Substituting or Complementing?—The Influence of Chinese Overseas Direct Investment on Domestic Exports

Chih-Fan Lin and Mei-Chen Yü

School of Economics & Management, South China Normal University

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Abstract

The aim of this paper is to verify whether overseas direct investment activities of China can substitute or complement domestic exports. Using panel data of 85 host countries from 2003 to 2011 we conduct detailed empirical examinations within the framework of the gravity model. After correcting for bias caused by synchronism between trade flow and investment flow and also for econometrical misspecifications we discover that, contrary to all existing studies, Chinese overseas direct investment has a very weak substituting relationship with domestic exports. Sub-sample regressions show that Chinese overseas direct investment substitutes exports to developed countries but complements exports to developing countries. Panel threshold model further confirms the role of host country's economic developmental stage (measured by per capita GDP) in determining the influence of overseas direct investment on exports and detects two thresholds. Thus the sample is divided into three regimes: (1) in the first regime where per capita GDP is lower than 1150.39 dollars, overseas direct investment complements exports to the host country; (2) in the second regime where per capita GDP falls between 1150.39 and 11601.63 dollars, the "gray zone", overseas direct investment has very weak influence on domestic exports; (3) in the third regime where per capita GDP exceeds 11601.63 dollars, overseas direct investment substitutes exports to the host country. This paper concludes with possible explanations to the empirical results and the threshold phenomenon.

Key Words: Overseas Direct Investment; Domestic Exports; Gravity Model; Panel Threshold Model

JEL Classification: F14, F21

Contents

1. Introduction

Recent decades have witnessed the increasing internationalization of production and its effect on the world economy is at the center of economic debate. While advanced economies have been offshoring their productions by investing abroad for decades, many studies have detected relative reductions of their exports and argue that overseas direct investment can substitute domestic exports.

Since the beginning of the 21st century, the Chinese government has been advocating the strategy of "Going Global" and its overseas direct investment has been rising very fast. According to the joint annual report published by the Ministry of Commerce and the National Bureau of Statistics, Chinese overseas direct investment[1] stock has averaged a 44.6% annual growth rate for the past ten years. In 2011, China ranks 13th worldwide in terms of ODI stock and 6th in terms of ODI flow. So it would be interesting to study the case of China, which has now become the largest exporting economy in the world.

The aim of this paper is to verify whether overseas direct investment activities can substitute domestic exports. This contributes to the literature as previous studies on Chinese ODI have focused primarily on the determinants and locational choices of these outward flows, and there hasn't been any studies systematically analyzing the impact of ODI on trade.

The remainder of this paper will be organized as following: Section 2 reviews theoretical literatures and empirical evidence from other economies, and we will also demonstrate that many existing studies concerning China are flawed in one way or another (major problems include the endogeneity issue and econometrical misspecifications); Section 3 sets our empirical model and introduces the estimation strategies; Section 4 reports the empirical results and illustrate the implications; Section 5 adopts the panel threshold model to test the heterogeneous influence of ODI on domestic exports and provides robustness checks; Section 6 concludes with possible explanations to the empirical results and the threshold phenomenon.

2. Review of Literatures

In theory, ODI may substitute or complement export trade. Mundell (1957) demonstrated in a general Heckscher-Ohlin model that international investment and trade can be perfect substitutes for each other. Hirsch (1976) noted that multinational corporations can either serve foreign markets by overseas investment or by export trade. Cost determines which way is adopted. But further developments reveals more possible linkages between international investment and trade: Markusen (1984) and Markusen and Venables (1998) showed that market-seeking direct investment by firms avoiding trade costs or jumping trade barriers can have a substituting relationship with trade. Helpman (1984) and Helpman and Krugman (1985) showed the possibility of a complementing relationship when vertical direct investments are involved due to the fragmentation of a production process geographically. This happens when the host economy offers comparative cost advantage and the source economy chooses to delocalize several or all stages of its production.

As for empirical literatures, just as Schmitz and Helmberger (1970) stated, the relationship between investments and trade is more of an empirical issue rather than a theoretical one and results can vary across countries and industries. Typical studies supporting substituting relationship between overseas direct investment and export trade are Horst (1972), Svensson (1996), Bayoumi and Lipworth (1997) and Ma et al. (2000). And studies supporting complementing relationship include Lipsey and Weiss (1984), Blomström et al. (1988), Grossman and Helpman (1989), Clausing (2000), Head and Ries (2001). Particularly, Amiti et al. (2000) discovered

[1] Thereafter referred to as ODI.

that the relationship between overseas direct investment and trade is more likely to be substitutioning in the case of horizontal investments between countries that are similar in terms of factor endowments or when trade costs are high. Otherwise, vertical investments by multinational corporations are more likely to lead to complementing relationships.

Empirical studies concerning the case of China are mainly in Chinese. They seem to have reached the same conclusion that Chinese ODI complements export trade. Early researches such as Wang (2003), Cai & Liu (2004), Zhang (2005) and Zhang (2007) use basic descriptive statistics and simple regressions and conclude that Chinese ODI can promote export trade. These results may not be reliable because they are constrained by the availability of data since the National Bureau of Statistics of China didn't start to publish host-country specific ODI data until 2003. Xiang (2009) and Chen (2010) use cross-country panel data but adopt unary linear regression model. In fact, using ODI as a sole explanatory variable of exports can cause serious omitted variable bias. During the past ten years, Chinese ODI and exports are both on upward trends (thus positively correlated), so it's natural that unary regressions can yield the conclusion that Chinese ODI promotes export trade. But this can be far from the truth. Chai & Hu (2011), Zhou & Niu (2012) and Zhang & Huang (2013) use cross-country panel data and the gravity model but estimate with pooled OLS methods. This method neglects the heterogeneity of individual effects across countries and also produces heavily biased results.

Most importantly, we note that all existing literatures use current ODI stock or flow data as the explanatory variables of exports and can result in serious endogenous problem: current ODI flows and export trade are subject to simultaneous exogenous shocks and demonstrate synchronism. These exogenous shocks include fluctuations of exchange rates, change of national policies, macroeconomic trend of the world and also the diplomatic relationship between China and the trade partner (which is also the host country of Chinese ODI). Based on the knowledge that current ODI stock data is calculated by adding current ODI flow data into existing stock data (after adjusting for some gains, losses and depreciation), we can also know that current ODI stock data demonstrates synchronism with trade data to some extent.

The synchronism of ODI and export trade can further produce misleading results as our aim is to study whether overseas production capacities can substitute or complement exports rather than the statistical correlation between ODI and exports. Based on the arguments above we consider it inappropriate to use current ODI flow or stock data as explanatory variables of exports. So this paper aims to produce accurate empirical results using carefully selected explanatory variables and by correcting for the econometrical misspecifications.

3. Empirical Model, Data and Estimation Strategies

3.1 The Gravity Model

As Bayoumi and Eichengree (1997) noted "the gravity equation has long been the work horse for empirical studies on the pattern of trade", the gravity model originally proposed by Tinbergen (1962) and Poyhonen (1963) has been very empirically successful for its superior explanatory power in trade-related studies. This model, in its simplest form, states that the bilateral trade volume between a pair of countries is positively correlated with their economic scales and negatively correlated with bilateral geographic distance.

Incorporate ODI into the gravity model and add a few control variables, we have our empirical model written as below:

$$ln(Export_{i,t}) = \alpha + \beta_1 \times ln(GDP_{Chn,t}) + \beta_2 \times ln(GDP_{i,t}) + \beta_3 \times ln(Distance_i) + \beta_4 \times ln(ODI\ stock_{i,t-1})$$
$$+ \beta_5 \times Neighbor_i + \beta_6 \times FTA_{i,t} + \beta_7 \times G7_i + \beta_8 \times English_i + \mu_i + \varepsilon_{i,t}$$

Where *ln(*)* denotes the natural logarithm, this procedure would greatly reduce the variance of variables and eliminate the disturbance of heteroskedasticity. In this case, the coefficients β_1, β_2,β_3,β_4 would reflect the elasticity between each explanatory variable and the explained variable;

$Export_{i,t}$ denotes the total export country *i* receives from China in year *t*, which would be the explained variable;

$GDP_{Chn,t}$ denotes the gross domestic product of China in year *t*, which would reflect the export supply capacity of China and have a positive expected sign;

$GDP_{i,t}$ denotes the gross domestic product of country *i* in year *t*, which would reflect the potential market scale in country *i* and also have a positive expected sign;

$Distance_i$ denotes the geographic distance between country *i* and China, this is measured by the great circle distance between capitals and reflects transportation cost, which would have a negative expected sign;

$Neighbor_i$ denotes countries that are adjacent to China, which has a positive expected sign because of a common border;

$FTA_{i,t}$ denotes countries that are in free trade agreements with China, which has a positive expected sign as free trade agreements set up favorable policies for participants;

$G7_i$ denotes Group of Seven countries, high-income countries and also the main destination of Chinese exports, which has a positive expected sign;

$English_i$ denotes countries that set English as their official language, which has a positive expected sign because English is widely used worldwide in business communications;

μ_i denotes the individual country effect, which consists of the unobserved and the unobservable effects of each particular country.

As for the key explanatory variable $ODI\_stock_{i,t-1}$, there are two main reasons that we use the lag term of ODI stock:

(1) The synchronism of current ODI flow and stock with international trade will result in endogeneity in regressions, which may lead to biased results (and predictably upward-biased);

(2) There are certain time lags from the very beginning of investment to the final formation of actual production capacities (for instance, obtaining approval from the local government, construction of production facilities, negotiation procedures involved in acquisitions and merges, recruiting and training of local labor force).

For the above reasons we consider it most appropriate to use the lag term of ODI data as the key explanatory variable but we will also provide results using the current data of ODI stock and flow so that we can compare results. Due to the endogeneity issue caused by synchronism between trade and investment flow, we expect results of the latter two to be upward-biased.

3.2 Data and Variables

The <Outward Direct Investment Statistical Bulletin> jointly published by the Ministry of Commerce and the National Bureau of Statistics of China provides Chinese ODI stock and flow data in most countries and territories. For consideration of economic significance, we use countries that have Chinese ODI stock exceeding one hundred million dollars only and there are 91 economies meeting this criterion. After dropping HongKong, Macao, North Korea, Cayman Islands, Bermuda, the British Virgin Islands[2], we have 85 economies in our sample as Table 1 shows:

[2] HongKong and Macao dropped because of political connection with China; North Korea dropped because of unavailability of reliable GDP data; Cayman Islands, Bermuda, the British Virgin Islands dropped because of their statuses as popular tax-avoiding countries and have very large inflows of non-production investments.

Table 1 Host Countries and Territories of Chinese ODI in Sample

Asia (28)	Afghanistan; Cambodia; India; Indonesia; Iran; Iraq; Japan; Kazakhstan; Kyrgyzstan; South Korea; Laos; Malaysia; Mongolia; Myanmar; Pakistan; Philippines; Qatar; Saudi Arabia; Singapore; Sri Lanka; Tajikistan; Thailand; Turkmenistan; Turkey; The United Arab Emirates; Uzbekistan; Vietnam; Yemen
Africa (24)	Algeria; Angola; Botswana; Chad; Congo Dem; Congo Rep; Egypt; Ethiopia; Gabon; Ghana; Guinea; Kenya; Liberia; Madagascar; Mali; Mauritius; Niger; Nigeria; South Africa; Sudan; Tanzania; Uganda; Zambia; Zimbabwe
Europe (16)	Belgium; France; Georgia; Germany; Hungary; Ireland; Italy; Luxembourg; Netherlands; Norway; Poland; Romania; Russia; Spain; Sweden; United Kingdom
America (12)	Argentina; Brazil; Chile; Cuba; Ecuador; Guyana; Mexico; Panama; Peru; Venezuela; Canada; United States of America
Oceania (5)	Australia; Marshall Islands; New Zealand; Papua New Guinea; Samoa

Note: Range of observation is 2003 through 2011.

Up till 2011, Chinese ODI stock in the host countries listed above takes up more than 90% of Chinese ODI stock worldwide, making it a very comprehensive and representative sample. Data source and expected signs of variables to be used in further empirical analysis are summarized as below in Table 2:

Table 2 Data Source and Expected Signs of Variables

Variable	Data Source	Expected Signs
$Export_{i,t}$	< China Statistical Yearbook >	Non
$GDP_{Chn,t}$	World Bank WDI Database	+
$GDP_{i,t}$	World Bank WDI Database	+
$Distance_i$	City Distance Calculator	-
$Neighbor_i$	Map of the World	+
$FTA_{i,t}$	Ministry of Commerce of China	+
$G7_i$	Common Sense	+
$English_i$	Common Sense	+
ODI_i *stock and flow*	<Outward Direct Investment Statistical Bulletin>	To be studied
Per Capita GDP_i	World Bank WDI Database	To be used elsewhere

3.3 The Hausman-Taylor Estimator

Earlier researches using the gravity model were carried out with cross-sectional data, but this doesn't allow for heterogeneity in regression equations and yield biased estimates. Panel data regression serves to correct this bias. Usually, panel data model can be estimated using Pooled OLS[3], fixed effect model[4] and random effect model[5].

The POLS method also assumes no heterogeneity for all countries just like cross-sectional regressions and is rarely suitable for cross-country panels. This method yields heavily biased results (see Chai & Hu (2011), Zhou & Niu (2012) and Zhang & Huang (2013)). In the empirical part of this paper, F tests and LM tests ruled out the

[3] Thereafter referred to as POLS.
[4] Thereafter referred to as FE.
[5] Thereafter referred to as RE.

possibility of POLS as an acceptable method for the estimation of our model.

As for the FE method, it provides the within-group estimator by assigning different intercepts for different countries to capture the heterogeneity so it provides consistent estimates regardless whether or not the country individual effect is correlated with the explanatory variables. Unfortunately, time-invariant variables (including geographic distance and several other dummy variables in the gravity equation) are crossed out when we apply the within operator in FE, so their coefficients vanish in the regression. From this perspective, the FE method is not suitable for the estimation of the gravity model either.

The RE method, which doesn't cross out the country individual effects, can produce estimates for all variables and may also be more efficient. But its consistency relies on the strict assumption that all explanatory variables are uncorrelated with the country individual effect. Hence, it's important to verify the consistency of RE method using Hausman test, whose null hypothesis is that there is no systematic difference between FE method and RE method. If the calculated test statistic rejects the null hypothesis, this suggests that the RE method is inconsistent and proves some correlation between some or all explanatory variables and the country individual effect. In the empirical part of this paper, Hausman tests reject the null hypothesis of each regression, so the RE method isn't appropriate for the estimation of our gravity model. This reveals that some or all of our explanatory variables are correlated with the country individual effect.

Fortunately, Hausman and Taylor (1981) proposed a procedure as an alternative to both the FE and RE method. It basically involves finding instrumental variables for the endogenous variables and then make regressions using the RE method. For our empirical equation, consider a panel model written as following:

$$y_{it} = x'_{1,it}\beta_1 + x'_{2,it}\beta_2 + z'_{1,i}\delta_1 + \mu_i + \varepsilon_{it}$$

Where x' are time-variant explanatory variables and z' are time-invariant explanatory variables. And explanatory variables with the subscript of *1* refers to exogenous variables (uncorrelated with the country individual effect μ_i), those with the subscript of *2* refers to endogenous variables (correlated with the country individual effect μ_i). Note that there are no endogenous time-invariant variables in this model because all time-invariant variables in our gravity equation are strictly exogenous. And $z'_{1,i}$ is the geographic distance in our model.

Hausman and Taylor (1981) suggested using $\left(x_{2,it} - \overline{x_{2,\iota}}\right)$ as the instrumental variable of $x_{2,it}$. Obviously, on one hand, $\left(x_{2,it} - \overline{x_{2,\iota}}\right)$ is strongly correlated with $x_{2,it}$. On the other hand, according to the law of iterated expectations, we have:

$$E\left[\left(x_{2,it} - \overline{x_{2,\iota}}\right)\mu_i\right] = E_{\mu_i}E\left[\left(x_{2,it} - \overline{x_{2,\iota}}\right)\mu_i|\mu_i\right] = E_{\mu_i}\left\{\mu_i E\left[\left(x_{2,it} - \overline{x_{2,\iota}}\right)|\mu_i\right]\right\} = E_{\mu_i}\{\mu_i \cdot 0\} = 0$$

So $\left(x_{2,it} - \overline{x_{2,\iota}}\right)$ is a valid instrumental variable for $x_{2,it}$. Usually, the identification of the endogenous variables involves making experimental regressions and comparing each estimation result with the FE estimator using another round of Hausman tests as Baltagi et al. (2003) recommended. If the identification of the endogenous variables is correct and the instrumental variables are valid, there should not be systematic difference between the FE estimator and the HT estimator, which is signaled by the acceptance of the null hypothesis.

4. Results and Implications

4.1 Whole Sample Regressions

Whole sample regression results are exhibited in Table 3. The first column shows the regression result using the lag term of ODI stock as the key explanatory variable, which we are interested in. The second and third column shows results using the current terms of ODI stock and flow respectively for comparison. The gravity model demonstrates excellent explanatory power in general, with the Wald Chi^2 statistic overwhelmingly exceeding the borderline of 10, indicating a high level of overall significance of the regression equation. Note that for each column two Hausman test results are provided, with the first one testing RE against FE and the second testing HT against FE. Results show that the RE method is rejected at 1% level of significance and the HT method is proved to be consistent.

Table 3 Whole Sample Regressions Using Hausman-Taylor Estimator

Explained variable is $ln(Export_i)$	(1)	(2)	(3)
$ln(GDP_{Chn})$	1.165***	1.242***	1.286***
	(18.95)	(20.15)	(24.77)
$ln(GDP_i)$	0.117*	0.103*	0.075#
	(1.94)	(1.76)	(1.30)
$ln(Distance_i)$	-0.852**	-0.904**	-0.922**
	(-2.23)	(-2.35)	(-2.40)
$ln(ODI\_stock_i)(-1)$	-0.003		
	(-0.17)		
$ln(ODI\_stock_i)$		0.015	
		(0.93)	
$ln(ODI\_flow_i)$			0.011*
			(1.68)
$Neighbor_i$	-0.372	-0.439	-0.454
	(-0.58)	(-0.67)	(-0.70)
FTA_i	-0.078	-0.138	-0.159
	(-0.62)	(-1.05)	(-1.16)
$G7_i$	3.155***	3.161***	3.165***
	(4.69)	(4.67)	(4.66)
$English_i$	-0.316	-0.310	-0.316
	(-0.78)	(-0.76)	(-0.78)
Constant	-16.94***	-18.55***	-18.88***
	(-4.54)	(-4.98)	(-5.22)
Model Information	N=661	N=745	N=759
	Chi^2=1716.5	Chi^2=2296.6	Chi^2=2268.3
Hausman Test 1	p=0.0001***	p=0.0001***	p=0.0001***
Hausman Test 2	p=0.2148	p=0.1912	p=0.1866

Note: (1) t statistics in parentheses; (2) # p<0.20, * p<0.10, ** p<0.05, *** p<0.01; (3) Hausman test 1---fixed effect versus random effect; (4) Hausman test 2---fixed effect versus Hausman-Taylor.

The GDP of China is significant at 1% level with an estimated elasticity coefficient around 1.20, and the GDP of the trade partner is also significant around 0.10. This means a 0.83% increase of China GDP or a 10% increase of trade partner GDP will boost Chinese exports by about 1%. The estimated elasticity coefficient of geographic distance is around 0.90 and significant at 5% level, revealing that with all things constant, a 1% increase in geographic distance will reduce exports by about 0.9%. The estimated coefficients and their significance levels match with the theoretical expectations of the gravity model, again proving its excellent explanatory power.

Take a look at the control variable *$Neighbor_i$*, we discover that countries sharing a common border with China doesn't receive more exports from China, which is contrary to our expectation. But considering that the border of China is mainly constituted of mountains and deep forests (especially North-West border), which are in fact natural barriers of trade, this phenomenon is understandable. *FTA_i* and *$English_i$* aren't statistically significant either, indicating China yet has to establish more cooperation with treaty countries and to exploit the common language advantage (consider the fact that English is widely taught and used in China). *$G7_i$* is positively significant, indicating that Chinese exports are more directed to high-income partners.

Let's focus on the key explanatory variable. We can find that the estimated coefficient of $ln(ODI\_stock_i)(-1)$ is -0.003 with a t-statistic of -0.17, it doesn't acquire any statistical significance but reveals that Chinese ODI very weakly substitutes exports on the whole. A 1% increase of Chinese ODI in one host country will substitute about 0.003% exports to that particular country.

For $ln(ODI\_stock_i)$ and $ln(ODI\_flow_i)$, the estimated coefficients are 0.015 and 0.011, and the latter is statistically significant. The comparison of these three coefficients proves that, due to the synchronism between ODI flow and trade, regressions using the current term of ODI stock and flow data yield upward-biased results, right to our prediction. Using the lag term of ODI stock to analyze the relationship between overseas production capacities and export trade effectively correct this bias and discover that there actually exists a very weak substituting relationship between ODI and export trade.

4.2 Sub-sample Regressions

Overseas investments may be driven by different motivations. Many literatures classify overseas investments in developed countries as market-seeking or strategic asset seeking investments and those in developing countries as resource-seeking. Investments of different types may have different influence on exports. In light of that we split the sample into developed and developing countries groups.

Sub-sample regression results are exhibited in Table 4.

Results from the sub-sample of developed countries can be seen in column (4) ~ (6), column (7) ~ (9) report results of developing countries. The framework of gravity model still holds for each sub-sample, with the expansion of GDP boosting exports and geographic distance working the opposite way.

For developed countries, Chinese ODI can substitute exports to the host country, the estimated coefficient is -0.083 and significant at 1% level, this means that a 1% increase of Chinese overseas investment stock in the host country will reduce exports to that particular country by about 0.083%. For developing countries things are different: a 1% increase of Chinese overseas investment stock in the host country will complement exports to that country by about 0.025%.

The upward-bias persists in sub-sample regressions:

(1) For developed countries, if the explanatory variable is $ln(ODI\_stock_i)$, the negative effect will be reduced to -0.040, and if the explanatory variable is $ln(ODI\_flow_i)$, the negative effect will turn into weakly positive effect;

(2) For developing countries, if the explanatory variable is $ln(ODI\_stock_i)$, the positive effect will be raised to 0.040, and if the explanatory variable is $ln(ODI\_flow_i)$, the significance of the positive effect will be overstated (from a 20% significance level to a 1% level).

Since sample splitting provides distinctive results for developed and developing countries, it's natural to question whether there is some connection between the influence of Chinese ODI upon exports and the economic developmental stage of the host country. This will be further investigated in the next section using the panel threshold model. The reasons why different types of countries demonstrate different effects will also be discussed in the final section of this paper.

Table 4　Sub-Sample Regressions Using Hausman-Taylor Estimator (developed and developing countries)

Explained variable is	Developed Countries			Developing Countries		
ln(Export$_i$)	(4)	(5)	(6)	(7)	(8)	(9)
ln(GDP$_{Chn}$)	0.891***	0.821***	0.665***	1.267***	1.360***	1.448***
	(9.78)	(9.00)	(8.51)	(18.60)	(19.85)	(24.96)
ln(GDP$_i$)	0.134$^{\#}$	0.219**	0.282***	0.067	0.049	0.032
	(1.47)	(2.43)	(3.05)	(0.99)	(0.73)	(0.47)
ln(Distance$_i$)	-1.072**	-0.993*	-0.909#	-0.430	-0.495	-0.534
	(-2.00)	(-1.71)	(-1.47)	(-0.92)	(-1.05)	(-1.11)
ln(ODI_stock$_i$)(-1)	-0.083***			0.025$^{\#}$		
	(-4.11)			(1.44)		
ln(ODI_stock$_i$)		-0.040*			0.040**	
		(-1.95)			(2.20)	
ln(ODI_flow$_i$)			0.002			0.021***
			(0.25)			(2.85)
Neighbor$_i$				0.311	0.248	0.244
				(0.44)	(0.34)	(0.33)
FTA$_i$	-0.128	-0.112	-0.068	-0.094	-0.166	-0.194
	(-0.80)	(-0.67)	(-0.38)	(-0.66)	(-1.10)	(-1.24)
G7$_i$	1.775***	1.750***	1.722**			
	(2.95)	(2.68)	(2.47)			
English$_i$	0.569	0.454	0.345	-0.642$^{\#}$	-0.637$^{\#}$	-0.620$^{\#}$
	(0.89)	(0.65)	(0.46)	(-1.41)	(-1.38)	(-1.33)
Constant	-5.681	-6.837$^{\#}$	-5.026	-22.93***	-24.78***	-26.32***
	(-1.14)	(-1.28)	(-0.90)	(-5.02)	(-5.41)	(-5.84)
Model Information	N=153	N=173	N=180	N=508	N=572	N=579
	Chi^2=371.6	Chi^2=551.2	Chi^2=544.2	Chi^2=1670.1	Chi^2=2187.0	Chi^2=2186.0
Hausman Test 1	p=0.0012***	p=0.0004***	p=0.0001***	p=0.0003***	p=0.0002***	p=0.0001***
Hausman Test 2	p=0.4253	p=0.2132	p=0.1532	p=0.1973	p=0.1605	p=0.3817

Note: (1) t statistics in parentheses; (2) # p<0.20, * p<0.10, ** p<0.05, *** p<0.01; (3) Hausman test 1---fixed effect versus random effect; (4) Hausman test 2---fixed effect versus Hausman-Taylor.

5. Extension of Empirical Examination

In this section, we will investigate the potential heterogeneity of the influence of Chinese ODI upon exports using the panel threshold model originally proposed by Hansen (1999, 2000). We will also provide robustness checks to address the potential endogeneity problem inherently involved in the gravity model to ensure that our empirical results obtained within the framework of gravity model is reliable.

5.1 The Panel Threshold Model

Distinctive empirical results obtained from sub-sample regressions provoke the suspicion that how Chinese ODI influence domestic exports may have something to do with the economic developmental stage of the host country. On the spectrum of economic development, there may be certain thresholds between which Chinese ODI may have different influence on domestic exports. Classifying host countries into developed and developing groups may be one way of exploring this potential heterogeneity but may not be accurate. We borrow from the ideas of Hansen (1999, 2000), measure the economic developmental stage of the host country by its per capita GDP (year 2000 fixed price in US dollars) and our panel threshold model can be written as:

$$ln(Export_{i,t}) = \alpha + \beta_1 \times ln(GDP_{Chn,t}) + \beta_2 \times ln(GDP_{i,t}) + \beta_3(Per\ Capita\ GDP_{i,t}) \times ln(ODI\ stock_{i,t-1}) + \beta_4 \times FTA_{i,t} + \mu_i + \varepsilon_{i,t}$$

Where $\beta_3(Per\ Capita\ GDP_{i,t})$ means the coefficient of $ln(ODI\ stock_{i,t-1})$ is a function of host country per capita GDP. Note that since the panel threshold model is based on non-dynamic fixed effect model, all time-invariant variables vanish in our equation but consistent estimates can still be yielded. Starting from the simplest form of single-threshold model, we have:

$$ln(Export_{i,t}) = \alpha + \beta_1 \times ln(GDP_{Chn,t}) + \beta_2 \times ln(GDP_{i,t}) + \delta_1 \times OFDI\_stock_{i,t-1} \times I\left(Per\ Capita\ GDP_{i,t} \le \gamma\right) + \delta_2 \times OFDI\_stock_{i,t-1} \times I\left(Per\ Capita\ GDP_{i,t} > \gamma\right) + \beta_4 \times FTA_{i,t} + \mu_i + \varepsilon_{i,t}$$

Where γ is the threshold parameter and *I(*)* is the indicator function which takes the value of 1 if the condition in the parentheses is satisfied and the value of 0 otherwise. For each regression depending on different selection of γ we note each residual sum of squares as $S_1(\gamma)$ and the estimated threshold parameter is identified as:

$$\hat{\gamma} = ArgMin[S_1(\gamma)]$$

After the identification of $\hat{\gamma}$, we also have to test the significance of the threshold by testing:

$$H_0: \delta_1=\delta_2;\ H_a: \delta_1 \neq \delta_2$$

If the null hypothesis is accepted, the threshold model falls back to be a linear one. Otherwise, the existence of a threshold is proved. The F statistic used to test this hypothesis can be written as:

$$F = \frac{S_0 - S_1(\hat{\gamma})}{\hat{\sigma_\varepsilon}^2} = \frac{S_0 - S_1(\hat{\gamma})}{S_1(\hat{\gamma})/n(T-1)}$$

Since the distribution of this F statistic is non-standard, Hansen (1999, 2000) suggested using the bootstrap simulations to obtain the asymptotic distribution of it. If the F statistic exceeds the critical value calculated from the bootstrap simulations, the null hypothesis gets rejected. In this case, we move on to search the possibility of a second threshold and continue the procedures listed above.

Panel threshold model estimation results are exhibited in Table 5 and 6.

The threshold model is estimated using the FE method, F statistic confirms the overall significance of the regression equation and a R^2 of 0.7694 demonstrates the excellent explanatory power of the threshold model. Two thresholds are detected in the model: the first is 1150.39 of per capita GDP and the second is 11601.63 of per capita GDP. They divide the whole sample into three regimes and the estimated coefficients differ greatly in each of them:

(1) For those observations with host country per capita GDP lower than 1150.39 US dollars (year 2000 fixed price), Chinese ODI complements exports to the host country. A 1% increase of investment stock in the host country will raise exports by about 0.035%, significant at 5% level;

(2) For those observations whose per capita GDP falling within the range of (1150.39, 11601.63), Chinese ODI in the host country has a very weak substituting relationship with exports. Hence we call this the “gray zone”;

(3) For those observations with host country per capita GDP higher than 11601.63 US dollars, Chinese ODI substitutes exports to the host country. A 1% increase of investment stock in the host country will reduce exports by about 0.081%, significant at 1% level.

Table 5 Statistical Significance Test of Thresholds

Hypothesis Tests	F Statistic	Critical Value		Rejection of H_0
		1%	5%	
H_0: No Threshold; H_a: One Threshold	55.09	20.45	10.93	Yes
H_0: One Threshold ; H_a: Two Thresholds	17.11	23.31	11.64	Yes
H_0: Two Thresholds ; H_a: Three Thresholds	8.61	24.72	11.99	No

Note: Critical value obtained from Bootstrap simulations. (Number of times of simulations = 500)

Table 6 Panel Threshold Model Regression

Explained variable is ln(Export$_i$)	
ln(GDP$_{Chn}$)	1.226*** (17.50)
ln(GDP$_i$)	0.115# (1.32)
ln(ODI_stock$_i$)(-1) *when Per Capita GDP < 1150.39*	0 .035** (2.18)
ln(ODI_stock$_i$)(-1) *when 1150.39 < Per Capita GDP < 11601.63*	-0.011 (-0.69)
ln(ODI_stock$_i$)(-1) *when Per Capita GDP > 11601.63*	-0.081*** (-4.48)
FTA$_i$	-0.182# (-1.49)
Constant	-25.467*** (-16.56)
Model Information	N=653 F=313.15 R^2=0.7694

Note: (1) t statistics in parentheses; (2) # p<0.20, * p<0.10, ** p<0.05, *** p<0.01.

In a word, overseas direct investment stock complements exports to low-income host countries but substitutes exports to high-income host countries. This conclusion matches what we discover from the sub-sample regressions, where we classify the countries into developed and developing groups. But the bisection method fails to discover the “gray zone”, where Chinese overseas investment stock has very weak influence on exports. As a matter of fact, of all 653 observations in our sample, 216 of them fall within the per capita GDP range between 1150.69 and 11601.63 US dollars. For these observations, Chinese overseas direct investment stock has very weak influence on export trade. The possible reasons leading to this threshold phenomenon will be discussed in Section 6.

5.2 Robustness Checks

One major defect of the gravity model is its inherent endogenous problem. As many economists have pointed out, there exists an obvious two-way causality relationship between economic growth and trade, so using GDP data as the explanatory variables may yield biased results. To alleviate the disturbance of endogeneity, we use the lag terms of GDP data as the explanatory variables and provide robustness checks, the results are exhibited in Table 7.

Table 7 Robustness Checks (Regressions Using Lag Terms of GDP as Explanatory Variables in the Gravity Model)

Explained variable is	Whole Sample			Developed Countries			Developing Countries		
ln(Export$_i$)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln(GDP$_{Chn}$)(-1)	1.096***	1.060***	1.154***	0.784***	0.638***	0.601***	1.199***	1.146***	1.302***
	(16.78)	(16.05)	(20.88)	(7.69)	(6.44)	(7.17)	(16.54)	(15.52)	(21.10)
ln(GDP$_i$)(-1)	0.088#	0.077#	0.068	0.144#	0.155#	0.158*	0.043	0.033	0.053
	(1.48)	(1.29)	(1.13)	(1.53)	(1.64)	(1.72)	(0.64)	(0.49)	(0.78)
ln(Distance$_i$)	-0.845**	-0.846**	-0.862**	-1.034*	-0.940*	-0.914*	-0.434	-0.442	-0.457
	(-2.24)	(-2.26)	(-2.28)	(-1.88)	(-1.72)	(-1.70)	(-0.93)	(-0.96)	(-0.97)
ln(ODI_stock$_i$)(-1)	0.020			-0.060***			0.047***		
	(1.23)			(-2.64)			(2.59)		
ln(ODI_stock$_i$)		0.042**			-0.0130			0.081***	
		(2.38)			(-0.58)			(3.94)	
ln(ODI_flow$_i$)			0.009#			-0.002			0.020***
			(1.40)			(-0.18)			(2.66)
Neighbor$_i$	-0.383	-0.402	-0.399				0.294	0.263	0.301
	(-0.60)	(-0.63)	(-0.62)				(0.42)	(0.37)	(0.42)
FTA$_i$	-0.059	-0.064	-0.078	-0.118	-0.047	-0.026	-0.069	-0.084	-0.089
	(-0.45)	(-0.48)	(-0.57)	(-0.66)	(-0.26)	(-0.14)	(-0.46)	(-0.56)	(-0.57)
G7$_i$	3.131***	3.102***	3.141***	1.751***	1.705***	1.695***			
	(4.71)	(4.69)	(4.70)	(2.84)	(2.78)	(2.80)			
English$_i$	-0.331	-0.333	-0.335	0.521	0.409	0.378	-0.651#	-0.632#	-0.612#
	(-0.83)	(-0.84)	(-0.84)	(0.79)	(0.62)	(0.59)	(-1.44)	(-1.40)	(-1.33)
Constant	-14.27***	-13.15***	-15.15***	-3.208	-0.458	0.193	-20.30***	-18.81***	-23.07***
	(-3.85)	(-3.57)	(-4.24)	(-0.62)	(-0.09)	(0.04)	(-4.46)	(-4.16)	(-5.20)
Model Information	N=662	N=668	N=676	N=153	N=155	N=160	N=509	N=513	N=516
	Chi^2=1459.8	Chi^2=1487.2	Chi^2=1465.0	Chi^2=268.5	Chi^2=252.9	Chi^2=264.1	Chi^2=1424.0	Chi^2=1485.9	Chi^2=1450.4
Hausman Test 1	p=0.0002	p=0.0001	p=0.0001	p=0.0014	p=0.0017	p=0.0012	p=0.0006	p=0.0001	p=0.0006
Hausman Test 2	p=0.2618	p=0.2664	p=0.2315	p=0.4006	p=0.3611	p=0.1954	p=0.2231	p=0.2163	p=0.3212

Note: (1) t statistics in parentheses; (2) # p<0.20, * p<0.10, ** p<0.05, *** p<0.01; (3) Hausman test 1---fixed effect versus random effect; (4) Hausman test 2---fixed effect versus Hausman-Taylor.

In Table 7, we are pleased to find that the gravity model still holds when we use lag terms of bilateral GDP as explanatory variables. And the results are mostly consistent with our previous findings. Our findings in previous sections are robust under different variable selections. The influence of Chinese overseas direct investment on its exports is vague in general, but it substitutes exports to developed countries and complements exports to developing countries. Both effects are significant at a 1% level (see columns numbered (1), (4) and (7) in Table 7). The upward-bias still persists, which again confirms the bias caused by synchronism between trade and investment flow is stickily systematic.

6. Conclusions

This paper serves to verify the relationship between Chinese overseas direct investment and its domestic exports. Using panel data of 85 host countries from 2003 to 2011 we discover a very weak substituting relationship between overseas direct investment and domestic export. By dividing the sample into developed and developing sub-samples we find distinctive results: direct investment in developed countries significantly substitutes exports to the host country, a 1% increase of investment stock will reduce exports by about 0.083%; while direct investment in developing countries complements exports, a 1% increase of investment stock will raise exports by about 0.025%. Panel threshold model further confirms the role of host country developmental stage (measured by per capita GDP) in determining the influence of overseas direct investment on domestic exports and detects two thresholds. Thus the sample is divided into three regimes: (1) in the first regime where per capita GDP is lower than 1150.39 dollars, overseas direct investment complements exports to the host country; (2) in the second regime where per capita GDP falls between 1150.39 and 11601.63 dollars, the “gray zone”, overseas direct investment has very weak influence on domestic exports; (3) in the third regime where per capita GDP exceeds 11601.63 dollars, overseas direct investment substitutes exports to the host country.

As to why different types of countries demonstrate different response to Chinese overseas investments, we offer two possible explanations to be illustrated below.

6.1 Trade Barrier to Lucrative Markets

Overseas direct investment may be the response to “jump” trade barriers as Markusen (1984) suggested. Multinational corporations may avoid trade barriers of the target market by direct investments. By forming production capacities in the target market, the multinational corporation serves the target market directly rather than exporting their commodities. In this way, the corporation also gets closer to the demand information of the target market and saves on transportation costs.

In recent years, many advanced economies are going through the trend of “re-industrialization”. As these economies have long been accusing “cheap” exports from China of depriving them of employment opportunities, this trend of “re-industrialization” may actually turns out to be a great chance for Chinese firms to invest abroad. If the core interest of their manufacturing industries is not compromised, advanced economies would hold a friendly attitude towards investments from China. By investing in these economies and meeting their requirement of certain “local component criterion”, Chinese overseas direct investments may enjoy profits by selling abroad and also serves to rescue the sluggish job market and weak economic performance of advanced economies. This would turn out to be a “win-win” situation rather than a “zero-sum” game which it used to be when Chinese exports squeezed local firms out of the market. However, producing in advanced economies may induce higher production cost, especially higher labor cost. They may also have to deal with stricter environmental supervisions, so the firms need to weigh these additional costs against the benefits.

Overall, Chinese direct investments in high-income countries often substitute exports, which is exactly indicated by our empirical results.

6.2 Inadequacy of Supporting Industries

Overseas direct investment in low-income economies may have a different influence on exports. Investments may be driven by resource-seeking motivations, which wouldn't have any substituting effect on exports in theory.

More importantly, even if the investment is market-seeking, it would only substitute trade within the same industry but promotes exports of its supporting industries. For a less developed economy with poor infrastructure and inadequacy of supporting industries, Chinese firms operating there may come across difficulties finding suitable production machineries as well as intermediate inputs. This is not a rare situation in reality, as events of Chinese firms operating in Africa have proved repeatedly that local supporting industries often fail to meet quality requirements and to complete the orders in time. Thus the multinational corporation tend to purchase machineries and intermediate inputs from its source economy, in this way promotes export trade of its supporting industries to the host economy. The same thing wouldn't happen in advanced economies as they have well-developed and mature industrial systems so Chinese firms operating there can acquire machinery and intermediate inputs of excellent quality much more easily.

In addition, due to inferior quality of property rights protection, Chinese firms operating in less-developed economies may prefer intra-corporation trade over contract deals so as to reduce uncertainties, this would also contribute to a complementing relationship between investment and trade for low-income host countries.

And for middle-income economies, the two effects discussed above may cancel out each other as neither can achieve a dominating status. In this case, Chinese overseas direct investment would turn out to have a vague relationship with domestic exports.

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