0.0239	0.0259	0.0218	0.0213	0.0186	0.0142	0.0296

According to average number of table 4, spillovers effects of downstream companies created by upstream companies providing semi-products varies not very big. The highest number is 0.0462 of 2008 and decrease to 0.0142 in 2015. It is upstream companies with foreign investing does not play the role of increasing spillovers effect. C8's forward spillovers are the highest of all subindustries, which means other subindustries companies with foreign investing provide high-tech products to C8 with relatively high spillovers. The forward spillovers of C0 is the lowest because its industry nature.

Table 5. Backward Spillovers in 2000-2015 (BACK)

	2001	2002	2003	2004	2005	2006	2007	2008
C0	0.0039	0.0038	0.0044	0.0047	0.0054	0.0045	0.0040	0.0105
C1	0.0081	0.0082	0.0107	0.0102	0.0113	0.0096	0.0075	0.0120
C3	0.0048	0.0047	0.0056	0.0056	0.0059	0.0052	0.0045	0.0050
C4	0.0151	0.0159	0.0191	0.0187	0.0196	0.0159	0.0143	0.0211
C5	0.0702	0.0697	0.0755	0.0730	0.0770	0.0704	0.0609	0.0653
C6	0.0353	0.0348	0.0401	0.0410	0.0436	0.0368	0.0310	0.0660
C7	0.0627	0.0579	0.0616	0.0683	0.0707	0.0610	0.0617	0.0602
C8	0.0851	0.0817	0.0897	0.0954	0.0962	0.0918	0.0832	0.0856
C99	0.0200	0.0208	0.0256	0.0245	0.0257	0.0227	0.0212	0.0188
AVG	0.0339	0.0331	0.0369	0.0379	0.0395	0.0353	0.0320	0.0383

(continued)

	2009	2010	2011	2012	2013	2014	2015	AVG
C0	0.0055	0.0040	0.0049	0.0029	0.0028	0.0024	0.0017	0.0044
C1	0.0081	0.0060	0.0065	0.0048	0.0044	0.0039	0.0028	0.0076
C3	0.0041	0.0032	0.0032	0.0030	0.0028	0.0025	0.0019	0.0041
C4	0.0146	0.0118	0.0116	0.0092	0.0083	0.0072	0.0052	0.0139
C5	0.0556	0.0507	0.0488	0.0521	0.0516	0.0457	0.0356	0.0601
C6	0.0377	0.0268	0.0309	0.0207	0.0190	0.0167	0.0121	0.0328
C7	0.0511	0.0383	0.0367	0.0348	0.0326	0.0290	0.0219	0.0499
C8	0.0721	0.0573	0.0568	0.0555	0.0534	0.0465	0.0370	0.0725
C99	0.0170	0.0144	0.0131	0.0128	0.0124	0.0107	0.0081	0.0179
AVG	0.0296	0.0236	0.0236	0.0218	0.0208	0.0183	0.0140	0.0292

Remark: subindustry C2 is not exit in table 3, 4, 5 because of zero foreign investing.

Table 5 shows backward spillovers is also not significant. The lowest number is 0.0140 from 2015 and the trend is down. In all subindustries, the number of C5 is highest, which means subindustry C5 provides more support to other subindustries. It is more foreign investing in C5, more effects to companies in other subindustries. C3's number is the lowest and the next is C1. The two subindustries are traditional industries that with little foreign investing and less products support to other subindustries.

In conclusion, the horizontal and vertical spillovers from FDI of manufacturing are not very significant but have some influence on exports technology contents. How spillovers from FDI influence exports technology contents needs more study and analyze.

3. CALCULATION OF EXPORTS TECHNOLOGY CONTENTS

3.1 Methods of Evaluation and Data

Exports technology contents could be measured by export technology complexity that is evaluated with Revealed Comparative Advantage Index (RCA) (Hausmann). Based on the method of Ye L. L (2016), the exports technology contents equals export RCA multiply average GDP. The equation is as follows.

$$ETC_i = \frac{X_i / X_t}{A_i / A_t} \bullet Y$$

Where i represents subindustry of manufacturing, ETC_i is exports technology contents, X_i is total exports amount of listed companies belong to subindustry i, X_t is total exports amount of listed companies belong to manufacturing, Ai is total exports amount of Chinese i subindustry, At is total exports amount of Chinese manufacturing, Y is average gross national income(GNI). Result of the equation is higher than real export technology contents of listed manufacturing companies since it does not get rid of semi-finished products or raw materials imported from abroad (because relevant data is failed to get).

All data is from Wind (a client provides finance information). Total overseas income represents total export amount of subindustry i and manufacturing. Overseas income is based on stock database of Wind. Total export amount of subindustry i and manufacturing is based on macroeconomic database. GNI is average GNI (international dollar) adjusted with purchasing power parity by the U. N.

3.2 Results and Analysis

Table 6 shows that exports technology contents of manufacturing is increasing by year, the trend is stable and growth rate is slow. The exports technology contents of C7 is highest compared with other subindustries. The main reason is that total exports amount of C7 occupied large proportion of manufacturing.

Table 6. Exports Technology Contents (ETC)

	2001	2002	2003	2004	2005	2006	2007	2008
C0	4125.68	4263.78	4266.49	3504.76	4090.36	3093.82	3263.76	4214.40
C1	964.91	792.50	908.99	1290.74	1283.39	1155.83	1654.09	1768.94
C2	2249.33	4124.44	3361.83	3237.31	3937.31	3526.63	6047.09	6209.27
C3	1246.38	4417.10	3365.38	6510.93	14519.3	10990.2	12012.2	10143.4
C4	8265.17	11258.8	13684.1	15642.1	11604.7	9851.90	10872.8	13603.4
C5	854.67	929.42	1738.02	1363.97	1906.48	2699.64	2920.93	3318.95
C6	14829.8	12497.6	12265.84	13527.71	15863.01	16718.94	17583.23	17816.09
C7	5565.58	10912.43	11248.24	13879.77	16528.02	22280.71	28695.51	30879.99

C8	4072.29	5363.64	5801.82	5458.24	5268.06	3840.97	3720.67	3764.82
C99	0.00	181.14	0.00	186.38	83.68	352.64	319.71	333.97
AVG	4217.38	5474.08	5664.07	6460.19	7508.43	7451.13	8709.00	9205.32

(continued)

	2009	2010	2011	2012	2013	2014	2015	AVG
C0	4863.22	4766.00	5890.34	6563.68	9042.80	8812.62	9796.07	5370.52
C1	2306.30	2304.07	2319.34	2568.50	2657.99	2418.50	2491.15	1792.35
C2	9441.12	9449.94	10482.4	12443.9	14195.2	13414.5	13356.6	7698.45
C3	11951.2	13136.6	11579.6	14014.6	13218.4	14065.6	13104.7	10285.0
C4	14045.6	14366.5	18296.1	24626.9	29785.5	31796.3	33696.1	17426.4
C5	4964.40	6473.29	6703.18	7291.60	7815.03	8785.78	9847.85	4507.55
C6	12977.5	15485.0	15089.2	14806.9	15575.2	16934.7	15991.8	15197.5
C7	37328.0	33736.2	40186.2	43198.9	49872.8	55921.4	61024.5	30750.5
C8	6347.90	5917.51	4729.22	5392.79	6047.37	6280.80	8288.33	5352.96
C99	460.42	543.14	508.64	476.32	488.28	535.92	559.95	335.35
AVG	10468.55	10617.83	11578.43	13138.41	14869.86	15896.61	16815.69	9871.67

4. EMPIRICAL ANALYSIS ON EFFECT OF FDI SPILLOVER WITH EXPORTS TECHNOLOGY CONTENTS

4.1 Methodology

As discussed earlier, FDI spillovers include horizontal and vertical spillovers. The way they make effect on exports technology contents is worth to research.

There is a Tobit model used for estimation.

Basic module as follows:

$$\ln \mathrm{E}TC = \alpha + \beta_1 HORI + \beta_2 FOR + \beta_3 BACK + \varepsilon$$

Where lnETC means the logarithm of exports technology contents, α is constant, β_1 β_2 β_3 are regression vector coefficient of explanatory variables for horizontal spillovers, forward spillovers and backward spillovers. ε is a random error term.

In fact, there are some other important factors besides FDI spillovers that could affect products technology contents, such as R&D investing ratio (RD), capital labor ratio (KL) and so on. So the paper imports RD and KL as control variables to keep the model moderate (using ratio as control variable could remove effects made by discrepancy of price and statistical standard). The full empirical model is as follows:

$$\ln ETC = \alpha + \beta_1 HORI + \beta_2 FOR + \beta_3 BACK + \gamma_1 RD + \gamma_2 KL + \varepsilon$$

RD is the ratio of R&D investing to main business income, KL is the ratio of total employment to net fixed assets (the data of fixed assets is adjusted with a 2001 price index of 100). Eventually, KL means average labor invested by per hundred RMB.

4.2 Empirical Analysis

(1) Statistical description of variables

Table 7. Statistical description of all variables

	N	Minimum	Maximum	Average	Standard deviation
lntc	148	4.4270	11.0190	8.6135	1.2687
hori	135	0.0088	0.5974	0.0727	0.0619
for	135	0.0020	0.0918	0.0296	0.0228
back	135	0.0017	0.0962	0.0292	0.0266
rd	150	0.0009	0.0542	0.0108	0.0104
kl	150	0.0028	0.0996	0.0265	0.0194
N	133				

Note: a. Subindustry C2 has no data of foreign investing, variables of HORI, FOR and BACK lack 15 data.

b. Subindustry C99 has no export data in year 2001 and 2003, so lnTC lack 2 data.

(2) Group unit root test

Group unit root test: Summary
Series: BACK, FOR, HORI, KL, LNTC, RD
Date: 10/09/16 Time: 21:22
Sample: 1 150
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.96638	0.0015	6	887
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.04793	0.0000	6	887
ADF - Fisher Chi-square	66.5503	0.0000	6	887
PP - Fisher Chi-square	87.1191	0.0000	6	890

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Figure 1. Group unit root test Summary

Figure 1 shows that each variable is a smooth sequence, regression could go on directly.

(3) Hausman Test

Theoretically, fixed effects model is more appropriate for all units, while random effects model is more appropriate for part of all units. The data of this paper is from listed manufacturing companies, so random effects model is suitable. The result of Hausman test is as figure 2.

Correlated Random Effects - Hausman Test
Pool: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	5.989300	5	0.3073

Figure 2. Hausman Test

Original hypothesis is random effects. Figure 2 reports Hausman statistic is 5.98, corresponding probability is 0.3073, it means suitable with original hypothesis – random effects model.

(4) Multicollinearity test

It's necessary to make multicollinearity test to all variables as panel data involves section data. There are 6 variables are used in this paper: logarithm of exports technology contents (lnTC), horizontal spillovers (HORI), forward spillovers (FOR), backward spillovers (BACK), R&D investing ratio (RD), capital labor ratio (KL). The result is shown in table 8.

Table 8. Result of Multicollinearity

	LNETC	HORI	FOR	BACK	RD	KL
LNETC	1.0000					
HORI	-0.3101	1.0000				
FOR	0.2282	-0.0678	1.0000			
BACK	0.0541	-0.0461	0.8906	1.0000		
RD	0.3399	-0.3410	0.1254	0.2230	1.0000	
KL	-0.5381	0.1036	0.0712	0.2210	-0.3101	1.0000

Table 8 reports that there is greater collinearity between forward spillovers and backward spillovers. There is close contact among subindustries of manufacturing. Companies belong to different subindustries may provide raw material or semi-finished products for each other. So it's common to have collinearity between the two variables.

Because of collinearity, the paper use stepwise regression analysis to keep the model correct. However, the results are the same compared with regression analysis (figure 3). It's obviously to find that collinearity between forward and backward spillovers does not influence the correctness and effectiveness of model.

Dependent Variable: LNTC
Method: Stepwise Regression
Date: 10/09/16 Time: 21:53
Sample: 1 150
Included observations: 148
No always included regressors
Number of search regressors: 6
Selection method: Stepwise forwards
Stopping criterion: p-value forwards/backwards = 0.05/0.051

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
C	8.966272	0.251584	35.63935	0.0000
KL	-26.71622	4.946615	-5.400909	0.0000
FOR	36.06820	8.108877	4.447989	0.0000
HORI	-3.718645	1.334938	-2.785631	0.0061
BACK	-23.63957	7.539323	-3.135503	0.0021
RD	22.01507	9.317116	2.362863	0.0195

R-squared	0.459152	Mean dependent var	8.613513
Adjusted R-squared	0.440108	S.D. dependent var	1.268670
S.E. of regression	0.949294	Akaike info criterion	2.773500
Sum squared resid	127.9646	Schwarz criterion	2.895008
Log likelihood	-199.2390	Hannan-Quinn criter.	2.822868
F-statistic	24.11013	Durbin-Watson stat	0.267897
Prob(F-statistic)	0.000000		

Dependent Variable: LNTC
Method: Least Squares
Date: 10/09/16 Time: 21:52
Sample: 1 150
Included observations: 148

Variable	Coefficient	Std. Error	t-Statistic	Prob.
HORI	-3.718645	1.334938	-2.785631	0.0061
FOR	36.06820	8.108877	4.447989	0.0000
BACK	-23.63957	7.539323	-3.135503	0.0021
RD	22.01507	9.317116	2.362863	0.0195
KL	-26.71622	4.946615	-5.400909	0.0000
C	8.966272	0.251584	35.63935	0.0000

R-squared	0.459152	Mean dependent var	8.613513
Adjusted R-squared	0.440108	S.D. dependent var	1.268670
S.E. of regression	0.949294	Akaike info criterion	2.773500
Sum squared resid	127.9646	Schwarz criterion	2.895008
Log likelihood	-199.2390	Hannan-Quinn criter.	2.822868
F-statistic	24.11013	Durbin-Watson stat	0.267897
Prob(F-statistic)	0.000000		

Figure 3. Comparison of STEP 15 and 15

(5) Result and analysis

The paper makes a research on data of listed manufacturing companies belong to 10 subindustries in period 2001-2015.Firstly, it estimates model 1 which covers 3 FDI spillovers variables. Secondly, it inputs control variables RD and KL for further analysis.

In the model 1, the data of horizontal spillovers and backward spillovers is negative, which means the two indicators failed to get through significant test. Foreign investing makes a negative effect on exports technology contents. It is foreign investing reduce technology level of exports. But the negative effects are not significant. Negative backward spillovers shows that intermediate products provided by upstream companies with foreign investing made a depressive impact on exports technology contents of companies which is in downstream industries. And the effect is significant. Positive forward spillovers indicates the fact - companies with foreign investing buy intermediate products from upstream companies makes significant positive effects on technology contents of upstream companies.

Table 9. Effects on Exports Technology Contents of FDI Spillovers

Variables	(1)	(2)
HORI (t)	-5.753 (-3.927)	-3.719 (-2.786)
FOR (t)	45.012 (5.210)	36.068 (4.448)
Back (t)	-33.080 (-4.390)	-23.640 (-3.136)
RD (t)		22.015 (2.363)
KL (t)		-26.716 (-5.401)
C (t)	8.652 (49.751)	8.966 (35.639)
Statistic F (P)	14.548 (0.000)	28.605 (0.000)
RR^2	0.24080.2250	0.45920.4401

The fact that adding two control variables RD and KL in model 2 does not affect significances of three variables. Horizontal and backward spillovers are still negative, forward spillovers is

still positive. Absolutely, their effects reduce.it shows that FDI with RD and KL makes depressive effects on exports spillovers. According to table 9, R&D investing ratio (RD) has significant positive effects on exports technology contents, which means the increase of R&D investing ratio promotes technology contents. The coefficient of KL is a large negative number, what reports capital labor ratio (KL) makes a significant negative effects on technology contents. it is more labor with each hundred capital, lower technology contents the exports. There is a fact that fewer labor with one unit capital, lower cost and bigger revenue.

5. RESULTS AND SUGGESTION

The study examines how and to what extend spillovers from FDI influence exports technology contents using linked and highly disaggregated firm-level and industry-level datasets relating to production and exports of listed manufacturing companies. It finds that subindustries of manufacturing have spillovers, but they are limited by a lot of extents. The results of regression analyze on fixed extents including horizontal spillovers, forward spillovers, backward spillovers, RD and KL suggest manufacturing companies should maximize the advantages and bypass disadvantages of spillovers from FDI. Even horizontal spillovers and forward spillovers have negative influences on exports technology contents, there is no doubt spillovers from FDI have provided local firms foreign market intelligence and export techniques. Positive effects of forward spillovers including advanced technology and manage experience could be made best use. Local companies with strong absorptive capability could enhance its competiveness with learning from foreign companies.

The evidence from this research has significant policy implications. Manufacturing still occupies relatively important proportion in China's development. The status of listed manufacturing companies represent trend of manufacturing, encouraging policy will support manufacturing companies introducing high-quality foreign investing. Less state-owned property in the firm would help firms invest foreign capital.

Besides, as we known, manufacturing has many subindustries, including labor-intensive subindustries, technology-intensive subindustries and so on, with different request on FDI. Reference to specific features, each subindustry could choose the most appropriate FDI to learn more useful knowledge to improve its competiveness.

Admittedly, R&D is the main driver of companies' development, especially for high-tech manufacturing. Increasing invests of research and development and reducing labor with each unit capital moderately would help firms get more revenue. The best condition is that maximum revenue with minimum cost. Higher technology means more invest and greater future. So the most important contents is persons with ability. Education is also need to be taken more attention by government. Launching more laboratories with high-tech and investing creative programs in the universities would help students pay their attention to research and might gain unexpected results. Of course, the government could encourage enterprises invest college programs with potential to transformed into productive.

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