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Vertical FDI Spillover from Joint Venture to Host Country's parent firm: Evidence from China

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***Abstract*—Compared with earlier literature focusing on domestic firm in macro level or industry level, this study investigates the FDI spillover from joint venture to host country's parent firm in firm level, especially vertical spillover. By matching two sets of Chinese firm-level comprehensive database and applying upstreamness developed by Antràs et al. (2012), we can identify the specific joint venture and host country's parent firm of the spillover and their positions in value chain. Finally, this study finds that there is the FDI spillover from joint venture to host country's parent firm. The farther the host country's parent firm is located downstream of the JV in value chain, the higher the spillover effect is. Furthermore, given the fixed "distance" between positions of those two firms in value chain, host country's parent firm is more productive with higher upstreamness in backward linkage. On the contrary, it is more productive with lower upstreamness in forward linkage.**

Keywords—Host country's parent firm; Vertical FDI spillover; Total factor froductivity; Upstreamness

I. INTRODUCTION

Many developing countries strive to establish joint venture to acquire advanced technology, management experience and sufficient capital from its foreign parent, hoping that knowledge will spill over to host country's parent firm and finally be diffused to other domestic firms (Javorcik, 2008; Aitken and Harrison, 1997).

However, existing literature only focuses on domestic firms, omitting the host country parent unfortunately. But if host country's parent firm cannot be spill over to, the spillover to domestic firms is more doubtable. This maybe one of the reasons that the conclusions of existence and effect of FDI spillover are controversial. What's more, due to difficulty of identifying the specific foreign affiliate and domestic firm of spillover, the existing empirical studies mostly focus on macro-level and industrial-level evdiences, especially studies of vertical spillover. So there is a lack of firm-level FDI spillover study (Blomström et al., 2000).

This study identifies the "joint venture – host country's parent firm" relationship by matching two sets of Chinese firm-level comprehensive database, 1998-2007 China Industrial Enterprise Database and 2001 & 2002 China Foreign Direct Investment Database. Position of both JV and China parent in the value chain are identify by upstreamness developed by Antràs et al. (2012). Then total factor productivity is measured by semi-paremetre estimated methods proposed by Amiti and Konings(1997) and Ackerberg et al. (2006) respectivily. Therefore, it is possible to study vertical spillover at firm level.

The contribution of this study is threefold. First, the host country's parent firm is investigated for the first time. So we can push the study of FDI spillover forward to spillover between JV and its domestic parent. Second, by identifying firm's position in the value chain, this study considers the vertical spillover of those two firms for the first time. Third, in contrast with earlier macro-level and industry-level studies, this study give us firm-level evidence of FDI spillover.

The remainder of this paper is structured as follows: Section II describes data, empirical strategy and method of measurement. Section III gives the empirical result of FDI spillover from JV to domestic parent, while Section IV further investigates their vertical spillover. Conclusions are presented in final section.

II. METHODOLOGY

A. Data Preparing

This paper uses two sets of Chinese firm-level comprehensive database: 1998-2007 China Industrial Enterprise Database and 2001 & 2002 China Foreign Direct Investment Database. So firm characteristics can be captured accurately and foreign affiliates can be covered widely.

Considering the reporting errors in CIE Database, this study follows Feenstra et al. (2014), Cai and Liu (2009), and the General Accepted Accounting Principles to discard observations. The FDIC Database is derived from Chinese Ministry of Commerce's multi-round survey of all foreign affiliates in China. Variables such as country of origin, China parent and investment amounts provide clues for the identification of "JV- China parent" relationships (Tang and Zhang, 2014).

This two databases are matched by firm ID and firm name. We can obtained 13,534 "joint venture – host country's parent firm" observations from 1998 to 2007.

B. Empirical Strategy

This study uses regression to estimate the FDI spillovers from JV to its domestic parent with following baseline reduced-form equation:

$$lnTFP\_P_{ijkt} = \beta_0 + \beta_1 lnTFP_{ijgk} + \beta_2 upstreamness_{ijkt} + AX\_P_{ijkt} + \xi\_P_j + \xi\_P_k + \xi\_P_t + \varepsilon\_P_{ijkt}$$

where $lnTFP_{ijkt}$ represents the logarithm of total factor productivity of firm i in industry k and regien j at year t. Its parameter β_1 is the estimated spillover effect from JV to domestic parent. $upstreamness_{ijkt}$ represents firm's position in value chain.

X_P is a set of controlled variables of domestic parent, which may affect parent's TFP. The set includes firm size, l_P (donated by logarithm of employment), export status, FX_P (equal to 1 for export and 0 otherwise), market share, MS_P (donated by 4-digit sector market share) and capital intensity, kintensity_P (donated by logarithm of capital per worker). Fixed effect terms of region, industry and year are also included and donated by ξ_P_j , ξ_P_k and ξ_P_t respectively. ε_P_{ijkt} is the error term that follows the standard normal distribution and includes all unobserved factors that may affect productivity. As variables in above equation is about firm-specific characteristics, error terms are clustered at firm level to address the potential correlation of errors within each firm. Thus, identifications in the baseline specification are based on changes over time in TFP within a firm [1].

C. Measurements

1) Total Factor Productivity

Productivity is used to represent technology. To capture more factor's contribution to productivity, this study apply total factor productivity. Considering the simultaneous bias and selection bias caused by traditional OLS method, an augmented Olley and Pakes (1996) approach, which is based on the improvement of Amiti and Konings (2007) for international economics scenario, is employed. Then the semi-parametre estimation method of Ackerberg et al. (2006) is also applied to deal with the problem of collinearity. Finally, we can get TFP_AK_P, TFP_ACF_P, respectively [2].

2) Upstreamness

Antràs et al. (2012) and Antràs and Chor (2013) develop upstreamness to measure industry's position in value chain to help us identify the specific JV and domestic parent of vertical spillover.

There are N industries in a closed economy. Among the total output Y_i in each industry $i \in \{1,2,\cdots,N\}$, F_i is the final product and Z_i is the intermediate input used for other industries. Therefore, we have:

$$Y_i = F_i + Z_i = F_i + \sum_{j=1}^{N} d_{ij} Y_j$$

where d_{ij} represents input of industry i used for per unit output of industry j [3]. Repeating this procedure, we can express the product of industry i as an infinite sum of how it is used in every industry in value chain. Then we can calculate the weighted-average position of industry i in the value chain:

$$U_i = 1\times\frac{F_i}{Y_i} + 2\times\frac{\sum_{j=1}^{N} d_{ij}F_j}{Y_i} + 3\times\frac{\sum_{j=1}^{N}\sum_{k=1}^{N} d_{ik}d_{kj}F_j}{Y_i} + 4\times\frac{\sum_{j=1}^{N}\sum_{k=1}^{N}\sum_{i=1}^{N} d_{il}d_{lk}d_{kj}F_j}{Y_i} + \cdots$$

Obviously, the upstreamness $U_i > 1$, indicating the weighted-average "distance" between the positions of industry i in value chain and the final consumption. The higher the value of upstreamness of an industry is, the more steps exist before the products of the industry reaches the final consumer.

What's more, considering $\sum_{i=1}^{N} d_{ij} > 1$, the numerator of each item in below equation is equal to the i-th element in the $N\times 1$ matrix, $[I-D]^{-2}F$. Since $Y=[I-D]^{-1}F$, the denominator can be expressed as the i-th element in the $N\times 1$ matrix, $[I-D]^{-1}Y$ [4]

It can be proved that if upstreamness of an industry is high, there exists many steps before the products of industry reach the final consumers.

The applied data includes each firm's total output and 2-digit industry code it belongs to. Noting the firm's industry code is based on firm's main products, we assume the firm do not produce multiple products which belong to different sectors. Thus, the upstreamness of industry can be used as an approximation to the firm's upstreamness.

III. SPILLOVER FROM JV TO ITS DOMESTIC PARENT

Domestic parent's TFP is regressed on JV's TFP at first. Then controlled variables and fixed effects are added in the model one by one. Results in Table I show that the parameters of TFP_AK are positive at the 1% significant level in every model. In model (5) this parameter is 0.197, which means that if the logarithmic TFP of JV increases by 1 unit, logaritmic TFP of domestic parent can increase by 0.197 units. So we

[1]Variable settings, summary statistics, T-tests, etc. are not listed and can be obtained from author.
[2]These two methods are represented as AK method and the ACF method. Since they have been widely applied, the derivation process is not presented and can be obtained from author.
[3] d_{ij} is derived from 2002 China Input-Output Table.
[4]D is a $N\times N$ matrix. The (i, j)-th element in the matrix is d_{ij} . F is a column vector whose each row is composed of F_i and *Y* is a column vector whose each row is composed of Y_i .

know that there exists FDI spillover from JV to its domestic parent.

TABLE I. SPILLOVER FROM JV TO HOST COUNTRY PARENT[5]

	TFP_AK_P				
	(1)	(2)	(3)	(4)	(5)
TFP_AK	0.429***	0.422***	0.361***	0.201***	0.197***
	(0.015)	(0.015)	(0.015)	(0.014)	(0.014)
l_P		-0.002	0.002	0.010***	0.011***
		(0.003)	(0.003)	(0.003)	(0.003)
FX_P		0.011	0.005	0.010	0.007
		(0.007)	(0.007)	(0.006)	(0.006)
MS_P		0.709***	0.804***	0.840***	0.839***
		(0.167)	(0.187)	(0.168)	(0.170)
kintensity_P		0.013***	0.009***	0.005	0.004
		(0.003)	(0.003)	(0.003)	(0.003)
Time Fixed Effect	N	N	Y	Y	Y
Induest Fixed Effect	N	N	N	Y	Y
Region Fixed Effect	N	N	N	N	Y
N	13534	13534	13534	13534	13534
R2	0.176	0.19	0.226	0.398	0.407
Adjusted R2	0.176	0.19	0.225	0.396	0.404

Javorcik (2004) found that foreign affiliate can cause fierce competition for domestic firm in same sector, which both increases and decreases domestic firm's productivity through competition effect. But for domestic firm in different sector, since foreign firms tend to expand distribution network and improve channels locally, they often provide technical support with more initiative. So honrizontal spillover and vertical spillover should be estimated.

Models (1)-(4) in Table II investigate honrizontal spillover, while model (5)-(8) investigate vertical spillover. Each type of spillover contains four kinds of productivity measurements, TFP measured by AK method and ACF method, and labor productivity measure by output per worker and value-added per worker. Results show that parameters of each model are positive at 1% significant level. So we can be convinced that the domestic parent can get positive spillover from JV in both honrizontal and vertical directions.

TABLE II. VERTICAL SPILLOVER AND HORIZONTAL SPILLOVER

	Honrizontal Spillover				Vertical Spillover			
	TFP_AK_P	TFP_ACF_P	productivity1_P	productivity2_P	TFP_AK_P	TFP_ACF_P	productivity1_P	productivity2_P
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TFP_AK	0.239***				0.162***			
	(0.020)				(0.019)			
TFP_ACF		0.237***				0.146***		
		(0.021)				(0.019)		
productivity1			0.226***				0.174***	
			(0.024)				(0.021)	
Productivity2				0.213***				0.152***
				(0.021)				(0.020)
Controlled Variables	Y	Y	Y	Y	Y	Y	Y	Y
3 types of Fixed Effect	Y	Y	Y	Y	Y	Y	Y	Y
N	6317	6317	6317	5801	7201	7201	7201	6642
R2	0.422	0.467	0.51	0.464	0.415	0.469	0.467	0.42
Adjusted R2	0.416	0.462	0.505	0.458	0.41	0.464	0.463	0.414

IV. VERTICAL SPILLOVER

A. Position of Firm in Value Chain

Javorcik(2004) found that spillover between foreign affiliate and domestic firm, which have backward linkage, is significant. But for forward linkage, it is not significant[6]. Is that still true between joint venture and domestic parent?

Models (1) and (2) in Table III regress the TFP of China parent on JV's TFP and upstreamness of China parent respectively. Then both independent variables are included in model (3). They both have positive effect at 1% significant level. We can find that the higher the upstreamness is, the higher the productivity China parent have. It is consistent with Ju and Yu (2014)'s conclusion. However, in model (4), the

[5]Cluster-robust standard error are in the parentheses in the tables. All regressions include a constant term. * represents p < 0.1; ** **represents p < 0.05; *** represents p < 0.01. Y and N respectively represent whether there is a fixed effect.

interaction item of those two independent variables is not significant and the significance of upstreamness is decreased. It means that position of domestic parent affects its TFP, but not the spillover effect. Maybe we have to consider the relative position and relationship between JV and its domestic paren

TABLE III. IMPACT OF DOMESTIC PARENT'S POSITION IN VALUE CHAIN

	TFP_AK_P	TFP_AK_P	TFP_AK_P	TFP_AK_P
	(1)	(2)	(3)	(4)
TFP_AK	0.197***		0.197***	0.211***
	(0.014)		(0.014)	(0.029)
Upstreamness		0.007***	0.009*	0.012*
		(0.001)	(0.005)	(0.007)
interaction				-0.004
				(0.008)
Controlled Variables	Y	Y	Y	Y
3 types of Fixed Effect	Y	Y	Y	Y
N	13534	1824637	13534	13534
R2	0.407	0.382	0.407	0.407
Adjusted R2	0.404	0.382	0.404	0.404

The "distance" between positions of JV and its domestic parent in value chain is investigated. disup is the difference which equals to upstreamness of domestic parent minus upstreamness of its JV and measures the "distance". Results from model (1)-(3) in Table Ⅳ show that disup does not affect domestic parent's TFP significantly and directly. But after including the interaction term between TFP of JV and disup in model (4), disup is significantly negative at 10% level and the interaction term is significantly positive at 5% level. We may know that the "distance" affects FDI spillover, but not parent's TFP. Besides, if there is forward linkage, the farther the "distance" is, the higher the spillover effect to domestic parent is. This means that forward linkage is more beneficial for technology spillover. In other words, the farther the domestic parent is located downstream of the JV, the higher the spillover effect is.

TABLE IV. "DISTANCE" OF POSITION IN VALUE CHAIN BETWEEN DOMESTIC PARENT AND JV

	TFP_AK_P	TFP_AK_P	TFP_AK_P	TFP_AK_P
	(1)	(2)	(3)	(4)
TFP_AK	0.197***		0.211***	0.214***
	(0.014)		(0.023)	(0.022)
disup		-0.000	0.001	-0.015*
		(0.001)	(0.003)	(0.008)
interaction2				0.027**
				(0.013)
Controlled Variables	Y	Y	Y	Y
3 types of Fixed Effect	Y	Y	Y	Y
N	13534	12616	3370	3370
R2	0.407	0.265	0.296	0.297
Adjusted R2	0.404	0.261	0.283	0.285

B. Forward Linkage and Backward Linkage

The model (1) in Table V investigates the backward linkage, showing that the higher upstreamness of domestic parent is, the higher the spillover effect is. Model (2) investigates the forward linkage and finds that the lower the upstreamness of domestic parent is, the higher the spillover effect is

[6] If foreigh affiliate is related to upstream domestic firm, they have backward linkage. Otherwise, if foreign affiliate is related to downstream domestic firm, they have forward linkage.

TABLE V. BACKWARD LINKAGE AND FORWARD LINKAGE

	TFP_AK_P	TFP_AK_P
	Backward Linkage	Forward Linkage
	(1)	(2)
TFP_AK	0.189***	0.159***
	(0.015)	(0.047)
upstreamness_P	0.015***	-0.047***
	(0.005)	(0.015)
Controlled Variables	Y	Y
3 types of Fixed Effect	Y	Y
N	10917	847
R2	0.426	0.327
Adjusted R2	0.423	0.283

C. Endogeneity

There exists two-sided effects between TFP of both JV and its domestic parent, which may lead to endogenous problem. So models (1)-(4) in Table Ⅵ replace JV's productivity with its lagged term. Besides, models (5) and (6) use lagged variable as instrument variable and then apply two stage least square method to modify the endogeneity. We may find that endogeneity doesn't affect the conclusion.

TABLE VI. ENDOGENEITY

	(1)	(2)	(3)	(4)	(5)	(6)
	TFP_AK_P	TFP_ACF_P	productivity1_P	productivity2_P	TFP_AK	TFP_AK_P
L.TFP_AK	0.150***				0.644***	
	(0.014)				(0.014)	
L.TFP_ACF_P		0.145***				
		(0.015)				
L.productivity1_P			0.176***			
			(0.017)			
L.productivity2_P				0.146***		
				(0.016)		
TFPHAT						0.232***
						(0.021)
Controlled Variables	Y	Y	Y	Y	Y	Y
3 types of Fixed Effect	Y	Y	Y	Y	Y	Y
N	10858	10858	10858	8917	9475	10858
R2	0.426	0.474	0.471	0.418	0.552	0.426
Adjusted R2	0.423	0.471	0.468	0.413	0.549	0.423

V. CONCLUSION

This study matches two sets of large firm-level database to get "joint venture - host country's parent firm" data. So specific firms of FDI spillover can be identified and spillover effect, especially vertical spillover effect, can be estimated at firm level.

The conclusion shows that there is FDI spillover from JV to domestic parent, both on horizontal and vertical directions. For the vertical spillover, position of domestic parent in value chain affects its own productivity, but not the spillover effect. Instead, "distance" between positions of domestic parent and its JV in value chain affects the spillover effect. That is, the farther the domestic parent is located downstream of the JV, the higher the effect of spillover is. Besides, given the fixed "distance", if those two firms are backward linkage, the domestic parent is more productive with higher upstreamness. Otherwise the parent is more productive with lower uptreamness in the forward linkage condition.

This study confirms the feasibility of achieving technology progress by establishing JV for domestic parent in developing country. In terms of vertical spillovers, parent should locate upstream of the value chain and establish upstream JV to provide raw materials and intermediate. Since the Sino-US trade war is advanced to the technology war, which involves issues of technology diffusion and intellectual property protection, this study provides developing country a way to achieve technology progress without compulsory technology transfer.

Due to the availability of data, this study lacks of foreign parent, which is one of the directions that future research can investigate.

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