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Determinants of foreign direct investment backward productivity spillovers: A meta-analysis

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Abstract

Drawing on a unique dataset of 694 estimates from 24 studies on backward productivity spillovers from foreign direct investment in China, our prime objective is to investigate the determinants of such spillovers using a Bayesian model averaging–based meta-analysis. Our results suggest that backward spillovers vary across firm attributes, namely 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, export-oriented foreign firms are likely to generate the greatest backward spillovers for the domestic economy among firm attributes.

Keywords: foreign direct investment; backward spillover effects; meta-analysis; Bayesian model averaging
JEL Classification Codes: C83, F21, F23

1. Introduction

It is well known that foreign direct investment (FDI) can not only bring capital and modern technology to domestic firms but also generate externalities—productivity spillovers—that may indirectly affect the productivity of local firms through horizontal spillovers (within the same sector), backward spillovers (from FDI to local suppliers), and forward spillovers (from FDI to local buyers). Moran (1998) and Navaretti and Venables (2004) offer comprehensive overviews of the benefits FDI can bring to a host country. China has been changing its economic system from a planned economy to market economy since 1978. After 1978, China advocated the so-called "market for technology" policy for attracting foreign investments to upgrade its 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 abundant empirical studies on FDI spillover effects, the reported estimates are widely dispersed in terms

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of both the signs and magnitude of spillover effects (Jefferson and Ouyang, 2014). A consensus has emerged that backward spillovers play a major role in FDI productivity spillovers (Havranek and Irsova, 2011). However, the determinants of FDI backward spillovers remain unclear.

Meta-analysis provides an effective method of quantitatively analyzing this specific topic, 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 variations of the reported estimates. For instance, Havranek and Irsova (2011) consider that the backward and forward spillover effects have a positive and statistically significant influence on the world average,[2] whereas the horizontal spillover effect is almost inexistent. Wooster and Diebel (2010) explain the magnitude and significance of FDI spillovers from the aspects of study design and data characteristics. To our knowledge, only Irsova and Havranek (2013) meta-analyze the determinants of horizontal spillovers using a dataset of 1,205 estimates from 45 countries. However, no study examines the determinants of backward spillovers in transition economies such as China. We aim to bridge this gap.

In this study, we attempt to quantitatively search for FDI backward spillover determinants in China from the aspects of firm attributes, such as the nature of foreign-invested firms and origin of foreign-invested firms, using a Bayesian model averaging (BMA) based meta-analysis. BMA is an attractive technique to account for model uncertainty; its basic idea is to regress a model with various subsets of variables and make inferences based on a weighted average over model regression.[3]

2. Data and methodology

2.1. The meta-dataset

To minimize selection bias, we included English and Chinese empirical studies that report FDI spillover estimates of China as much as possible. We only focused on the empirical studies written in English and Chinese because the majority of studies on FDI backward productivity spillovers in China are written in these two languages. The searches of English language–based literature were conducted through Google Scholar, as it provides a powerful full-text search features. Additionally, the China National Knowledge Infrastructure was used for Chinese language–based literature; it is the most widely database for Chinese researchers. We conducted 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 yielded more than 200 English studies and 1300 Chinese studies.

To ensure the comparability of the reported estimates across studies in a meta–regression analysis, studies must satisfy three basic criteria. First, the study must report the FDI backward empirical spillover estimates of China. Second, the study must define foreign presence as a ratio. Third, the study must report associated standard errors or t-statistics. For Chinese studies, however, quality is a concern because most are unpublished student papers and theses. Thus, on the basis of the aforementioned criteria, we selected the most (top 1) cited published papers for each year if available.[4]

We identified a gross list of 24 admissible studies published from 2005 to 2016, among which 17 were in English and the rest was in Chinese.[5] To account for outliers, we applied the

[1] Stanley and Doucouliagos (2012) provide comprehensive overviews of meta-analyses.
[2] Havranek and Irsova (2011) employ a dataset of 3,626 estimates from 49 economies.
[3] Zeugner and Feldkircher (2015) offer a brief summary of Bayesian model averaging.
[4] The number of citations for each Chinese study is given by the China National Knowledge Infrastructure.
[5] A listing of the 24 admissible studies is provided in Table A1 in the Appendix.

multivariate method proposed by Hadi (1994) that identifies outliers in pairs of estimates and the corresponding precision (the inverse of standard errors). Consequently, 68 outliers were identified through the procedure for backward estimates; that is, 9.80% of backward estimates were identified as outliers. In this exercise, we report the results without outliers.

In this study, two major categories—firm attributes and study designs—are collected to capture potential sources of FDI backward spillovers determinants. First, firm attributes include foreign firm characteristics and local firm characteristics. Foreign firms can be classified on the basis of their ownership structure (wholly-owned subsidiaries (WOSs) versus joint ventures (JVs)) or by their origin (investors from Hong Kong, Macao, and Taiwan (HMTs) versus investors from other countries (non-HMTs)), or by their market orientation (domestic-oriented versus export-oriented). Local firms can be divided by their ownership structure (state-owned enterprises (SOEs) versus non-state-owned enterprises (non-SOEs)) or by their technological levels (high-tech, middle-tech, and low-tech). Note that most researchers unclassified backward spillover effects by firm attributes. For instance, 39 and 42 estimates (out of a total of 694) of backward spillover effect are from WOSs onto local firms and from JVs onto local firms, respectively. The rest of estimates are unclassified and they are meant to be backward spillover effects from generic foreign firms onto local firms. To uncover the backward spillover determinants, we consider these unclassified groups as benchmark. Second, following Havranek and Irsova (2011), study designs are based on data characteristics, specification characteristics, estimation characteristics, and publication characteristics. Eventually, 43 explanatory variables are collected to capture firm attributes and study designs.[6] In our search for backward spillover determinants, we focus on the firm attributes in China.

2.2. Methodology

Publication bias is considered a serious concern that distorts statistical inference in empirical studies (Card and Krueger, 1995). It arises from the preferences of academics who favor "statistically significant" empirical results or results that are consistent with conventional theories. Estimates and their associated standard errors are deemed independent if no publication bias is noted. However, publication bias results in a systematic pattern between the reported estimates and their corresponding standard errors, which can be captured by the so-called meta-regression (Stanley and Doucouliagos, 2012) as follows:

$$e/Se(e_i) \equiv t_i = \beta_0 + e_0 \cdot 1/Se(e_i) + \varepsilon_i \quad (1)$$

where subscript i refers to individual estimate; e_0 is the reported estimate of FDI backward spillover effect in this exercise; $Se(e_i)$ is the standard error of the corresponding estimate, thus $1/\ Se(e_i)$ is its precision; t_i is the t-statistic of the reported estimate; β_0 measures the extent of publication bias; e_0 is the publication bias-corrected spillover effect; and ε_i is the random error. Our aim is to investigate the determinants of backward spillovers; thus, we rewrite Eq. (1) as follows:

$$e/Se(e_i) \equiv t_i = \beta_0 + e_0 \cdot 1/Se(e_i) + \gamma \cdot Determinants + \lambda \cdot Controls + \varepsilon_i \quad (2)$$

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

[6] He et al. (2018) offer a detailed description of the 43 variables.

3. Results

Table 1 reports the results of the search of FDI backward spillover determinants using BMA. 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" respectively report the mean and standard error computed from the full posterior distribution of a parameter. If the PIP of a variable lies between 0.5 and 0.75, 0.75 and 0.95, 0.95 and 0.99, and 0.99 and 1, then the variable has an acceptable, substantial, strong, and decisive effect, respectively (Havranek et al., 2015; Kass and Raftery, 1995). A variable with a PIP under 0.5 is considered ignorable. Apart from the firm attributes, we identify 10 characteristics of study designs that affect reported estimates. However, our main purpose is to discover the determinants of backward spillovers. Therefore, our next analysis focuses on the 11 potential determinants from firm attributes.

The priors on parameters and priors on models are required to estimate posterior distributions in BMA. We employ the unit information prior ("UIP") on Zellner's g-prior (prior on parameters) and a uniform model prior ("uniform") that is prior on models following Zeugner and Feldkircher (2015), which are commonly used to reflect unknown parameter and model size.[7]

Table 1. Determinants of FDI backward spillovers: BMA (weighted specification)[8]

	Prior on parameters = "UIP" Prior on models = "uniform"		
	PIP	Post Mean	Post SD
1/Se	1.000	1.357	0.786
Constant	1.000	0.382	NA
Firm attributes			
Foreign firm characteristics			
WOSs	**1.000**	**-0.312**	**0.099**
JVs	**1.000**	**0.148**	**0.082**
HMTs	**1.000**	**0.036**	**0.346**
Non-HMTs	**1.000**	**0.187**	**0.347**
Domestic-oriented firms	**1.000**	**0.134**	**0.126**
Export-oriented firms	**1.000**	**1.142**	**0.140**
Local firm characteristics			
SOEs	**1.000**	**0.256**	**0.182**
Non-SOEs	**1.000**	**-0.045**	**0.140**
High-tech firms	**1.000**	**-0.491**	**0.499**
Middle-tech firms	**1.000**	**0.219**	**0.486**
Low-tech firms	**1.000**	**0.070**	**0.488**

[7] Note that there are alternative settings for priors on parameters and priors on models, such as benchmark prior ("BRIC") on parameters and beta-binomial model prior ("random") on models. We also try these settings, and get quite similar results comparing with Table 1. The associated results are available on request

[8] To check the robustness, we generate the BMA results for unweighted specification based on the following equations $e = e_0 + \beta_0 \cdot Se(e_i) + \alpha \cdot Determinants + \varphi \cdot Controls + \varsigma_i$; the results are available on request.

Study designs			
Data characteristics			
Panel data	0.133	0.052	0.178
Aggregated data	0.239	0.105	0.219
Time span	**0.767**	**0.046**	**0.031**
Average year of data	**0.998**	**0.131**	**0.031**
Specification characteristics			
Both vertical and horizontal	0.032	0.001	0.038
Both backward and forward	0.220	0.081	0.177
More estimates	0.059	-0.006	0.042
Combination of estimates	**0.960**	**-0.656**	**0.217**
Lagged spillover	0.040	-0.001	0.028
Foreign presence in employment	**0.857**	**0.362**	**0.199**
Foreign presence in asset	0.267	0.091	0.180
Control for foreign presence	0.073	-0.009	0.062
Control for export	0.107	-0.021	0.076
Control for absorption capability	0.169	0.067	0.185
Control for sector competition	0.085	-0.010	0.041
Estimation characteristics			
One-step estimation	0.084	-0.008	0.039
OLS	0.038	-0.002	0.029
Olley–Pakes or Levinsohn-Petrin	0.037	-0.002	0.026
Pooled OLS	**0.727**	**-0.361**	**0.278**
Random effects	**0.973**	**-0.432**	**0.141**
GMM	0.069	-0.033	0.187
Year-fixed effects	0.133	0.022	0.103
Region-fixed effects	0.053	0.004	0.050
Sector-fixed effects	0.356	-0.140	0.215
Estimated in differences	**0.982**	**-0.643**	**0.199**
Non-loglin form	0.030	-0.004	0.666
Translog	**1.000**	**-1.187**	**0.177**
Publication characteristics			
Published	0.050	-0.001	0.032
Publication date	**0.994**	**-0.137**	**0.027**
Paper citations	0.087	-0.010	0.046
English study	**0.616**	**0.307**	**0.290**
Chinese co-author	0.232	-0.224	0.470
N	626		

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

Five major firm attributes are frequently highlighted in the 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. However, the

findings are mixed. In terms of market orientation of foreign firms, for example, Xu and Sheng (2012) suggest export-oriented foreign firms are likely to yield more backward spillovers compared with domestic-oriented foreign firms; however, Lin et al. (2009) report opposite findings.

For the ownership structure of foreign firms, the posterior mean of WOSs is −0.312 and that of JVs is 0.148 in Table 1, suggesting that JVs tend to yield positive technology diffusion, whereas WOSs negative. JVs have three methods to facilitate technology diffusion when WOSs do not. First, local partners of JVs have easier access to insider information and advanced technologies through their foreign partners. Second, JVs can facilitate technology diffusion channels via learning-by-watching, labor market turnover, and reverse engineering. Third, JVs have a higher tendency to participate in the local production chain through vertical integration (Javorcik and Spatareanu, 2008). Unlike JVs, WOSs have a stronger incentive to safeguard technology and trade secrets, which can help them maintain their technology advantages over local firms.

Table 1 indicates that non-HMT foreign firms are likely to be more beneficial to technology diffusion than HMT foreign firms, which is in accordance with the findings of Lin et al. (2009). Most non-HMT foreign firms in China come from the Organization for Economic Co-operation and Development (OECD). Such countries have more advanced technologies and invest more in R&D. HMT firms tend to take advantage of the lower cost of labor in China and compete with local firms. Therefore, HMT firms tend to generate larger crowding-out effects than non-HMT firms.

On the market orientation of foreign firms, export-oriented foreign firms tend to generate considerably more productive spillovers than domestic-oriented foreign firms. One potential reason is that export-oriented foreign firms can lower information barriers for their suppliers and stimulate them to pursue international markets. To achieve this goal, local suppliers have to promote their product quality and productivity to meet international standards. Export-oriented foreign firms are likely to generate the largest backward spillovers for local firms among all aforementioned firm types.

For the ownership structure of local firms, the posterior mean of SOEs is 0.256 and that of non-SOEs is -0.045. The BMA results indicate that SOEs are likely to benefit from more technology spillovers from FDI than non-SOEs. It is well recognized that SOEs are less efficient and market-oriented because they undertake more noneconomic roles in China. Because of ownership discrimination, however, SOEs have a superior quantity and quality of technology as well as a better human resources foundations compared to non-SOEs in China. In addition, Chinese central and local governments provide more favorable policies and financial support for SOEs. These factors may encourage technology spillovers from foreign firms. Lin et al. (2009) also argue that SOEs do not lack the technology absorption capacity to learn from foreign customers.

Under the technological levels of local firms, Table 1 demonstrates that middle-tech local firms tend to obtain more productivity spillovers than high-tech and low-tech local firms do. The posterior mean of high-tech local firms is negative. One potential reason is that high-tech local firms lack the necessary ability to provide immediate products for high-tech foreign firms and absorb the backward spillover effects from FDI. However, international suppliers will follow the high-tech foreign firms entering the Chinese market. Their international suppliers own much more advanced technology and have more levels of management, such as the case with Japanese automobile firms, which outperform local suppliers. Jeon et al. (2013) also reported similar findings.

4. Conclusion

In this study, we conduct a meta-analysis of FDI backward productivity spillover effects in China using BMA. The prime objective is to search for determinants of backward spillovers from the aspect of firm attribute, that is, 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 that firm attributes are major determinants of backward spillovers. First, for the ownership structure of foreign firms, JVs tend to yield positive technology diffusion, whereas WOSs negative. Second, regarding the origin of foreign firms, non-HMT firms are likely to be more beneficial for technology diffusion than foreign firms from HMT are. Third, in terms of market orientation, export-oriented foreign firms tend to generate substantially more productive spillover than domestic-oriented foreign firms. Fourth, as for the ownership structure of local firms, SOEs are likely to benefit more from technology spillovers from FDI than non-SOEs. Fifth, concerning the technological levels of local firms, middle-tech local firms tend to obtain more backward productivity spillovers than high-tech and low-tech local firms do.

References

Card, D., and Krueger, A.B. (1995) Time-series minimum-wage studies: A meta-analysis, *The American Economic Review*, 85(2), 238-243.

Hadi, A. S. (1994) A modification of a method for the detection of outliers in multivariate samples, *Journal of the Royal Statistical Society. Series B (Methodological)*, 56, 393-396.

Havranek, T., Horvath, R., Irsova, Z., and Rusnak, M. (2015) Cross-country heterogeneity in intertemporal substitution, *Journal of International Economics*, 96(1), 100-118.

Havranek, T., and Irsova Z. (2011) Estimating vertical spillovers from FDI: Why results vary and what the true effect is, *Journal of International Economics*, 85(2), 234-244.

He, S., Kwan Y. K., and Fan H. (2018) In search of FDI horizontal spillovers in China: Evidence from meta-analysis, *Quality & Quantity*, (2018): 1-23. doi: 10.1007/s11135-018-0825-3 (forthcoming).

Irsova, Z., and Havranek, T. (2013) Determinants of horizontal spillovers from FDI: Evidence from a large meta-analysis, *World Development*, 42, 1-15.

Javorcik, B. S., and Spatareanu, M. (2008) To share or not to share: Does local participation matter for spillovers from foreign direct investment? *Journal of Development Economics*, 85(1-2), 194-217.

Jefferson, G. H., and Ouyang, M. (2014) FDI spillovers in China: Why do the research findings differ so much?, *Journal of Chinese Economic and Business Studies*, 12(1), 1-27.

Jeon, Y., Park, B. I., and Ghauri, P.N. (2013) Foreign direct investment spillover effects in China: Are they different across industries with different technological levels? *China Economic Review*, 26, 105-117.

Kass, R. E., and Raftery, A.E. (1995) Bayes factors, *Journal of the American Statistical Association*, 90(430), 773-795.

Lin, P., Liu, Z., and Zhang, Y. (2009) Do Chinese domestic firms benefit from FDI inflow? Evidence of horizontal and vertical spillovers, *China Economic Review*, 20(4), 677-691.

Moran, T. (1998) Foreign direct investment and development. *Institute for international Economics*: Washington D.C..

Navaretti, B., and Venables A. (2004) Multinational firms in the world economy. *Princeton University Press*: Oxford.

Stanley, T. D., and Doucouliagos H. (2012) Meta-regression analysis in economics and business. *Routledge*: London.

Stanley, T. D., and Jarrell, S.B. (1989) Meta-regression analysis: A quantitative method of literature surveys, *Journal of Economic Surveys*, 3(2), 161-170.

Wooster, R. B., and Diebel D.S. (2010) Productivity spillovers from foreign direct investment in developing countries: A meta-regression analysis, *Review of Development Economics*, 14(3), 640-655.

Xu, X,. and Sheng, Y. (2012) Are FDI spillovers regional? Firm-level evidence from China. *Journal of Asian Economics*, 23(3), 244-258.

Zeugner, S., and Feldkircher, M. (2015) Bayesian model averaging employing fixed and flexible priors: The BMS package for R, *Journal of Statistical Software*, 68(4), 1-37.

Appendix

Table A1. List of primary studies.

ID	***Study***	***Publication type***	***Language***	***No. of estimates***	
				With outliers	***Without outliers***
1	Blake, Deng and Falvey (2009)	Journal article	English	6	6
2	Du, Harrison and Jefferson (2012)	Journal article	English	15	15
3	Girma and Gong (2008a)	Journal article	English	48	48
4	Girma and Gong (2008b)	Journal article	English	8	5
5	Huang and Sharif (2009)	Journal article	English	26	25
6	Jeon, Park and Chauri (2013)	Journal article	English	62	58
7	Lin, Liu and Zhang (2009)	Journal article	English	22	21
8	Liu (2008)	Journal article	English	6	6
9	Liu, Wang and Wei (2009)	Journal article	English	36	36
10	Qiu, Yang, Xin and Kirkulak (2009)	Journal article	English	7	7
11	Ran, Voon and Li (2007)	Journal article	English	27	27
12	Wang and Zhao (2008)	Journal article	English	7	5
13	Xu and Sheng (2012)	Journal article	English	17	13
14	Tang (2008)	PhD diss.	English	129	129
15	Chang, Chung and Xu (2007)	Working paper	English	32	8
16	Du, Harrison and Jefferson (2011)	Working paper	English	113	110
17	Liang (2009)	Working paper	English	24	24
18	Chen, Zhu and He (2012)	Journal article	Chinese	2	2
19	Fan and Wu (2011)	Journal article	Chinese	3	3
20	Qi, Xu and Ai (2008)	Journal article	Chinese	36	36
21	Xu, Wei, Lai and Wang (2007)	Journal article	Chinese	12	1
22	Yang and Chen (2015)	Journal article	Chinese	36	36
23	Yang, Li and Cai (2016)	Journal article	Chinese	5	5
24	Zhou and Qi (2005)	Journal article	Chinese	15	-
Total				694	626