

China's Outward Foreign Direct Investment and Regional Innovation: Based on a View of Firm Ownership

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Abstract

This paper explores the relationship between China's outward foreign direct investment (OFDI) and regional innovation from the perspective of firm ownership. Based on a classification of China's firm ownership, we build a database including data of China's regional OFDI with heterogeneous ownership and data of China's regional innovation. Through concentration analysis and correlation analysis, this paper finds that: firstly, in general, China's regional OFDI is highly regionally concentrated, which is varying slightly among heterogeneous ownership; secondly, innovation construction of China's regional OFDI is significantly heterogeneous; thirdly, although both OFDI of state-owned firms and OFDI of private firms can improve regional innovation, improvement of the latter is stronger due to different sector distribution of OFDI.

Keywords: OFDI; regional innovation; firm ownership;

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This essay discusses the relationship between China's outward foreign direct investment (OFDI) and regional innovation from the perspective of firm ownership. Based on a classification of China's firm ownership, a database including data of China's regional OFDI with heterogeneous ownership and data of China's regional innovation is established. After comparison and correlation analysis, we find that: Firstly, in general, China's regional OFDI is highly regionally concentrated, which is varying slightly among heterogeneous ownership; Secondly, innovation construction of China's regional OFDI is significantly heterogeneous; Thirdly, although both OFDI of state-owned firms and OFDI of private firms can improve regional innovation, improvement of the latter is stronger due to different sector distribution of OFDI.

1. Classification of China's firm ownership

In China, neither academy nor legislation has provided a clear and uncontroversial classification standard of firm ownership. According to definition and classification of firm ownership in Xue (2020), China's firms are classified into 4 types: private firms; state-owned firms; firms invested by Hongkong, Macao or Taiwan; firms invested by foreign countries. These are specific classification standard:

Firstly, state-owned firms include: (1) national proprietorship firms solely or jointly invested only by governmental sectors or institutes; (2) firms solely or jointly invested by (1) which hold more than 50% of shares, and one of which is the major shareholder; (3) firms solely or jointly invested by (1) and/or (2) which hold more than 50% of shares; (4) firms, other than (1)-(3), in which the major shareholder is govern-

mental sector or institute or state-owned firm that actually controls the firm through shareholder's agreement, firm's rule, board of directors and so on¹.

Secondly, firms invested by Hongkong, Macao or Taiwan include: (1) firms solely or jointly invested only by individuals, firms or other organizations located in Hongkong, Macao or Taiwan; (2) firms solely or jointly invested by (1) and/or individuals, firms or other organizations located in Hongkong, Macao or Taiwan which hold more than 50% of shares, and one of which is the major shareholder; (3) firms solely or jointly invested by (1) and/or (2) which hold more than 50% of shares; (4) firms, other than (1)-(3), in which the major shareholder is individuals, firms or other organizations located in Hongkong, Macao or Taiwan that actually controls the former through shareholder's agreement, firm's rule, board of directors and so on.

Thirdly, firms invested by foreign countries include: (1) firms solely or jointly invested only by individuals, firms or other organizations located in foreign countries (foreign investors for short); (2) firms solely or jointly invested by foreign investors which hold more than 50% of shares, and one of which is the major shareholder; (3) firms solely or jointly invested by (1) and/or (2) which hold more than 50% of shares; (4) firms, other than (1)-(3), in which the major shareholder is foreign investors that actually controls the former through shareholder's agreement, firm's rule, board of directors and so on.

¹ Although collectively owned firms, generated in special historical stage in China, are a part of China's public owned economy, in light of its difference with whole-people-owned firms in terms of subject, object and obtainance, this essay classifies collectively owned firms into private firms.

Finally, private firms are all firms other than state-owned firms, firms invested by Hongkong, Macao or Taiwan or firms invested by foreign countries, including solely individual firms, corporative firms, limited liability firms and joint stock firms.

2. China's regional OFDI in a view of firm ownership

In order of size, there are 4 types of China's administrative region: (1) provincial-level (including autonomous regions and 4 municipalities), (2) prefecture-level, (3) county-level and (4) township-level. In this essay, China's regions are defined as cities not lower than prefecture-level, including 293 prefecture-level cities and 4 municipalities thus 297 regions in total, except autonomous or special administrative regions. Based on BvD-Zephyr database, which is representative in terms of mergers & acquisitions investment, fDi-Markets, which is provided by Financial Times in Britain and has authority on overseas green field investment, and firm-level database from Tonghuashun and Qichacha², this essay classifies China's firms according to above-mentioned standard, categorizes data and then establishes China's Regional OFDI database in a view of firm ownership.

Table 1 reflects number and value of China's regional OFDI projects (top 5), which ranks regions in order of cumulative amount from 2005 to 2019. Table 2 is similar but in a view of different ownership. In terms of heterogeneous ownership, on the one hand, top 5 regions in order of OFDI projects number respectively are: (1) state-owned: Beijing, Shang-

² These two are China's companies which provide firm-level data.

Table 1 . Number and value of China's regional OFDI projects (top 5), 2005-2019
Unit: number (piece); value (million US dollars)

year	OFDI projects number						OFDI projects value					
	BJ	SH	SZ	HZ	GZ	rate of top 5	BJ	SH	SZ	HZ	HAK	rate of top 5
2005	84	27	47	10	1	60%	15363	1126	1314	296	0	90%
2006	88	48	35	5	9	58%	26090	6105	4807	115	270	77%
2007	165	34	44	15	7	57%	64317	1083	13938	556	0	86%
2008	180	54	52	10	15	58%	60646	4514	10940	533	1	86%
2009	254	66	58	14	5	57%	92011	1260	3245	179	30	84%
2010	230	58	61	13	20	58%	58017	6802	16150	2119	49	74%
2011	273	75	90	14	11	55%	88734	10715	14544	5295	4757	77%
2012	255	87	60	17	16	57%	89185	5394	1444	474	0	81%
2013	246	85	94	25	14	60%	91557	12849	5726	4726	3685	86%
2014	307	163	92	24	20	61%	408310	48904	10617	1530	19599	87%
2015	446	237	117	66	48	64%	217994	62946	14318	25269	6807	71%
2016	497	313	229	86	48	62%	192855	75667	26182	8827	20455	75%
2017	451	285	208	87	70	61%	273835	48293	41203	14255	11642	77%
2018	570	340	237	124	62	61%	106084	48080	26810	17390	3628	68%
2019	411	257	194	90	51	59%	112078	24256	15251	6408	447	72%

Note: (1) Data here is inconsistent with data from National Bureau of Statistics of China due to different measurement and method of statistics. (2) Names of regions are abbreviated: Beijing to BJ, Shanghai to SH, Shenzhen to SZ, Hangzhou to HZ, Guangzhou to GZ, Haikou to HAK

hai, Shenzhen, Guangzhou and Wuhan; (2) private: Beijing, Shenzhen, Shanghai, Hangzhou and Guangzhou; (3) Hongkong-Macao-Taiwan: Beijing, Shanghai, Shenzhen, Suzhou and Guangzhou; (4) foreign: Shanghai, Beijing, Jiaying, Shenzhen, Wuxi. On the other hand, top 5 regions in order of OFDI projects value respectively are: (1) state-owned: Beijing, Shanghai, Shenzhen, Wuhan and Guangzhou; (2) private: Beijing, Shanghai, Shenzhen, Hangzhou and Haikou; (3) Hongkong-Macao-Taiwan: Beijing, Shanghai, Guangzhou, Shenzhen and Kunming; (4) foreign: Shanghai, Beijing, Jiaying, Wuxi and Wuhan.

It is obvious that China's regional OFDI is highly regionally concen-

Table 2. China's regional OFDI in terms of firm ownership, 2005-2019

year	rate of top 5 OFDI projects number				rate of top 5 OFDI projects value			
	SO	P	HMT	F	SO	P	HMT	F
2005	70%	49%	67%	17%	91%	56%	66%	0%
2006	62%	48%	53%	86%	80%	80%	50%	99%
2007	63%	48%	54%	64%	89%	79%	52%	81%
2008	72%	39%	68%	71%	91%	72%	77%	80%
2009	68%	41%	69%	78%	88%	37%	65%	86%
2010	70%	45%	67%	72%	82%	78%	63%	91%
2011	67%	43%	61%	79%	82%	67%	46%	96%
2012	72%	47%	59%	61%	91%	47%	87%	65%
2013	73%	55%	58%	82%	93%	87%	59%	98%
2014	70%	56%	57%	87%	97%	66%	46%	79%
2015	72%	59%	74%	83%	90%	59%	85%	93%
2016	71%	57%	72%	78%	84%	67%	90%	95%
2017	71%	57%	68%	74%	91%	55%	79%	92%
2018	68%	57%	73%	84%	79%	55%	74%	94%
2019	62%	57%	69%	77%	82%	63%	85%	85%

Note: (1) Firm ownership types are abbreviated: state-owned to SO, private to P, Hongkong-Macao-Taiwan to HMT, foreign to F. (2) Regions are ranked in order of cumulative amount from 2005 to 2019.

trated. Specifically, in a view of number, top 5 regions account for about 60% of total OFDI; in a view of value, top 5 regions account for more than 70% of total OFDI. However, this feature is varying slightly among heterogeneous ownership. In a view of OFDI projects number, for state-owned firms top 5 regions account for more than 65% in most years, and for private firms top 5 regions are less than 55% in most years. In addition, in either an overall view or a heterogeneous view considering ownership, extent of regional concentration of OFDI projects' value is more significant than that of OFDI projects' number, indicating that, in regions where OFDI is concentrated, OFDI value per project is larger than that of China's country-level.

Here, China's top 4 cities—Beijing, Shanghai, Guangzhou and Shenzhen—are analyzed for a deeper insight to ownership heterogeneity of regional OFDI. By means of comparing proportion of cumulative OFDI from 2005 to 2019 in top 4 cities, two significant attributes are found according to table 3:

Firstly, the OFDI ownership structure in top 4 cities varies significantly. Particularly, in a view of either OFDI projects' number or value, more than half of OFDI from Beijing flows from state-owned firms, and more than half of OFDI from Shenzhen flows from private firms. From this aspect, discrepancy of firm vitality of different ownership in distinct regions are reflected.

Secondly, in top 4 cities, in terms of ratio of OFDI projects value proportion to OFDI projects number proportion, average OFDI value per project from state-owned firms is much higher than that from private firms, indicating that state-owned firms in China's top 4 cities incline to invest larger amount of money in single OFDI project.

Table 3 . OFDI Ownership structure in China's top 4 cities from 2005 to 2019

		BJ	SH	GZ	SZ
OFDI projects value	SO	83.8%	49.1%	75.5%	47.8%
	P	14.7%	42.4%	17.1%	50.5%
	HMT	0.9%	4.4%	6.6%	1.5%
	F	0.6%	4.1%	0.8%	0.2%
OFDI projects number	SO	58.1%	28.8%	37.0%	21.9%
	P	33.1%	48.4%	52.0%	70.7%
	HMT	4.7%	9.8%	7.3%	5.3%
	F	4.1%	13.0%	3.7%	2.1%

Note: (1) Due to incomplete statistics, proportions of 4 ownership features in China's top 4 cities listed in table 3 are calculated according to cumulative OFDI from 2005 to 2019, rather than OFDI stocks. (2) Abbreviations of ownership types and regions are same as table 1 and table 2.

3. Current status of China's regional innovation

We access to data of China's regional innovation from Innojoy database. Specifically, by means of searching address and year, we arrange data of amount of application and authorization of invention patent, utility model patent and design patent respectively. For an analysis as comprehensive as possible, we process data as below: (1) newly established or canceled cities not lower than prefecture-level during 2005-2016 are not included in our sample; (2) for cities having changed names during 2005-2016, approach of data matching depends on when the name changed. If a city name changed in the first half of a year, we match data by the new name. Conversely, if a city name changed in the latter half of a year, we match data by the old name. For instance, in January 2007, a prefecture-level city called Simao City located in Yunnan Province was renamed as Puer City. Thus, in our innovation data matching, we use Simao for data during 2005-2006 and then use Puer for data during 2007-2016.

Table 4. China's top 5 regions of patent application from 2005 to 2016

invention patent application	Region	BJ	SH	SZ	SUZ	TJ
	number	529604	322079	315446	220188	148432
	Rate	11.3%	6.9%	6.7%	4.7%	3.2%
utility model patent application	Region	BJ	SH	SZ	SUZ	TJ
	number	291463	268821	222287	193600	163277
	Rate	5.6%	5.2%	4.3%	3.7%	3.2%
design patent application	Region	SUZ	SZ	NB	SH	WX
	number	221867	154259	139146	131729	131087
	Rate	7.3%	5.1%	4.6%	4.4%	4.3%

Note: region name abbreviations: Suzhou to SUZ; Tianjin to TJ; Ningbo to NB; Wuxi to WX; others are the same with table 1 and 2.

Table 5 . China's top 5 regions of patent authorization from 2005 to 2016

invention patent authorization	Region	BJ	SZ	SH	HZ	NJ
	number	191055	109843	104179	45613	42331
	Rate	15.3%	8.8%	8.3%	3.6%	3.4%
utility model patent authorization	Region	BJ	SH	SZ	SUZ	HZ
	number	265586	247106	197289	169476	142626
	Rate	5.7%	5.3%	4.3%	3.7%	3.1%
design patent authorization	Region	SUZ	SZ	NB	SH	WX
	number	219739	142934	134103	130390	129175
	Rate	7.7%	5.0%	4.7%	4.6%	4.5%

Note: region name abbreviations: Hangzhou to HZ; Nanjing to NJ; others are the same with table 1-4.

Table 4 and table 5 respectively list top 5 regions of patent application and authorization in order of cumulative amount during 2005-2016. Comparing table 4 and table 5, we find that:

Firstly, to some extent, China's regional innovation is regionally concentrated. In detail, proportion of top 5 regions' invention, utility model and design patent application are respectively 32.8%, 22.0% and 25.7%. Besides, proportion of top 5 regions' invention, utility model and design patent authorization are respectively 39.4%, 22.0% and 26.4%.

Secondly, innovation construction in different regions appears heterogeneous. Particularly, in terms of both invention and utility model patent, Beijing is the top city among all 297 regions. However, in terms of design patent, Beijing ranks out of top 5. Besides, in view of any type of patent, Shenzhen ranks in top 5.

Thirdly, compared with utility model and design patent, invention patent is authorized relatively less. Ignoring time lag from application to authorization of an invention patent, authorization rate of innovation patent in China is only approximately one third.

4. China's regional OFDI and innovation

Relation between OFDI and innovation has been the focus of academia for long time. Globerman et. al (2000) analyzed country level data in Sweden in 1986 and found that, through labor mobility, industrial correlation effect and demonstration effect, OFDI improved innovation performance in home country. Branstetter (2006) empirically researched OFDI from 189 Japanese firms to U.S. during 1980-1997, then concluded that OFDI was an effective approach for Japanese firms to utilize U.S. technology network which provided Japanese firms with technology spillover from U.S. local firms and elevated innovation performance of Japanese firms. Zhao and Li(2017), after matching OFDI data published by Ministry of Commerce of China and China's public-listed firms, also conducted empirical research and claimed that OFDI raised technological innovation capability of China's firms.

Different from existing researches, this essay analyzes relation between China's regional OFDI and innovation based on a view of firm ownership. Although 4 types of ownership— (1) state-owned, (2) private, (3) Hongkong, Macao or Taiwan, (4) foreign—are defined in this essay, our data shows that OFDI from firms of the last 2 types only share a small proportion, thus we only focus on OFDI from firms of the first 2 types.

Using patent application as a proxy of regional innovation, figure1-3 illustrate relationship between China's regional OFDI and regional innovation during 2005-2016 in a view of firm ownership. For a more precise fitting, none of point corresponding to zero OFDI is shown in Figure 1-3.

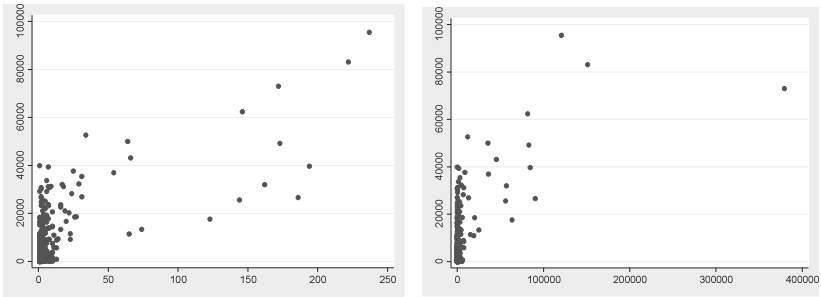


Figure 1. Scatter plot of OFDI from state-owned firms and regional innovation (left x-axis: OFDI projects number; right x-axis: OFDI projects value)

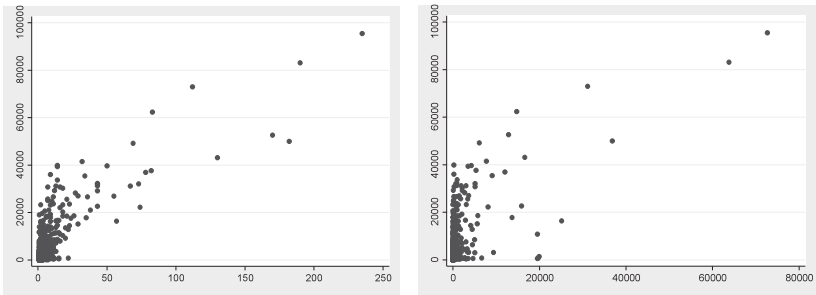


Figure 2. Scatter plot of OFDI from private firms and regional innovation (left x-axis: OFDI projects number; right x-axis: OFDI projects value)

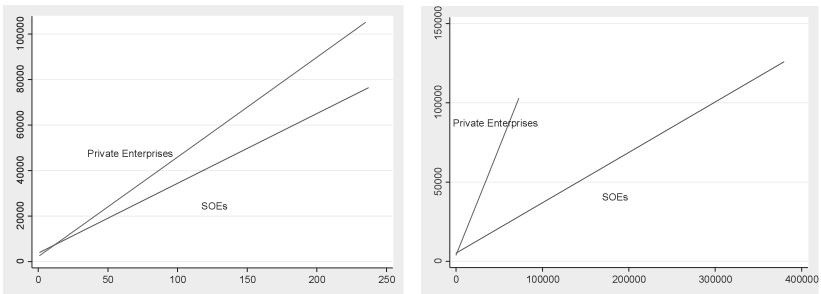


Figure 3. Fitted line of OFDI from state-owned firms or private firms and regional innovation (left x-axis: OFDI projects number; right x-axis: OFDI projects value)

Through comparison, we draw following two conclusions. Firstly, in view of either OFDI projects number or value, for either state-owned or private firms, OFDI positively correlates to innovation, indicating that OFDI from both state-owned and private firms has improved regional innovation performance. Secondly, correlation coefficient between OFDI and regional innovation for state-owned firms is significantly lower than that for private firms, and the gap is even larger in a view of OFDI projects value than that in a view of OFDI projects number. It is possibly a result of heterogeneous industrial composition of OFDI. For OFDI projects number, proportion of manufacture in private OFDI is 30.0%, quite close to that in state-owned OFDI, 30.8%. But for OFDI projects value, proportion of manufacture in private OFDI is 37.0%, much larger than that in state-owned OFDI, only 26.6%³.

The correlation coefficients between regional OFDI and innovation in a view of firms' ownerships are showed in table 6 in order to provide a deeper insight. Patent 1-3 respectively mean authorization of innovation patent, utility model patent and design patent. ODI1 and ODI2 respectively mean number and value of OFDI projects from cities not lower than prefectural-level. Meanings of ODI1-SOE and ODI2-SOE are similar to ODI1 and ODI2 except that only OFDI from state-owned firms are considered. Likewise, ODI1-Private and ODI2-Private only consider OFDI from private firms. We can find that:

Firstly, China's regional OFDI positively correlates to regional innovation, but coefficients vary. Specifically, coefficient of correlation between invention patent authorization and regional OFDI is the highest, and

³ The data were compiled by the author according to BvD-Zephyr database and fDi-Markets database.

Table 6. Correlationship between regional innovation and OFDI of state-owned firms or private firms

	patent1	patent2	patent3	ODI 1	ODI 2	ODI1-SOE	ODI2-SOE	ODI1-Private	ODI2-Private
patent 1	1								
patent 2	0.9139*	1							
patent 3	0.5896*	0.6967*	1						
ODI 1	0.8108*	0.6642*	0.3407*	1					
ODI 2	0.6306*	0.4674*	0.1817*	0.8134*	1				
ODI1-SOE	0.6868*	0.5029*	0.2110*	0.9303*	0.8168*	1			
ODI2-SOE	0.5689*	0.4059*	0.1468*	0.7477*	0.9824*	0.7905*	1		
ODI1-Private	0.8192*	0.7308*	0.4213*	0.9149*	0.6917*	0.7101*	0.5910*	1	
ODI2-Private	0.6437*	0.5324*	0.2455*	0.7749*	0.7273*	0.6329*	0.5869*	0.8276*	1

Note: * means 5% level of significance.

that between design patent authorization and regional OFDI is the lowest, which possibly results from unequal levels of requirement to technology.

Secondly, consistent with table 3, correlation coefficient between OFDI and innovation is significantly higher when only considering OFDI from private firms than when only considering OFDI from state-own firms. Specifically, in a view of OFDI projects number, correlation coefficient for private firms is 0.8192, larger than that for state-own firms, 0.6868, and in a view of OFDI projects value, correlation coefficient for private firms is 0.6437, larger than that for state-own firms, 0.5689. This indicates that OFDI of private firms has a more significant driving force for regional innovation

Third, correlation coefficient between regional OFDI project number and value is 0.8134, lower than that only considering private firms, 0.8276, and higher than that only considering state-own firms, 0.7905. This shows that regional OFDI project number and value from state-

own firms diverge more than that from private firms.

Fourthly, correlation coefficient between patent authorization of invention and utility model is 0.9139, far higher than that between patent authorization of invention and design, 0.6967. This indicates that innovation construction heterogeneity among regions is significant.

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