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Heterogeneous Spillover Effects of Outward FDI on Global Value Chain Participation

Summary: This study delves into the effects of outward foreign direct investment (FDI) on global value chain (GVC) participation from 2000 to 2014. The utilization of traditional panel models, the spatial Durbin model (SDM), and the threshold model provides a comprehensive understanding of the heterogeneous spillover effects of outward FDI. The results show that increased outward FDI not only facilitates the GVC participation of parent countries but also has a profound impact on that of other countries. The spillover effects of outward FDI play a vital role in the GVC participation of low total factor productivity (TFP) countries. However, for developed countries with high TFP levels, outward FDI has positive impacts on deep GVC participation while not influencing shallow participation. These findings serve as an extension to the relevant theories and suggest a way for developing countries to capture gains from outward FDI and participate further in GVCs.

Key words: Outward FDI, GVC participation, SDM, Threshold model.

JEL: F15, F23.

The accelerating globalization of production, coupled with capital account liberalization at the multilateral level, prompts firms to invest abroad to expand their operations. Despite the increasing attention paid to the complementary or substitutionary effects of outward foreign direct investment (FDI) on employment, investment, trade in exports, and so on, the relationship between outward FDI and global value chain (GVC) participation has been neglected by mainstream academics to some extent. Hence, our study intends to fill this gap and explores the potential mechanisms within the framework of GVCs and the "knowledge capital model" (KC model). In addition to traditional panel models, we estimate the spatial Durbin model (SDM) jointly with the threshold model to investigate the heterogeneous spillover effects of outward FDI on GVC participation. By doing so our study has sought to act as an extension to the existing theories on multinational enterprises (MNEs) and GVCs and lends support to the opening-up strategies implemented in many developing and transition economies.

The rest of this paper is arranged as follows. Section 1 explores the potential mechanisms and presents the main hypotheses based on the relevant literature. Section 2 introduces the construction of the models. Section 3 provides details of the measurement of variables as well as the data sources. Section 4 illustrates the descriptive and

empirical results, including the spatial autocorrelation and heterogeneity test. Section 5 concludes with policy implications.

1. Literature Review

This section reviews the relevant studies on both outward FDI and GVC participation and puts forward three hypotheses according to the existing literature and theories.

An early explanation for the rise of outward FDI in industrial organization theory was that the key intangible assets, such as advanced technology, management skills, and production differentials, possessed by transnational firms bring them profit and competitive advantages over the other firms in the host countries (Stephen Hymer 1970; Richard E. Caves 1971). Afterwards, further development of the MNE theory produced the KC model (David L. Carr, James R. Markusen, and Keith E. Maskus 2001), which spawned burgeoning interest in FDI (Markusen 1997; Markusen and Maskus 2002; Bruch A. Blonigen, Ronald B. Davies, and Keith Head 2003). A large body of literature has argued that outward FDI may have substitutionary or complementary effects on employment (Jozef Konings and Alan Murphy 2001; Ludo Cuyvers et al. 2005; Marc A. Muendler and Sascha O. Becker 2010), investment (Pontus Braunerhjelm, Lars Oxelheim, and Per Thulin 2005), exporting (Giorgio B. Navaretti and Davide Castellani 2003; Neil Foster-McGregor, Anders Isaksson, and Florian Kaulich 2014), and so on. However, fewer studies by far have investigated the effects of outward FDI on GVC participation.

Outward FDI and exporting are alternative ways to participate in GVCs, but whether increasing outward FDI will lead to growing GVC participation depends on the measurement of GVC participation. As illustrated in Figure 1, the domestic value added consists of four parts: the first two parts are identified as non-GVC participation, since they are either a non-trade part or traded for consumption purposes, while the third and fourth parts are identified as shallow and deep GVC participation, respectively, because the value added in these parts is traded for production purposes (Robert Koopman, Zhi Wang, and Shang-Jin Wei 2008; Wang et al. 2017). After adding outward FDI, we can obtain three typical cases to simplify the analysis. In case I, outward-investing firms from country *i* set up affiliates to produce final products for local consumers in country *j*, belonging to non-GVC activities; thus, the outward FDI may not influence the GVC participation. In case II, there may be two outcomes: (a) the affiliates engage in certain production stages, then the outward FDI may facilitate the GVC participation of country *i* by inducing more exports of intermediate inputs from *i*; (b) the affiliates supply the same intermediate inputs to local final goods manufacturers, then the outward FDI may reduce the GVC participation of *i* by substituting the intermediate inputs from *i*. In case III, the affiliates produce intermediate goods and provide them to a third country, then outward FDI may increase the GVC participation of the host country *j* while reducing that of the parent country *i*. In fact, the situations are much more complicated.

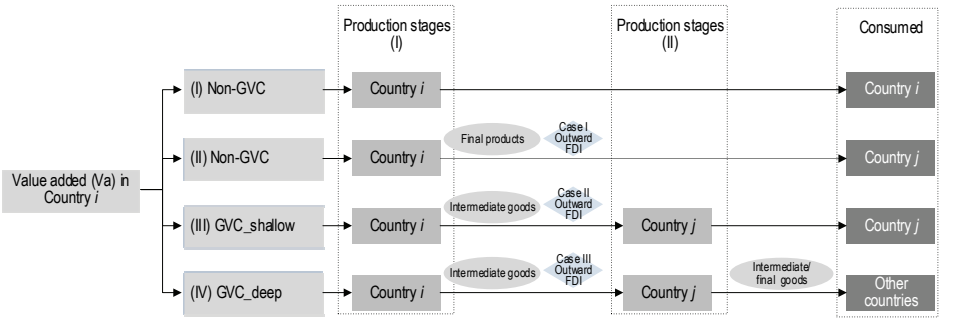


Figure 1 The Decomposition of Value Added and Possible Cases of Outward FDI

However, the preponderance of extant literature favors the complementary effects of outward FDI. On the one hand, through technology spillovers, marketing skills, newly developed products, and so on, outward FDI is conducive to the expansion of the industry size in host countries, thus inducing more exports of intermediate inputs from parent countries (Walid Hejazi and Peter Pauly 2003; Peter Egger 2007; Zitian Victor Chen, Jing Li, and Daniel M. Shapiro 2012). Subsequent to the increasing value added embedded in the exported intermediate inputs, the GVC participation of the home country would show a rise, which may surpass the initial reduction. On the other hand, investing in low-cost host countries helps to cut down the production costs of MNEs, promote economies of scale, and improve their competitiveness (Jaan Masso, Urmas Varblane, and Priit Vahter 2007). Moreover, the repatriation of profits brought by such improvement to the parent firms allows the scaling up of production and boosts R&D investment, hence contributing to increasing the GVC participation of the parent country. Summarizing this line of argument produces the first hypothesis.

H1. An increase of outward FDI may have positive effects on the GVC participation of parent countries.

Meanwhile, outward FDI may benefit the GVC participation of the host countries when the outward investors relocate the production of intermediate inputs to these countries. The local producers may gain "spillover" effects from externalities generated by the existence of transnational firms, since the monopolistic advantages of the outward investors may not be completely internalized by the foreign affiliate firms and thus spill over to local firms in the host countries. As verified by some empirical evidence, the spillover effects of outward FDI facilitate the product innovation of local firms (Jaya P. Pradhan 2004; Pinelopi K. Goldberg et al. 2010). The improvement in innovation ability facilitates more GVC participation of the host countries. Besides, this can be extended a little further to other countries. A spatial perspective may enable a better understanding of the spillover effects of outward FDI in other countries. As Zoltan J. Acs, Luc Anselin, and Attila Varga (2002) argued, neighboring locations may receive spillovers from others and lead to correlation transnationally. Similarly, Etienne B. Yehoue (2009) confirmed the obvious Marshallian externalities of FDI for productivity improvement elsewhere. Therefore, the spillovers of outward FDI could

play a positive role in a third country through the intermediate inputs exported by the foreign affiliates, in which case outward FDI may have effects on the GVC participation of the other countries. Hence, the second hypothesis is as follows.

H2. The spillover effects of outward FDI may benefit the GVC participation of the other countries, especially the host countries.

Furthermore, there are obvious distinctions of outward FDI between developed and developing countries. The monopolistic advantages of outward investors from developing countries are different with those from developed countries, due to different levels of productivity, infrastructure, industry, skills, and so on. More specifically, multinationals from developing economies show competition generally in price rather than sophisticated product diversification or cutting-edge technology (Pradhan 2004; Hsiu-Yun Lee, Kenneth S. Lin, and Hsiao-Chien Tsui 2009). Hence, less developed countries (LDCs) are more likely to act as platforms for exporting back to their parent countries (Stephen R. Yeaple 2003). In particular, the adverse spillovers of advanced technology in management, production, and marketing from the host countries could also promote the GVC participation of developing countries. By contrast, in many developed countries, like the United Kingdom, Korea, and the US, vertical outward FDI prevails, which follows a pattern in accordance with the comparative advantage (Maskus and Allan Webster 1995; Yeaple 2003). These distinctions in outward FDI may result in different effects on GVC participation. Accordingly, we posit that:

H3. There may be a broad range of effects of outward FDI on GVC participation in developing and developed countries.

In a nutshell, the question on the effects of outward FDI on GVC participation remains very much unexplored, which may partially be attributed to the limited quantity of empirical studies conducted on this issue. Moreover, the relevant literature generally has not considered the spatial dependence, namely the correlation of GVC participation among neighboring countries. This omission motivates our study to utilize spatial econometric techniques to investigate the spillover effects of outward FDI on GVC participation. The consideration of the parent and other countries, together with developing and developed countries, allows for a more comprehensive view of the effects that outward FDI has on GVC participation.

2. Research Methodology

This section illustrates the details of the construction of the baseline model, the SDM, and the threshold model as well as the spatial autocorrelation test with Moran's I index.

2.1 Baseline Model

The specification of the baseline model is shown in Equation (1):

$$lnGVC_{it} = \beta_0 + \beta_1 lnOFDI_{it} + \beta_2 X_{it} + \mu_i + \delta_t + \varepsilon_{it}, \quad (1)$$

where i and t indicate the country and year, respectively, $lnGVC$ is the logarithm of the overall GVC participation, which consists of two parts, shallow participation and deep participation; $lnOFDI$ denotes the logarithm of outward FDI; X represents a series of control variables, including imports and exports of intermediate goods, foreign

direct investment (FDI), the labor force, the capital density, human resources, research and development (R&D) expenditure, infrastructure level, and the Theil index; μ and δ are the country dummy and year dummy, respectively; and ε is the error term.

The underlying assumption of the baseline model is that the investigated countries are spatially separated and independent of each other. However, on the one hand, the rapid development of GVCs leads to closer cooperation and dependence among countries; on the other hand, as mentioned previously, the GVC participation of one country is influenced not only by its outward FDI but also by other countries' outward FDI, the neglect of which may result in omitted-variable bias and endogeneity. Therefore, we construct the SDM with a spatially lagged dependent variable and the key independent variable to determine the real effects of outward FDI. Before that, the spatial autocorrelation test is applied to verify the existence of GVC participation correlation among countries.

2.2 Spatial Autocorrelation Test

The global Moran's I index is utilized to diagnose the spatial autocorrelation of GVC participation, as shown in Equation (2):

$$Moran's\ I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij}(GVC_i-\overline{GVC})(GVC_j-\overline{GVC})}{(\sum_{i=1}^{n}\sum_{j=1}^{n} W_{ij})\sum_{i=1}^{n}(GVC_i-\overline{GVC})^2},\ \text{if}\quad j \neq i \tag{2}$$

where n is the number of countries; GVC_i and GVC_j indicate the GVC participation of country i and country j, respectively; $\overline{GVC}$ represents the sample mean of GVC; W_{ij} is the geographical distance-based weight matrix, the element w_{ij} of which is calculated using Equation (3):

$$w_{ij} = 1/(D_{ij})^2,\ \text{if}\quad i \neq j \tag{3}$$

where D_{ij} is the geographical distance between i and j; when $i = j$, w_{ij} equals 0. The value of *Moran's I* is between [-1,1]. Its main statistical test index is the Z value, as shown in Equation (4):

$$Z(Moran's\ I) = \frac{Moran's\ I - E(Moran's\ I)}{\sqrt{VAR(Moran's\ I)}}, \tag{4}$$

where *E*(*Moran's I*) denotes the mathematical expectation of *Moran's I* and VAR (*Moran's I*) is the variance. The test of spatial autocorrelation makes a difference only when the *Z*-statistic is significant at least at the 10% level. Then, if *Moran's I* index is higher than zero, the autocorrelation of GVC participation in different countries is positive, implying the spatial agglomeration of regions with similar higher levels of GVC participation and areas with lower GVC participation; if the index is lower than zero, the spatial autocorrelation is negative, indicating a significant difference between country i and its neighboring countries in GVC participation; finally, if the index is close to zero, different regions' GVC participation is independent.

2.3 Spatial Durbin Model

The SDM is thought to be more efficient than the other spatial models, like the spatial lag model (SLM) and the spatial error model (SEM) (James P. LeSage and Kelley R. Pace 2008). It can estimate the direct and indirect effects of each variable without prior restrictions, while these effects are nearly the same in the SLM and the SEM (Paul J. Elhorst and Solmaria H. Vega 2013). The specification of the SDM is shown in Equation (5):

$$lnGVC_{it} = \rho W lnGVC_{it} + \beta lnOFDI_{it} + \theta W lnOFDI_{it} + \gamma lnX_{it} + \mu_i + \delta_t + \varepsilon_{it}, \quad (5)$$

where $lnGVC$, $lnOFDI$, X, μ, and δ are the same as those in Equation (1); W is the geographical distance-based weight matrix; ρ represents the parameter for the spillovers of GVC participation from neighboring countries; and θ is the parameter for outward FDI spillovers. We estimate Equation (5) by utilizing maximum likelihood (ML) techniques rather than ordinary least squares (OLS) to obtain consistent and unbiased estimators.

Our study is more than a parameter estimation of β or θ, because the existence of spatial correlation of GVC participation indicates that GVC participation in one country is influenced not only by its own outward FDI but also by the outward FDI from other countries. The approach developed by LeSage and Pace (2008) is applied to understand this point better. Rearranging Equation (5) yields:

$$\begin{aligned} lnGVC_{it} = (1-\rho W)^{-1}(\beta lnOFDI_{it} + \theta W lnOFDI_{it} + \gamma lnX_{it}) \\ +(1-\rho W)^{-1}(\mu_i + \delta_t + \varepsilon_{it}). \end{aligned}$$

Namely,

$$\begin{aligned} lnGVC_{it} &= \sum_{r=1}^{3} \beta_r (1-\rho W)^{-1} x_r + (1-\rho W)^{-1}(\mu_i + \delta_t + \varepsilon_{it}) \\ &= \textstyle\sum_{r=1}^{3} C_r(W) x_r + (1-\rho W)^{-1}(\mu_i + \delta_t + \varepsilon_{it}), \end{aligned} \quad (6)$$

where β_r includes β, θ, and γ; x_r incorporates $lnOFDI_{it}$, $W lnOFDI_{it}$, and lnX_{it}; and $C_r(W)$ equals $\beta_r(1-\rho W)^{-1}$. The extensive form of Equation (6) is:

$$\begin{pmatrix} lnGVC_1 \\ lnGVC_2 \\ \vdots \\ lnGVC_n \end{pmatrix} = \begin{bmatrix} C_r(W)_{11} & C_r(W)_{12} & \cdots & C_r(W)_{1n} \\ C_r(W)_{21} & C_r(W)_{22} & \cdots & C_r(W)_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ C_r(W)_{n1} & C_r(W)_{n2} & \cdots & C_r(W)_{nn} \end{bmatrix} \begin{pmatrix} x_{1r} \\ x_{2r} \\ \vdots \\ x_{nr} \end{pmatrix} + \quad (7)$$

$$(1-\rho W)^{-1}(\mu_i + \delta_t + \varepsilon_{it}),$$

where $C_r(W)_{ij}$ is the element of matrix $C_r(W)$. According to LeSage and Pace (2008), the mean value of the diagonal elements in matrix $C_r(W)$ is defined as the direct effects, denoting the average effects of outward FDI from parent countries on GVC participation, while the average of a row or column sum of non-diagonal elements is regarded as the indirect effects, which are produced by the variation of outward FDI from other regions.

2.4 Threshold Model

As mentioned previously, the obvious distinctions in outward FDI between developed and developing countries may cause heterogeneous effects on GVC participation. Hence, we employ the threshold model proposed by Bruce E. Hansen (1999) and set the total factor productivity (TFP) as the threshold variable to distinguish different levels of economic development. The fundamental form with a threshold is shown in Equation (8):

$$y_{it} = \mu_0 + \alpha_1 x_{it} I(q_{it} \leq \gamma) + \alpha_2 x_{it} I(q_{it} > \gamma) + \varepsilon_{it}, \tag{8}$$

where q_{it} is the threshold variable, γ denotes the threshold value, and $I(\cdot)$ represents the indicator function. Given the purpose of our research, we obtain Equation (9):

$$\begin{aligned} lnGVC_{it} = \beta_0 + \beta_1 \ln OFDI_{it}\, I(TFP_{it} \leq \gamma) + \beta_2 \ln OFDI_{it}\, I(TFP_{it} > \gamma) \\ +\beta_3 \ln X_{it} + \mu_i + \delta_t + \varepsilon_{it}, \end{aligned} \tag{9}$$

where TFP_{it} is the same as q_{it} in Equation (8), representing the different levels of development. Following Stephanie Kremer, Alexander Bick, and Dieter Nautz (2013), we first calculate the critical value of the TFP and confidence intervals with Equation (9), then we divide the samples into sub-panels according to the critical value, and finally we estimate these sub-panels with spatial econometric techniques. Additionally, bootstrap methods are adopted to obtain the critic values, which are verified by the likelihood ratio.

3. Variable Definitions and Data Sources

Our panel data set ranges from 2000 to 2014 and covers 42 World Input-Output Database (WIOD) countries, which account for approximately 76% of exports and 95% of imports of intermediate goods and 80.85% of the global outward FDI in 2014. Our main data sources are the WIOD, World Development Indicators (WDI), Organization for Economic Cooperation and Development (OECD), Penn World Table (PWT), CEPII, World Bank (WB), and so on. Details of the calculation and data processing are provided in sequence.

As mentioned earlier, in Figure 1, the measurement of GVC participation is based on the decomposition of the value added created by domestic production. Only the value added crossing national borders for production purposes rather than consumption purposes is treated as GVC participation. Further, according to the times of crossing national borders, the overall GVC participation can be divided into a shallow part and a deep part, the former crossing a national border only once and the latter traversing national borders at least twice. Taking a chip firm in Japan as an example, if the chips are exported to China for toy manufacturing and ultimately consumed in China, then the value added embedded in the chips belongs to the shallow GVC participation of Japan. If those Chinese-made toys are exported to a third country, the US,

for example, then the value added is treated as deep GVC participation. Mathematical expressions of the decomposition are shown in Equation (10)[1]:

$$\begin{aligned} Value\_added' = \hat{V}(I-A)^{-1}Y = \underbrace{\hat{V}(I-A^d)^{-1}Y^d}_{\text{i) Produced and consumed domestically}} \\ +\hat{V}(I-A^d)^{-1}Y^f \quad \underbrace{\qquad\qquad}_{\text{ii) Embodied in the trade of final products}} \\ +\hat{V}(I-A^d)^{-1}A^f\underbrace{(I-A^d)^{-1}Y^d}_{\text{iiia) Shallow GVC participation}} \\ +\hat{V}(I-A^d)^{-1}A^f\underbrace{[(I-A)^{-1}Y-(I-A^d)^{-1}Y^d]}_{\text{iiib) Deep GVC participation}}, \end{aligned} \tag{10}$$

where the superscripts d and f denote domestic and foreign, respectively; $\hat{V}$ denotes the diagonal matrix with value-added coefficients V; A and Y are the direct input coefficients and final outputs; $(I-A)^{-1}$ and $(I-A^d)^{-1}$ are the global and domestic Leontief inverse matrix, respectively. The calculation of Equation (10) is based on the world input-output tables (WIOT) released by the WIOD with the assistance of Rstudio 1.1.463.

The outward FDI stocks are mainly collected from the FDI database of the United Nations Conference on Trade and Development (UNCTAD). The current values are converted into constant 2010 US dollars (US$) with the deflators of each country. Control variables, like export trade in intermediate goods (*EINT*), import trade in intermediate goods (*MINT*), FDI, and research and development expenditure (*R&D*), are also transformed into 2010 constant values with the above deflators. To address the concerns of omitted variable bias, other variables, like employment (*EMP*), human capital (*HC*), capital stock density (*CK*), infrastructure level (*Infras*), and industrial structure (*TL*) are also controlled.

Infras is measured by a simple average of three infrastructure indicators: (i) the air transport of passengers carried *per capita*; (ii) the simple average of *per capita* fixed broadband, fixed telephone, and mobile cellular subscriptions; and (iii) the *per capita* kilometers of railroad. Besides, the Theil index (TL) is defined by Equation (11):

$$TL = \sum_i^m (GDP_i/GDP)\, ln(\frac{GDP_i}{L_i} / \frac{GDP}{L}), \tag{11}$$

where *i* represents three industries, including primary, secondary, and tertiary; L indicates the total employment; and GDP_i/L_i implies the productivity per unit of labor. The closer the *TL* index is to 0, the more rational the industrial structure is.

[1] For simplification, we assume that there are *G* countries and *N* industries, *X* is a *GN**1 vector of gross outputs, and *Value-added* is a 1**GN* vector. The intermediate products *Z* plus the final outputs *Y* equal the gross outputs, that is, $Z+Y=X$; the direct input coefficient *A* can be defined as *Z* divided by *X* on its diagonal, namely $A = Z\hat{X}^{-1}$, then we have $(I-A)^{-1}X = Y$. Similarly, we can obtain the domestic Leontief inverse matrix $(I-A^d)^{-1}$, where A^d is the domestic input coefficient matrix. Dividing the total value added by the gross outputs, we can obtain the value-added coefficient, that is, $V = Va/\hat{X}$. For details of the decomposition, please refer to Wang et al. (2017).

As regards the threshold variable, the TFP is used to determine the heterogeneity of the spillover effects of outward FDI on GVC participation. The calculation of the TFP is shown in Equation (12):

$$TFP = GDP/[K^{(1-\alpha)}L^{\alpha}], \tag{12}$$

where K denotes the capital stocks. We utilize stochastic frontier analysis (SFA) together with Frontier 4.1 version to estimate Equation (12).

Statistical descriptions of all the variables and their sources are presented in Table 1.

Table 1 Descriptive Statistics of the Variables

Variables	Definitions and sources	Obs.	Mean	S. E.	Min	Max
$Overall\_GVC_{it}$	Overall GVC participation	630	123.10	171.97	0.74	1098.58
$Shallow\_GVC_{it}$	Shallow GVC participation	630	74.24	101.86	0.48	642.00
$Deep\_GVC_{it}$	Deep GVC participation	630	48.86	71.06	0.27	456.58
$OFDI_{it}$	Outward FDI stocks, in billions, constant 2010 US$ (UNCTAD)	630	356.97	725.86	0.00	5956.42
$EINT_{it}$	Intermediate goods export, in billions, constant 2010 US$ (WIOD)	630	148.59	206.78	0.00	1260.79
$MINT_{it}$	Intermediate goods import, in billions, constant 2010 US$ (WIOD)	630	199.34	144.15	40.15	1329.98
EMP_{it}	The number of persons employed, in millions (PWT)	630	48.91	135.14	0.15	798.37
FDI_{it}	FDI stocks, in billions, constant 2010 US$ (UNCTAD)	630	320.35	558.62	0.00	5000.00
$R\&D_{it}$	Research and development expenditure, in billions, constant 2010 US$ (WDI)	630	26.61	65.88	0.02	436.04
HC_{it}	Human capital based on the years of schooling (PWT)	630	3.08	0.45	1.78	3.73
CKit	Capital stock density, measured by the proportion of capital stocks in GDP (WDI)	630	4.07	1.11	1.53	8.05
$PGDP_{it}$	GDP *per capita*, in ten thousand, constant 2010 US$ (WDI)	630	3.05	2.29	0.08	11.00
$Infras_{it}$	Index of infrastructure level	630	0.59	0.79	0.01	7.23
TL_{it}	Rationalization of industrial structure	630	0.05	0.08	0.00	0.75

Source: Authors' calculations.

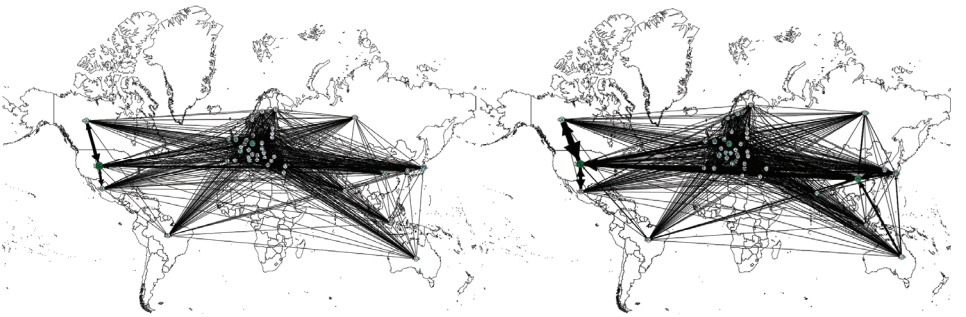
4. Results and Discussion

In this section, both the descriptive and the empirical results are displayed to demonstrate the effects of outward FDI on GVC participation.

4.1 Descriptive Results

As shown in Figure 2, during the period 2000 to 2014, the network of overall GVC participation almost tripled, that of shallow GVC participation increased 2.88 times, and that of deep GVC increased 3.15 times, indicating the gradually closer relations among countries. In 2000, the GVC participation was mainly dominated by developed countries, as more than 45% of the total value added for GVC participation was generated by countries such as the US (15.39%, proportion of the total hereinafter),

Germany (7.46%), Japan (7.57%), the UK (5.65%), France (4.43%), Canada (4.02%), and so on, while the proportion of developing countries, like China, Russia, and Brazil, was relatively small. In 2014, the share of developed countries dropped by various degrees, while that of developing countries, especially China, rose sharply to 10.13%, ranking only second to the US. Though the GVC participation network with developed countries at the core did not change, developing countries like China, Russia, and Brazil participated more and more in the GVCs and gradually moved from the periphery to the core.



Notes: The dots represent different countries; the thickness of each line represents the volume of over-all GVC participation. The thicker the lines, the more GVC participation is. Situations of shallow and deep GVC participation remain roughly the same, so details are not repeated.

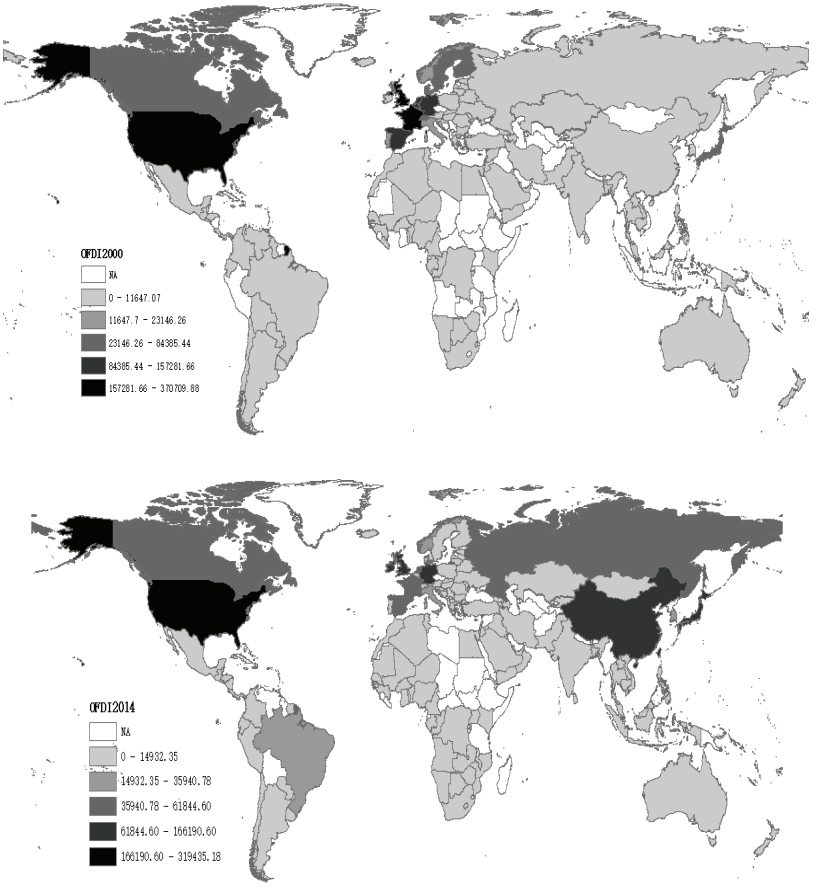
Source: Authors' calculations.

Figure 2 The Trade Network of Overall GVC Participation among Countries in 2000 and 2014

The spatial distribution of outward FDI in 2000 and 2014 is also mapped with the geographical information system (GIS) (Figure 3). In 2000, outward FDI was generally distributed among developed countries, such as the US, the UK, France, and Canada. However, with the rapid development of globalization and production fragmentation, developing countries placed increasing emphasis on outward FDI, which was gradually oriented towards developed countries (Carlos Rodríguez and Ricardo Bustillo 2011). As a result, the outward FDI from developing countries saw dramatic changes during the fifteen-year period from 2000 to 2014. Furthermore, the surging outward FDI took on obvious characteristics of geographical agglomeration. For instance, around 80% of outward FDI from some developed countries and developing countries (such as Russia and Mexico) flowed to the US and European countries. By contrast, more than 80% of Chinese outward FDI flowed to developing areas.

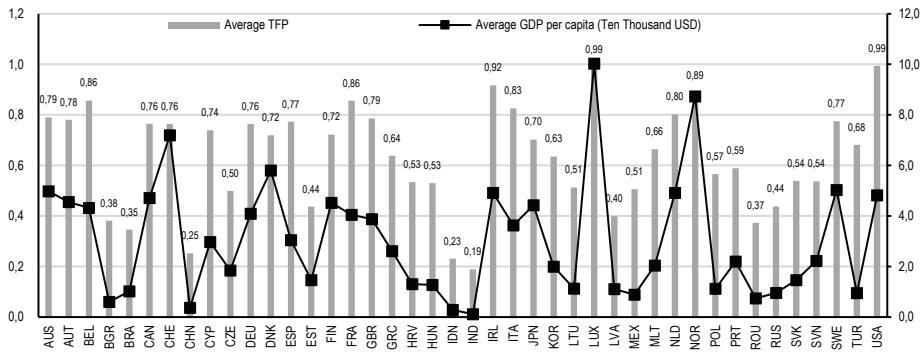
The estimation of the TFP is reported in Figure 4. The TFP varies greatly from country to country and is positively correlated with the average GDP *per capita*. Additionally, for most developed countries, the TFP is generally more than 0.7, and some countries even hit the maximum value of 0.99, like the US and Luxembourg.

Meanwhile, for developing countries, such as Brazil, China, and Indonesia, the average TFP values are less than 0.5.



Source: Mapped by the authors.

Figure 3 The Spatial Distribution of Outward FDI in 2000 and 2014 (million US$, constant 2010)



Source: The authors' calculations.

Figure 4 The Estimation of TFP and Its Relationship with Economic Development

4.2 Baseline Model Regression

As reported in Table 2, we replace the dependent variable in Equation (1) with overall, shallow, and deep GVC participation successively to obtain the first three models, then we add the intersection terms of outward FDI and TFP to gain the last three models, which are expected to uncover the potential pathways. The variance inflation factor (VIF) value of the baseline model is 6.03, less than 10, indicating that the multicollinearity problem among the explanatory variables can be ignored. The Hausman tests of each model turn out to be significantly positive, implying that fixed-effect models are better than random-effect ones.

Table 2 Estimate Results of the Baseline Model

	Overall GVC(1)	Shallow GVC(2)	Deep GVC(3)	Overall GVC(4)	Shallow GVC(5)	Deep GVC(6)
lnOFDI	0.058***	0.047***	0.072***	0.254***	0.265***	0.232***
	(3.643)	(2.818)	(4.422)	(10.780)	(11.061)	(9.426)
lnEINT	0.020***	0.021***	0.021***	0.016***	0.016***	0.017***
	(3.575)	(3.490)	(3.546)	(3.102)	(2.997)	(3.117)
lnMINT	0.148**	0.140*	0.156**	0.032	0.012	0.061
	(2.076)	(1.908)	(2.163)	(0.490)	(0.174)	(0.885)
lnFDI	-0.027	-0.041**	-0.000	-0.016	-0.028	0.009
	(-1.489)	(-2.146)	(-0.024)	(-0.951)	(-1.643)	(0.504)
lnEMP	0.184	0.172	0.290**	0.371***	0.381***	0.444***
	(1.533)	(1.392)	(2.392)	(3.343)	(3.379)	(3.825)
lnHC	0.534	0.748*	0.109	0.436	0.637	0.027
	(1.263)	(1.710)	(0.253)	(1.126)	(1.621)	(0.068)
lnCK	-0.227**	-0.211*	-0.200*	-0.115	-0.085	-0.107
	(-2.157)	(-1.933)	(-1.875)	(-1.183)	(-0.861)	(-1.059)
lnR&D	0.176***	0.233***	0.072	0.145***	0.199***	0.047
	(3.758)	(4.810)	(1.520)	(3.380)	(4.546)	(1.038)
TFP	6.507***	6.090***	7.400***	4.708***	4.084***	5.922***
	(10.925)	(9.894)	(12.272)	(8.256)	(7.046)	(9.925)
Infras	0.032*	0.040**	0.025	0.045**	0.054***	0.035*
	(1.665)	(1.999)	(1.247)	(2.525)	(2.994)	(1.873)
TL	-0.286*	-0.278*	-0.326**	-0.123	-0.096	-0.192
	(-1.824)	(-1.716)	(-2.053)	(-0.850)	(-0.654)	(-1.271)
*lnOFDI*TFP*				-0.380***	-0.424***	-0.312***
				(-10.585)	(-11.614)	(-8.312)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-2.313***	-2.712***	-3.689***	-0.966	-1.210*	-2.583***
	(-3.513)	(-3.987)	(-5.536)	(-1.571)	(-1.937)	(-4.014)
Observations	630	630	630	630	630	630
Adj-R2	0.924	0.912	0.933	0.937	0.929	0.940
Hausman	110.94***	91.12***	127.80***	42.20***	42.15***	39.47***
LR test				114.53***	135.52***	73.04***
Log likelihood	362.942	342.193	355.187	420.205	409.954	391.708

Notes: *t* statistics in the parentheses; *, **, and *** denote significant at the 10%, 5%, and 1% level, respectively; ln means the natural logarithm of the original values.

Source: Authors' calculations.

The coefficients of *lnOFDI* in the first three models are statistically significant at the 1% level and range from 0.047 to 0.072, indicating that the rise of outward FDI promotes GVC participation, especially deep participation. Outward FDI reduces production and trade costs and improves the economies of scale and resource productivity of MNEs, thus facilitating the GVC participation of parent countries. This evidence is broadly in line with hypothesis H1 (Section 1). In the latter three models, the estimators for *OFDI* are significantly positive, in contrast to the significant negative coefficients for the interaction terms of *OFDI* and TFP, indicating that the effects of outward FDI on GVC participation depend on the TFP level of the home country. Using model (4) as an example, the partial derivative of *GVC_overall* over *OFDI* equals 0.254-0.380**TFP*; therefore, if the value of TFP is over the critical value 0.668, the partial derivative is negative, and otherwise it is positive. A possible reason may be that, compared with low-TFP countries, high-TFP countries are more likely to transfer their manufacturing industry to countries with cheap factors, as they have done since the middle of the last century, which causes a reduction in the GVC participation.

Regarding the results for the other control variables, the coefficients of *lnEINT*, *lnEMP*, *lnR&D*, *Infras*, and TFP are significantly positive under most circumstances, denoting that an increase in intermediate goods exports, employment, R&D expenditure, infrastructure level, and TFP contributes to GVC participation.

4.3 Spatial Autocorrelation Analysis

Table 3 presents the results of the global Moran's I index from 2000 to 2014. For shallow GVC participation, the index is positive and significant at least at the 5% level, while, for overall and deep GVC participation, the index is not statistically significant initially. However, the results of the overall and deep GVC participation gradually become significant and show an increase since 2004 and 2008, respectively. These discoveries indicate that the GVC participation levels of different countries are positively correlated and the Matthew effect on GVC participation gradually comes into being.

Table 3 Moran's I Test for Spatial Autocorrelation of GVC Participation

Year	2000	2002	2004	2006	2008	2010	2012	2014
Overall GVC	0.139	0.139	0.168*	0.209**	0.230**	0.245**	0.274***	0.229**
	(1.579)	(1.533)	(1.711)	(2.071)	(2.233)	(2.402)	(2.658)	(2.275)
Shallow GVC	0.200**	0.197**	0.218**	0.256**	0.267**	0.284***	0.307***	0.274***
	(2.083)	(2.013)	(2.118)	(2.454)	(2.547)	(2.735)	(2.948)	(2.672)
Deep GVC	0.048	0.048	0.088	0.138	0.178*	0.188*	0.225**	0.162*
	(0.738)	(0.715)	(1.031)	(1.467)	(1.780)	(1.901)	(2.210)	(1.675)

Notes: *z* statistics in parentheses; *, **, and *** denote significant at the 10%, 5%, and 1% level, respectively.

Source: Authors' calculations.

The spatial dependence and interaction of GVC participation in different countries suggests that the traditional econometric models without the consideration of spatial factors are far from enough to identify the true effects of outward FDI on GVC participation. Therefore, the SDM model is applied in the following section.

4.4 SDM Estimates

We carry out the same strategy for Equation (5) as for the baseline regression, the estimates of which are displayed in Table 4. The coefficients for *lnOFDI* are significantly positive in all six models; however, as mentioned in the third part, such estimates cannot be interpreted as the influence coefficients of outward FDI on GVC participation. In addition, likelihood ratio (LR) tests show that the models with interaction terms are more appropriate. Therefore, our attention in the following discussion is mainly focused on the decomposition of the spatial effects in the latter three models. In models (4) and (5), the spatial effects of *lnOFDI* are positive and significant at the 1% level, suggesting that the GVC participation of the parent country is not only influenced directly by its own outward FDI but also affected indirectly by the outward FDI from other countries. The other countries, the host countries in particular, may benefit from the outward FDI spillovers, such as production technology and management skills, which are conducive to their GVC participation. The estimation with spatial techniques can act as a robustness test of the baseline models, at the same time confirming the spillover effects of outward FDI on GVC participation. These results seem to be consistent with the second hypothesis, H2.

Table 4 Estimation Results of SDM

		Overall GVC(1)	Shallow GVC(2)	Deep GVC(3)	Overall GVC(4)	Shallow GVC(5)	Deep GVC(6)
lnOFDI		0.074***	0.063***	0.088***	0.260***	0.266***	0.247***
		(4.410)	(3.648)	(5.193)	(11.498)	(11.577)	(10.522)
*lnOFDI*TFP*		-	-	-	-0.379***	-0.415***	-0.325***
					(-11.196)	(-12.022)	(-9.218)
WlnOFDI		-0.003	0.039	-0.068**	0.017	0.060*	-0.047
		(-0.087)	(1.066)	(-1.970)	(0.528)	(1.798)	(-1.458)
Spatial autoregressive		0.201***	0.137**	0.284***	0.243***	0.183***	0.313***
		(3.820)	(2.489)	(5.717)	(4.931)	(3.585)	(6.595)
Direct effect	*lnOFDI*	0.074***	0.064***	0.085***	0.263***	0.269***	0.248***
		(4.476)	(3.755)	(5.056)	(11.673)	(11.799)	(10.524)
	*lnOFDI*TFP*	-	-	-	-0.383***	-0.417***	-0.330***
					(-11.145)	(-11.988)	(-9.174)
Indirect effect	*lnOFDI*	0.014	0.054	-0.058	0.101***	0.129***	0.041
		(0.362)	(1.465)	(-1.339)	(2.830)	(3.818)	(0.985)
	*lnOFDI*TFP*	-	-	-	-0.119***	-0.091***	-0.142***
					(-3.372)	(-2.705)	(-3.887)
Total effect	*lnOFDI*	0.088**	0.117***	0.027	0.364***	0.398***	0.289***
		(2.079)	(2.945)	(0.565)	(7.830)	(9.067)	(5.419)
	*lnOFDI *TFP*	-	-	-	-0.501***	-0.508***	-0.472***
					(-8.504)	(-8.987)	(-7.414)
Control variables		Yes	Yes	Yes	Yes	Yes	Yes
Observations		630	630	630	630	630	630
Adj-R2		0.633	0.672	0.625	0.909	0.927	0.857
Hausman		22.23*	19.21	24.23*	22.82*	17.88	23.39*
LR test		-	-	-	113.99***	129.81***	79.50***
Log likelihood		291.560	273.770	281.268	348.555	338.675	321.019

Notes: *t* statistics in parentheses; *, **, and *** denote significant at the 10%, 5%, and 1% level, respectively.

Source: Authors' calculations.

The spatial effects of the interaction term in models (4), (5), and (6) are significantly negative, verifying again that the effects of outward FDI on GVC participation change along with the TFP level of the parent countries. Hence, we will test the heterogeneous effects of outward FDI in high-TFP countries and low-TFP countries.

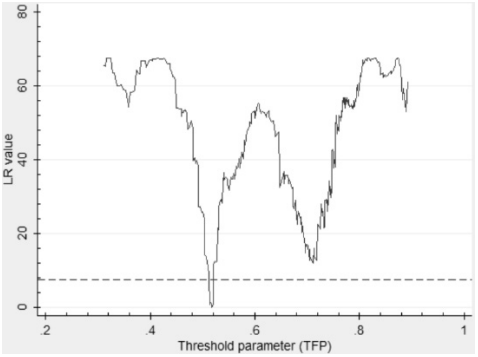
4.5 Heterogeneity Test

The results of the threshold tests are illustrated in Table 5. The estimated threshold values are 0.517, 0.711, and 0.787, respectively, but the LR test in Figure 5 implies that only the first threshold is significant at the 5% level, so we select 0.517 as the critical value to determine the threshold effects.

Table 5 Threshold Effect Test and the Confidence Interval

	F-value	*P*-value	BS	1% critical value	5% critical value	10% critical value	Threshold value
Single threshold	67.09	0.003	300	42.673	26.12	20.647	0.517
Double threshold	49.44	0.017	300	60.132	30.446	23.424	0.711
Triple threshold	24.46	0.075	200	45.058	29.871	21.219	0.787

Source: Authors' calculations.



Source: Authors' calculations.

Figure 5 Threshold Parameter and the LR Value

Firstly, we divide the samples into two groups according to the critical value: one group with an average TFP over 0.517 and another below 0.517, which are termed the developed and developing group, respectively. Subsequently, we estimate the spatial effects of these two sub-panels separately with the SDM.

Table 6 reports the results for the developed group. The direct effects of outward FDI on deep GVC participation are 0.052 and significant at the 1% level, while the indirect effects remain insignificant. Contrarily, the indirect effects on the overall and shallow GVC participation are significantly positive, while the direct effects remain insignificant. These results indicate that outward FDI from developed countries contributes to their deep GVC participation and facilitates the shallow GVC participation of neighboring countries at the same time. A probable explanation is that multinationals from developed countries generally dominate the design, R&D, and marketing of

the GVCs and that the value added embedded in their exports may traverse national borders more than twice for processing and packaging, thus facilitating deep GVC participation. Nevertheless, local foreign firms in developed countries are more competitive in price, which may increase the intermediate goods supply, thus contributing to the shallow GVC participation.

Table 6 Spatial Effects of the Developed Group, with the Average TFP Value over 0.517

	Overall GVC	Shallow GVC	Deep GVC
Direct effect			
lnOFDI	0.026	0.007	0.052***
	(1.546)	(0.386)	(2.800)
Indirect effect			
lnOFDI	0.071*	0.118***	-0.017
	(1.703)	(2.935)	(-0.347)
Total effect			
lnOFDI	0.098**	0.124***	0.035
	(1.978)	(2.643)	(0.596)
Spatial autoregressive	0.310***	0.258***	0.367***
	(6.244)	(5.010)	(7.436)
Control variables	Yes	Yes	Yes
Observations	450	450	450
Adj-R2	0.894	0.900	0.867
Log likelihood	353.972	342.677	316.215

Notes: *t* statistics in parentheses; *, **, and *** denote significant at the 10%, 5%, and 1% level, respectively.

Source: Authors' calculations.

Table 7 Spatial Effects of the Developing Group, with the Average TFP Value Less Than or Equal to 0.517

	Overall GVC	Shallow GVC	Deep GVC
Direct effect			
lnOFDI	0.125***	0.139***	0.097***
	(4.124)	(4.554)	(3.209)
Indirect effect			
lnOFDI	0.175***	0.174***	0.160**
	(2.658)	(2.903)	(2.083)
Total effect			
lnOFDI	0.300***	0.313***	0.257***
	(3.687)	(4.231)	(2.720)
Spatial autoregressive	0.385***	0.308***	0.492***
	(4.267)	(3.262)	(6.042)
Control variables	Yes	Yes	Yes
Observations	180	180	180
Adj-R2	0.687	0.669	0.739
Log likelihood	63.784	60.959	68.473

Notes: *t* statistics in parentheses; *, **, and *** denote significant at the 10%, 5%, and 1% level, respectively.

Source: Authors' calculations.

However, a different picture emerges in the low-TFP countries. As displayed in Table 7, the parameter estimation of outward FDI in all three models turns out to be positive and significant at least at the 5% level, indicating that outward FDI in developing countries not only promotes the shallow and deep GVC participation of parent countries but also improves those of the other countries. For parent countries, outward

FDI from developing countries is generally in the character of technology seeking and market seeking (Castellani and Fabio Pieri 2016), which may accelerate the productivity and economies of scale, thus inducing more GVC participation. For other countries, many foreign affiliates of the multinationals from developing countries possess comparative advantages in price and cheap factors. These advantages may facilitate the value-added exports of the host countries. The different results of both sub-panels appear to be in line with the third hypothesis, H3.

5. Conclusions

Based on the KC model and the GVC framework, our study sheds light on the heterogeneous spillover effects of outward FDI on GVC participation using a panel data model covering 42 WIOD countries from 2000 to 2014. The results show that the expansion of outward FDI not only contributes to the GVC participation of parent countries but also has a profound effect on the GVC participation of other countries. The spillover effects of outward FDI make sense under the spatial correlation of GVC participation among countries. In addition, heterogeneous effects of outward FDI on GVC participation appear in developing and developed countries. Specifically, for the developing sub-panel, the effects of outward FDI on both the shallow and the deep GVC participation of parent countries are dramatically positive. However, for the developed sub-panel, outward FDI has positive effects on deep GVC participation while not influencing shallow participation. The indirect effects of outward FDI on GVC participation in both sub-panels are significantly positive. The augmentation of R&D, infrastructure level, labor and capital input, and so on, can also accelerate the integration into globalization and GVCs.

Actually, outward FDI brings more than cost reduction and market expansion. Cross-border investment among countries motivates the transnational flows of technology, labor, goods, even cultures, and so on; thus, the relocation of production activities also motivates the reallocation of resources, which are no longer confined by national borders and initial factor endowments. If the economic specialization and integration in global production facilitate the development of GVCs, then outward FDI offers both developed and developing countries an alternative way to specialize in the production stages in which they have comparative advantages and to integrate into specific regional production networks characterized by high entry barriers. Developing countries, in particular, can exploit their advantages of backwardness and encourage domestic enterprises to invest abroad to access the advanced and sophisticated technology in developed countries.

As an extension to the KC theoretical model, our study enables a comprehensive understanding of the fundamental role that multinationals play in GVC participation. Our findings suggest a way for developing countries to capture gains from outward FDI and participate further in GVCs. However, with regard to developed countries, some of them have transferred their manufacturing and producer service industries to developing countries, typically with a lower labor cost, through outward FDI during the past couple of years. As a result, the GVC participation of parent countries is declining and the problem of hollowing out of manufacturing industries has grown into a major concern in countries like the US, Japan, and South Korea.

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