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In Search of Determinants of FDI Horizontal Spillovers: A meta-analysis

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Abstract

This paper constructs a unique dataset of 1018 estimates from 41 studies on foreign direct investment horizontal productivity spillovers in China, and the prime objective is to investigate determinants of horizontal spillovers from foreign direct investment using Bayesian Model Averaging based meta-analysis. Our results suggest that horizontal spillovers vary across firm attributes, including the ownership structure of foreign firms, the origin of foreign firms, market orientation of foreign firms, the ownership structure of local firms and the technological levels of local firms. For instance, our results show the nonlinear relationship between technological levels of local firms and FDI horizontal spillovers.

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1. Introduction

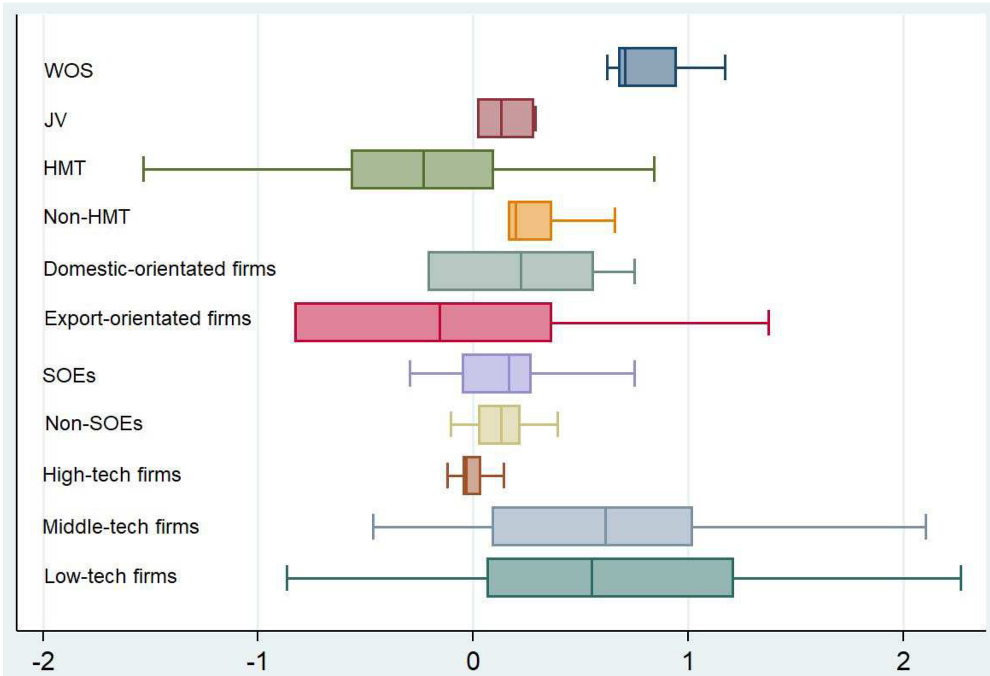
It is well known that foreign direct investment (FDI) cannot only bring capital and modern technology to domestic firms, but generate externalities ¯ productivity spillovers ¯ that may indirectly impact the productivity of local firms via horizontal spillovers (within the same sector), backward spillovers (downstream sectors: from FDI to local suppliers) and forward spillovers (upstream sectors: from FDI to local buyers). Moran (1998) and Navaretti and Venables (2004) offer comprehensive overviews of the benefits that FDI can bring to host countries. It is worth noting that China tuned its economic system from planned economy to market economy since 1978. Subsequently, China advocated the so-called "market for technology" policy for attracting foreign investments to upgrade her technology in the early 1980s. Over the last four decades, China has become the second largest economy in the world and the largest FDI recipient in the developing world. Despite empirical studies on FDI spillover effects are abundant, the reported estimates are widely dispersed in terms of both the sign and magnitude (Jefferson and Ouyang, 2014; He et al., 2019).

Meta-analysis provides an effective way to quantitatively analyze all the relevant scientific findings on one specific subject, and it has been widely employed in economics since Stanley and Jarrell (1989).[1] The previous meta-analyses of FDI spillover effects mainly focused on examining the `true_ effects and accounting for study-to-study variation of reported estimates. For instance, Havranek and Irsova (2011) find backward and forward spillover effects are positive and statically significant on world average, while horizontal spillover effect is little. Wooster and Diebel (2010) explain the magnitude and significance of FDI spillovers from the aspects of study design and data characteristics.

Despite Irsova and Havranek (2013) investigate the determinants of worldwide FDI horizontal spillovers as a whole, the determinants of FDI horizontal spillovers in China, especially from the aspects of various firm attributes, are still unclear. Figure 1 presents Box Plots of FDI horizontal spillover estimates from the meta-dataset used in current paper by 11 firm attributes (See the note in Figure 1). From Figure 1, we find the horizontal estimates under each firm attribute have a wide spectrum, indicating that it is difficult to infer clear conclusions about the effects of firm attributes on horizontal spillovers. For instance, the estimates under domestic-orientated firms and the estimates under export-orientated firms largely overlap.

Figure 1 Box Plots of FDI horizontal spillover estimates: Firm attributes

[1] Stanley and Doucouliagos (2012) provide comprehensive overviews of Meta-Analysis.



Note: According to different firm attributes, foreign-invested firms can be classified by their ownership structure (wholly-owned subsidiaries (WOS) versus joint ventures (JV)) or by their origin (investors from Hong Kong, Macao and Taiwan (HMT) versus that from other countries (non-HMT)) or by market orientation of foreign-invested firms (domestic-orientated firms and export-orientated firms). Local firms can be divided by their ownership structure (state-owned enterprises (SOEs) versus non-state-owned enterprises (non-SOEs)) or the technological levels of local firms (High-tech firms, Middle-tech firms and Low-tech firms).

In this study, we try to quantitatively search for FDI horizontal spillover determinants in China from the aspects of various firm attributes using Bayesian Model Averaging (BMA) based meta-analysis. BMA is an attractive technique to account for model uncertainty, its basic idea is to regress models with many different subsets of variables and make inferences based on a weighted average over model regressions.[2]

2. The meta-dataset

To minimize selection bias, we to the extent possible included the English and Chinese empirical studies that report FDI spillover estimates of China. The search of English literature uses Google Scholar as Google Scholar provides powerful full-text search, and is supplemented with China National Knowledge Infrastructure (CNKI) for Chinese literature that is the most widely used for Chinese researchers. We conducted the searches using the keywords `FDI spillovers in China_, `FDI horizontal spillovers in China_, `FDI vertical spillovers in China_, `FDI backward spillovers in China_ and `FDI forward spillovers in China_. These searches primarily yielded more than 200 English studies and 1300 Chinese studies, respectively. There is a concern of quality of

[2] Zeugner and Feldkircher (2015) offer a brief summary of BMA approach.

Chinese studies as most of them are unpublished student working papers and theses, we therefore confine our attention to the most cited published Chinese papers for each year if available.

To ensure the comparability of reported estimates across studies in meta-regression analysis, studies must satisfy the three basic criteria. First, the study must report the FDI horizontal empirical spillover estimates of China. Second, the study must define foreign presence as a ratio. Third, the study must report standard errors or t-statistics of spillover estimates. Eventually, we identified a gross list of 41 admissible studies published from 2002 to 2016, among which 29 are in English and the rest in Chinese. To account for outliers, we applied the multivariate method proposed by Hadi (1994) to identify outliers in pairs of estimates and the corresponding precisions (the inverse of standard errors). Consequently, the procedure identified 122 outliers for horizontal estimates. In other words, 11.98% of horizontal estimates are identified as outliers. In this exercise, we report the results without these outliers.

In this study, two major categories ¯ firm attributes and study designs ¯ are collected to capture potential sources of determinants of FDI horizontal spillovers. First, firm attributes include foreign-firm characteristics and local-firm characteristics. Foreign-invested firms can be classified by their ownership structure (wholly-owned subsidiaries (WOS) versus joint ventures (JV)) or by their origin (investors from Hong Kong, Macao and Taiwan (HMT) versus that from other countries (non-HMT)) or by market orientation of foreign-invested firms (domestic-orientated firms and export-orientated firms). Local firms can be divided by their ownership structure (state-owned enterprises (SOEs) versus non-state-owned enterprises (non-SOEs)) or the technological levels of local firms (High-tech firms, Middle-tech firms and Low-tech firms). Second, following Havranek and Irsova (2011), study designs include data characteristics, specification characteristics, estimation characteristics and publication characteristics. Eventually, we collected 46 study characteristics to capture these firm attributes and study designs.[3] In search for horizontal spillover determinants, we focus on the 11 firm attributes in this paper.

3. Methodology

Publication selection bias is widely recognized as a serious issue that will distort statistical inference in empirical economics research (Card and Krueger, 1995; Fan et al., 2019). It arises from the preferences of researchers and/or reviewers who favor `statistically significant_ empirical results or results that are consistent with the conventional theories. As guaranteed by random sampling theory, estimates and their associated standard errors will be independent if there is no publication selection bias (Stanley and Doucouliagos, 2012). On the contrary, publication selection bias will result in a systematic pattern between the reported estimates and their corresponding standard errors. Therefore, the so-called `meta-regression_ is as following (Stanley and Doucouliagos, 2012):

$$e / Se(e_i) \times t_i = b_0 + e_0 [1 / Se(e_i)] + e_i \quad (1)$$

where subscript i refers to individual estimate. t_i is the t-statistic of the reported estimate; b_0 measures the extent of publication selection bias; $Se(e_{ij})$ the standard error of corresponding

[3] He et al. (2018) offer a detailed description about the 46 variables and the list of 24 admissible studies.

estimate, $1 / Se(e_{ij})$ is its precision; e_0 the publication bias-corrected spillover effect; e_{ij} is the idiosyncratic random error. Our aim is to investigate determinants of horizontal spillovers, so we rewrite Eq. (1):

$$e / Se(e_i) \times t_i = b_0 + e_0 \,\text{IJ}1 / Se(e_i) + g\,\text{IJ}\text{Determinants} + / \,\text{IJ}\text{Controls} + e_i \quad (2)$$

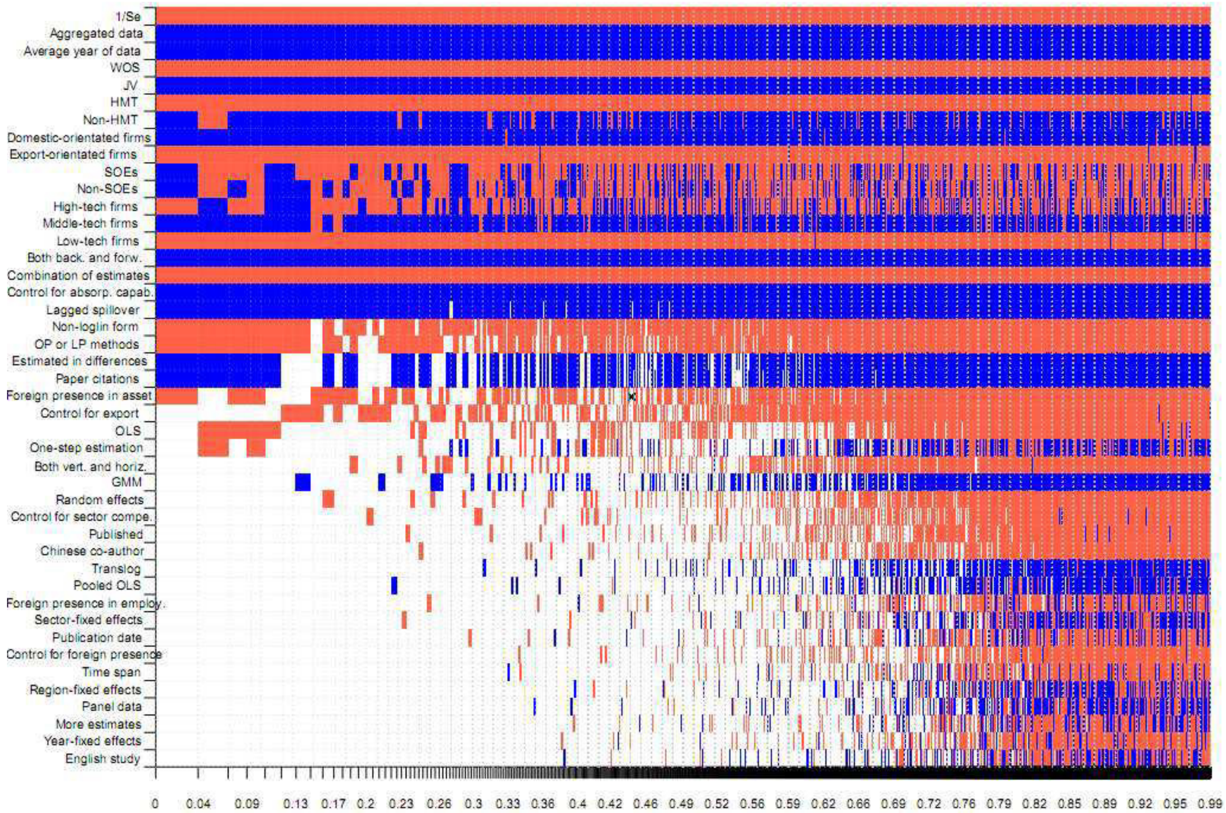
Eq. (2) is the so-called `multivariate meta-regression_ (Stanley and Doucouliagos, 2012). Determinants denotes the 11 potential spillover determinants from firm attributes (divided by corresponding standard errors), which should be included in the regression; Controls denotes study designs (divided by corresponding standard errors), which may be included in the regression.

4. Results

Figure 2 presents information of the top 40,000 model specifications that have the highest posterior model probabilities, which measure the degree it is favored by data. The 46 study characteristics are listed on the vertical axis in descending orders of their posterior inclusion probabilities, which measure the likelihood of including a parameter in the regression. Each column represents a model specification with the column width indicates its posterior model probability. For each column, a blue cell (darker color in grayscale) implies that the corresponding study characteristic listed on the vertical axis is included in the model specification and has a positive coefficient estimate, a red cell (lighter color in grayscale) implies the corresponding study characteristic is included and has a negative coefficient estimate, and a blank cell means that the study characteristic is not included in the model specification. Figure 2 shows each study characteristic displays a consistently negative sign (red cell; lighter color in grayscale) or positive sign (blue cell; darker color in grayscale) in these specifications. For instance, WOS has a negative coefficient consistently across all 40,000 models while JV positive.

On the horizontal axis, these model specifications are presented from left to right according to their posterior model probabilities from high to low, and the cumulative posterior model probabilities are listed on the horizontal axis. The 40,000 models with highest posterior model probabilities account for about 99% of the probability on the model space.

Figure 2 The top 40,000 model specifications that have the highest posterior model probabilities



Note: The 46 study characteristics are listed on the vertical axis in descending orders of their posterior inclusion probabilities. Each column represents a model specification with the column width indicating its posterior model probability. For each column, a blue cell (darker color in grayscale) implies that the corresponding study characteristic listed on the vertical axis is included in the model specification and displays a positive estimated effect, a red cell (lighter color in grayscale) implies the corresponding study characteristic is included and displays a negative estimated effect, and a blank cell means that the study characteristic is not included in the model specification. These model specifications are presented from left to right according to their posterior model probabilities from high to low, and the cumulative posterior model probabilities are listed on the horizontal axis.

Table 1 reports the results in search of determinants of FDI horizontal spillovers using BMA-based meta-analysis. Under the columns, `PIP_ refers to posterior inclusion probability which measures the likelihood of including a parameter in the regression; `Post Mean_ and `Post SD_ report the mean and standard error computed from the full posterior distribution of a parameter. If PIP of a variable lies between 0.5-0.75, 0.75-0.95, 0.95-0.99 and 0.99-1, then the variable has an acceptable, substantial, strong or decisive effect correspondingly (Havranek et al., 2015; Kass and Raftery, 1995). A variable with PIP under 0.5 is considered to be ignorable. Apart from the 11 firm attributes, we can find 10 characteristics of study designs impact reported horizontal estimates. However, our main purpose is to investigate the determinants of horizontal spillovers. Therefore, our next analysis will focus on the 11 potential determinants from firm attributes.

Table 1 Determinants of FDI horizontal spillovers: Firm attributes

	PIP	Post Mean	Post SD

1/Se	1.000	-0.183	0.078
Constant	1.000	0.253	NA
Firm attributes			
Foreign-firm characteristics			
WOS	1.000	-0.036	0.017
JV	1.000	0.030	0.019
HMT	1.000	-0.033	0.026
Non-HMT	1.000	0.019	0.024
Domestic-orientated firms	1.000	0.043	0.063
Export-orientated firms	1.000	-0.042	0.051
Local-firm characteristics			
SOEs	1.000	-0.007	0.027
Non-SOEs	1.000	-0.003	0.028
High-tech firms	1.000	-0.010	0.055
Middle-tech firms	1.000	0.042	0.047
Low-tech firms	1.000	-0.068	0.048
Study designs			
Data characteristics			
Panel data	0.037	0.000	0.007
Aggregated data	1.000	0.299	0.054
Time span	0.041	0.000	0.001
Average year of data	1.000	0.034	0.007
Specification characteristics			
Both vertical and horizontal	0.184	-0.012	0.030
Both backward and forward	1.000	0.169	0.033
More estimates	0.037	0.000	0.005
Combination of estimates	1.000	-0.146	0.032
Lagged spillover	0.953	0.116	0.042
Foreign presence in employment	0.057	-0.002	0.016
Foreign presence in asset	0.478	-0.029	0.034
Control for foreign presence	0.051	-0.001	0.009
Control for export	0.466	-0.040	0.046
Control for absorption capability	0.999	0.156	0.042
Control for sector competition	0.093	-0.004	0.014
Estimation characteristics			
One-step estimation	0.216	-0.007	0.030
OLS	0.264	-0.023	0.046

Olley‾Pakes or Levinsohn-Petrin	0.673	-0.041	0.042
Pooled OLS	0.056	0.002	0.011
Random effects	0.128	-0.008	0.026
GMM	0.177	0.016	0.039
Year-fixed effects	0.037	-0.001	0.006
Region-fixed effects	0.037	0.000	0.006
Sector-fixed effects	0.054	0.000	0.009
Estimated in differences	0.588	0.066	0.059
Non-loglin form	0.822	-0.115	0.069
Translog	0.060	0.002	0.010
Publication characteristics			
Published	0.082	-0.003	0.015
Publication date	0.053	0.000	0.002
Paper citations	0.577	0.030	0.029
English study	0.034	0.000	0.007
Chinese co-author	0.069	-0.004	0.020
N	896		

Notes: A bold font indicates that the corresponding study characteristics has an estimated PIP larger than 0.5.

It is widely recognized that firm attributes have important effects on FDI spillover effects, however, the findings are mixed. There are five important firm attributes that are frequently highlighted in existing literature: the ownership structure of foreign firms, the origin of foreign firms, market orientation of foreign firms, the ownership structure of local firms and the technological levels of local firms.

For the ownership structure of foreign firms, the posterior mean of WOS is -0.036 while JV 0.03 in Table 1, suggesting that JV tends to yield positive technology diffusion while WOS negative. Irsova and Havranek (2013) also find JV is more likely to bring positive technology spillovers than WOS as a whole. JV may have three ways to better facilitate technology diffusion than WOS. First, local partners of JV can get easier access to insider information and advanced technologies through their foreign partners. Second, JV can better facilitate technology diffusion channels via learning-by-watching, labor market turnover and reverse engineering. Third, JV has higher tendency to participate in local production chain via vertical integration (Javorcik and Spatareanu, 2008). Unlike JV, WOS has better incentive to safeguard technology and trade secrets, which can maintain their technology advantages over local firms.

Table 1 show that foreign firms from non-HMT is likely to be more beneficial for technology diffusion than that from HMT, which is accordance with Lin et al. (2009). They argue that HMT firms tend to be more labor intensive and produce closer substitutes to products of Chinese domestic firms, which implies a stronger crowding-out effect on Chinese domestic firms by HMT firms compared to non-HMT firms. Besides, the majority of non-HMT foreign firms is from the Organization for Economic Co-operation and Development countries, which own more advanced technologies and invest more in R&D than HMT firms.

On the market orientation of foreign firms, domestic-orientated foreign firms (0.043) tend to generate much more productive spillovers than export-orientated foreign firms (-0.042). One possible explanation for this finding is that domestic-oriented foreign firms are more likely to compete with intra-sector local firms directly to acquire higher market share, the competition pressure forces local firms to adopt advanced technology (Gorg and Greenaway, 2004). Otherwise, local firms will loss their profits and innovation capabilities. In this case, the local firms have stronger incentive to imitate domestic-oriented foreign firms via learning-by-watching and reverse engineering.

For the ownership structure of local firms, the posterior means of SOEs and non-SOEs are both negative and little. It is well recognized that SOEs are less efficient and market-orientated as they undertake more non-economic roles in China (e.g. Jefferson et al., 2008). Because of ownership discrimination, however, SOEs substantiate more and better technology and human resources over non-SOEs in China. Additionally, Chinese central and local governments provide more favorable policies and financial supports for SOEs (Chen and Lin, 2009; Du et al., 2011). The respective advantages and disadvantages of SOEs and non-SOEs seem to make the two kinds of local firms similar under the absorption of technology spillovers from foreign firms.

Under the technological levels of local firms, Table 1 shows that middle-tech local firms tend to obtain more productivity spillovers than high-tech local firms and low-tech local firms. This finding reveals the nonlinear relationship between technological levels of local firms and FDI spillovers. One main potential reason is technology gap. Perez (1998) finds firms with a smaller technological gap experience positive spillovers, and firms with a larger technological gap negative spillovers. Cheng (2012) also reveals local firms significantly benefit when the technological gap is moderate. The technology gap between high-tech foreign firms and high-tech local firm is deemed to be higher than that between middle-tech foreign firms and middle-tech foreign firms in China since 1978. High-tech local firms probably lack the absorption capabilities required. On the contrast, the technology gap between low-tech foreign firms and low-tech local firms tends to be smaller, which leads to little technology leakage. Additionally, the main purpose of low-tech foreign firms may seek for cheaper labor force or/and market share in China, which results in crowding-out effect on local firms.

5. Conclusion

In this paper, we conduct a BMA-based meta-analysis of the determinants of FDI horizontal productivity spillover effects in China. The prime aim is to search for determinants of horizontal spillovers from the aspect of various firm attributes, including the ownership structure of foreign firms, the origin of foreign firms, market orientation of foreign firms, the ownership structure of local firms and the technological levels of local firms.

Our results suggest firm attributes are important determinants of horizontal spillovers. First, the ownership structure of foreign firms. JV yields positive technology diffusion while WOS negative. Second, the origin of foreign firms. Foreign firms from non-HMT is likely to be more beneficial for technology diffusion than foreign firms from HMT. Third, market orientation of foreign firms. Domestic-orientated foreign firms tend to generate much more productive spillover than export-orientated foreign firms. Fourth, the ownership structure of local firms. SOEs and non-SOEs seem to benefit similar technology spillovers from FDI. Fifth, the technological levels of local firms. Middle-tech local firms tend to obtain more horizontal productivity spillovers than high-tech local firms and low-tech local firms.

These findings also have important policy implications for policymakers. For the ownership structure of foreign firms, government should adjust the relevant policies to attract more JV. Currently, there emerges a tendency of WOS in China. The proportion of WOS reaches to 75% in 2015, meanwhile the proportion of JV reduces to 22%. The excessive proportion of WOS may reduce technology diffusion. Under the origin of foreign firms, the finding suggests that more non-HMT foreign firms facilitate technology diffusion. However, non-HMT foreign firms only account for as much as 29.7% of the total FDI stock in China as of 2015.[4] A higher proportion of FDI from non-HMT economies should be encouraged. With respect to market orientation of foreign firms, government policies on FDI inflows should pay more attention to the competition effect and crowding-out effect of domestic-orientated foreign firms. On the ownership structure of local firms, policymakers in China are suggested to free market mechanisms and enhance cooperation between SOEs and non-SOEs, which may help different domestic firms to absorb technology diffusion. In addition, domestic firms should expand investments in R&D and strengthen exchanges and cooperation in talent and technology with foreign firms, which will improve their technology absorption capacities, especially in high-tech fields.

[4] Source: China Statistical Yearbook of 2016.

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