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An empirical study of the effect of China's direct investment in ASEAN on bilateral intra industry trade

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Abstract. The variable coefficient panel data model is used to test of the effect of Chinese direct investment in ASEAN countries on bilateral intra industry trade. The empirical results show that: (**??**) The effect of China's direct investment in ASEAN on bilateral intra industry trade is different because of the ASEAN economic differences; (**??**) Whether China's direct investment in ASEAN countries promotes trade in the bilateral industry or not can be explained by extrusion effect between HIIT and VIIT.

Key words. Outward foreign direct investment,intra-industry trade,variable coefficient panel data model.

1. Introduction

ASEAN, the first stop on the Maritime Silk Road, will be seen to play an important role once again when China has established "One Belt, One Road" as its strategic concept and cooperation initiatives for external and internal opening up. Under China's "Go Global" strategy, the economic exchanges China and ASEAN have expanded greatly; and the focus now should be quality enhancement[1]. Since China joined the Treaty of Amity and Cooperation in Southeast Asia in 2003, becoming the first non-ASEAN signatory to the treaty, both the flow and stock of the direct investment from China to ASEAN countries are growing year by year. ASEAN has become the fourth-largest destination for China's outward foreign direct investment (OFDI). Has China's OFDI promoted the bilateral intra-industry trade (IIT) between China and a specific ASEAN country? Why does China's OFDI have a positive effect on the bilateral intra-industry trade between China and some

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ASEAN countries while the same effect is not significant or even inhibiting for the other countries? To answer these questions, this paper, based on the differences between ASEAN countries, first gives an in-depth exploration on the impact of OFDI on horizontal intra-industry trade (HIIT) and vertical intra-industry trade (VIIT). And then varying coefficient panel data models are constructed to test and explain the impact of China's OFDI on the bilateral IIT between China and each ASEAN country.

2. OFDI's Impact on Bilateral Intra-industry Trade

2.1. Model Selection

The impact of China's OFDI on bilateral intra-industry trade between China and ASEAN countries cannot be generalized due to the economic difference existing between these ten countries. For its ability to reflect the changes of variables over time or at cross-sections well, a varying coefficient panel data model is selected to measure the impact of China's OFDI on intra-industry trade between China and ASEAN countries:

$Ln(IIT_{it}) = \alpha_i + \beta_{\mathrm{it}} Ln(FDI_{it}) + \gamma_{\mathrm{it}} Ln(AGDP_{\mathrm{it}}) + \mu_{it}$ Equation (1)

Where, IIT denotes the China-ASEAN intra-industry trade index of each year; FDI denotes the stock of Chinese FDI to ASEAN; AGDP denotes the per capita GDP difference between China and ASEAN countries; α_{it} denotes the constant term; β_{it} denotes the coefficient of Ln (FDI); γ_{it}denotes the coefficient of Ln (AGDP); μ_{it} is the disturbance term; and i = 1, 2, ..., N, and t = 1, 2, ..., T.

2.2. Variable Selection and Data Sources

2.2.1. IIT indicator From the point of view of international investment and trade, Grubel-Lloyd index is the most widely used and applicable IIT measure. It can be calculated based on the following equation:

$G - L_{ij} = 1 - \frac{|X_{ij} - M_{ij}|}{X_{ij} + M_{ij}}$ Equation (1-1)

Where, i denotes a certain country; j denotes a certain industry of the country; X_{ij} denotes the total exports of industry j in country i; M_{ij} denotes the total import of industry j in country i; $X_{ij} + M_{ij}$ denotes the total trade volume of the commodities in industry j (i.e., imports plus exports); $|X_{ij} - M_{ij}|$ denotes the inter-industry trade, that is, the "asymmetric" trade, which is equal to the absolute difference between the export and import of the commodities in industry j, and $G - L_{ij}$ is the IIT index of industry j in country i.

In view of the overall intra-industry trade between two countries, the IIT index between country a and country b can be calculated as follows by weighting the IIT index of an industry based on the share of its total imports and exports in the total imports and exports of all the industries between the two countries:

$IIT_{ab} = \sum_{j=1}^{J} \left(\left[\frac{X_{abj} + M_{abj}}{\sum_j (X_{abj} + M_{abj})} \right] \cdot \left[1 - \frac{|X_{abj} - M_{abj}|}{X_{abj} + M_{abj}} \right] \right)$ Equation (1-2)

The weighted average IIT indexes for China and each of the ten ASEAN countries

is then obtained based on the import and export data of HS21 (miscellaneous edible preparations) for 2003 to 2012 (see Table 1) from the UN Comtrade database.

Table 1 IIT Indexes for China and each of ASEAN Countries from 2003 to 2012

Country	2003	2004	2005	2006	2007	2008	2009	2010
Brunei	0.002	0.004	0.009	0.023	0.024	0.042	0.017	0.024
Myanmar	0.077	0.099	0.102	0.109	0.126	0.156	0.134	0.155
Cambodia	0.046	0.055	0.055	0.057	0.055	0.045	0.049	0.070
Indonesia	0.568	0.580	0.625	0.585	0.457	0.365	0.412	0.377
Laos	0.031	0.056	0.152	0.105	0.198	0.171	0.152	0.140
Malaysia	0.470	0.471	0.492	0.490	0.522	0.514	0.482	0.434
Philippines	0.357	0.405	0.337	0.340	0.313	0.361	0.503	0.463
Singapore	0.699	0.743	0.770	0.680	0.623	0.577	0.641	0.666
Thailand	0.544	0.526	0.544	0.541	0.528	0.486	0.525	0.528
Vietnam	0.501	0.356	0.401	0.353	0.307	0.318	0.409	0.431

2.2.2. Chinese FDI stock in ASEAN To avoid negative or zero variable value, this paper chooses the Chinese FDI stock in ASEAN countries as an independent variable. Our data are obtained from the *Statistical Bulletin of China's Outward Foreign Direct Investment* from 2003 to 2012.

2.2.3. Per capita GDP gap between China and each of ASEAN countries In this paper, the per capita GDP gap between China and each of ASEAN countries is used as the proxy variable of the per capita income gap. Its data is based on the per capita GDP at 2000 current price (in US dollar) from the World Bank World Development Indicators (WDI) database.

2.3. Model Estimates

2.3.1. Per capita GDP gap between China and each of ASEAN countries In order to eliminate heteroscedasticity and data volatility and enable flexible interpretation of the variable, the ADF test is conducted on Ln (IIT), Ln (FDI) and Ln (AGDP) (see Table 2).

Table 2 ADF test results

Variable	Form	P value	Stationary or not
Ln(IIT)	(C,0,0)	0.0917	>0.05, non-stationary
DLn(IIT)	(C,0,0)	0.0026	<0.05, stationary
Ln(FDI)	(C,0,0)	0.7576	>0.05, non-stationary
DLn(FDI)	(C,0,0)	0.0000	<0.05, stationary
LnAGDP	(C,0,0)	0.3922	>0.05, non-stationary
DLnAGDP	(C,0,0)	0.0178	<0.05, stationary

It can be concluded from Table 2 that Ln (IIT), Ln (FDI) and Ln (AGDP) are non-stationary. However, we can see that their first difference, DLn (IIT), DLn (FDI) and DLn (AGDP), are stationary. These variables can be integrated of the same order (order 1).

2.3.2. Regression results In this paper, Eviews7.0 is used to conduct regression analysis for Equation (1). Considering the difference between all ten ASEAN countries, we adopt the method of generalized least squares (GLS) that uses cross-section weights based on cross-section residual variances. We also choose the White cross-section method to calculate the coefficient covariance to overcome the heteroscedasticity and contemporaneous correlation for cross-sections with random error term. Equation(2) is then obtained as follows:

Equation (2)

Where, D_{it} is a dummy variable, the value of which is defined as below:
1, if it is the t-th year of i-th country; where i=1, 2,. . . ,10; t=1, 2,. . . ,10.
D_{it}=
0, in other conditions

And β_{it}, γ_{it} and μ_{itare} variablesvarying with the cross-section members (see Table 3).

As the regression analysis results show, when China's OFDI increases by 1%, the IIT index for China and Singapore, Indonesia, Cambodia, the Philippines, Laos and Brunei will increased by 0.017%, 0.120%, 0.253%, 0.193%, 0.682% and 0.228%, respectively, indicating China's OFDI has a positive effect on the IIT between China and these countries; and the IIT index for China and Myanmar, Thailand, Vietnam and Malaysia will reduce by 0.037%, 0.007%, 0.201% and 0.004%, respectively, indicating a negative effect of China OFDI on China's IIT with these countries.

Table 3 Values of β_{it}, γ_{it} and μ_{it}

	β_{it}	γ_{it}	μ_{it}
Singapore	0.017	-0.156	5.764
Indonesia	0.120	-0.376	5.646
Myanmar	-0.037	0.652	-2.294
Cambodia	0.253	-0.367	3.147
Thailand	-0.007	-0.014	4.140
Laos	0.682	-1.453	10.054
Vietnam	-0.201	0.442	1.586
Malay	-0.004	0.264	1.774
Philippines	0.193	-0.199	4.315
Brunei	0.228	3.385	-34.132

2.3.3. Cointegration test Though Ln (IIT), Ln (FDI) and Ln (AGDP) variables are first-order integrated, to avoid spurious regression caused by the order of integration, cointegration test is conducted using the Engle-Granger (EG) 2-step approach. It is tested whether the residual for Equation (**??**), r_1, is stationary. If stationary residual is found, then the regression should be valid and these variables are cointegrated. The test results are shown in Table 4.

Table 4 Residual ADF test results

Variable	Differential order	Form	P value	Stationary or not
r_1	level	(C,0,0)	0.0002	<0.05, stationary

According to Table 4, r_1 is stationary and it can be determined that there is a long-term equilibrium relationship among Ln(IIT), Ln(FDI) and Ln(AGDP). The above regression analysis is valid.

3. Impact of OFDI on Horizontal and Vertical Intra-industry Trades

3.1. Model Selection

Varying variable panel data models are selected to measure the impact of China's OFDI on the horizontal intra-industry (HIIT) and vertical intra-industry (VIIT) between China and ASEAN countries:

$Ln(HIIT_{it}) = \alpha_{1i} + \beta_{1it}Ln(FDI_{it}) + \gamma_{1it}Ln(AGDP_{it}) + \mu_{1it}$ Equation (3)

$Ln(VIIT_{it}) = \alpha_{2i} + \beta_{2it}Ln(FDI_{it}) + \gamma_{2it}Ln(AGDP_{it}) + \mu_{2it}$ Equation (4)

Where, α_{it} and α_{2it} are the constant term; β_{1it} and β_{2it} are the coefficient of Ln(FDI); γ_{1it} and $\gamma_{2it}$are the coefficient of Ln(AGDP); μ_{1it} and μ_{2it} are the distur-

bance term; and i = 1,2, ..., N, and t = 1,2, ..., T. In addition, IIT denotes the China-ASEAN intra-industry trade index of each year; HIIT denotes the China-ASEAN horizontal intra-industry trade index of each year; HIIT denotes the China-ASEAN vertical intra-industry trade index of each year; FDI denotes the stock of Chinese FDI in ASEAN; and AGDP denotes the per capita GDP difference between China and ASEAN countries.

3.2. Variable Selection and Data Sources

3.2.1. HIIT index and VIIT index Greenai et al. (1994) divided IIT into HIIT and VIIT, which are calculated based on import and export unit value. The detailed calculation formulas are as follows:

HIIT: $1-\alpha \leq \frac{UV_{ij}^{X}}{UV_{ij}^{M}} \leq 1+\alpha$ Equation (3-1)

VIIT: $1+\alpha > \frac{UV_{ij}^{X}}{UV_{ij}^{M}}$?? $\frac{UV_{ij}^{X}}{UV_{ij}^{M}} < 1-\alpha$ Equation (4-1)

Where, UV_{ij}^{X} denotes the export unit value of product i in industry, which is equal to the export value of the i product divided by its export volume; UV_{ij}^{M} denotes the import unit value of product i in industry, which is equal to the import value of the i product divided by its import volume; and α is a discretization factor, usually at 0.15 or 0.25, and is set at 0.25 in this paper.

Based on import and export data of HS21 (miscellaneous edible preparations) between China and ASEAN countries for 2003 to 2012 from the UN Comtrade database and using Equations (3-1) and (4-1), the HIIT indexes and VIIT indexes (see Table 6) for China and each ASEAN country are obtained (see Table 5 and 6).

Table 5 HIIT Indexes for China and each of ASEAN Countries from 2003 to 2012

Country	2003	2004	2005	2006	2007	2008	2009	2010
Brunei	0	0.000	0.000	0	0.002	0	0.000	0
Myanmar	0.039	0.007	0	0	0	0	0.003	0.033
Cambodia	0.022	0.052	0.036	0.024	0.000	0.020	0.026	0.058
Indonesia	0.367	0.025	0.026	0.052	0.056	0.090	0.066	0.103
Laos	0	0	0	0.000	0	0	0	0.022
Malaysia	0.043	0.024	0.019	0.017	0.025	0.060	0.103	0.068
Philippines	0.256	0.300	0.243	0.010	0.201	0.001	0.000	0.018
Singapore	0.111	0.051	0.058	0.123	0.050	0.063	0.154	0.146
Thailand	0.109	0	0.057	0.018	0.020	0.071	0.101	0.115
Vietnam	0.071	0.003	0.004	0.004	0.042	0.181	0.034	0.091

Table 6 VIIT Indexes for China and each of ASEAN Countries from 2003 to 2012

Country	2003	2004	2005	2006	2007	2008	2009	2010
Brunei	0.002	0.004	0.009	0.023	0.022	0.042	0.017	0.024
Myanmar	0.038	0.092	0.102	0.109	0.126	0.156	0.131	0.122
Cambodia	0.024	0.003	0.019	0.034	0.055	0.025	0.023	0.012
Indonesia	0.201	0.555	0.598	0.533	0.402	0.276	0.346	0.274
Laos	0.031	0.056	0.152	0.104	0.198	0.171	0.152	0.118
Malaysia	0.427	0.447	0.473	0.473	0.497	0.454	0.379	0.366
Philippines	0.101	0.105	0.094	0.330	0.112	0.359	0.503	0.445
Singapore	0.588	0.692	0.712	0.557	0.573	0.515	0.460	0.520
Thailand	0.434	0.526	0.487	0.523	0.507	0.414	0.424	0.414
Vietnam	0.430	0.353	0.397	0.349	0.265	0.137	0.374	0.340

3.2.2. Chinese FDI stock in ASEAN To avoid negative or zero variable value, this paper chooses the Chinese FDI stock in ASEAN countries as an independent variable. Our data are obtained from the *Statistical Bulletin of China's Outward Foreign Direct Investment* from 2003 to 2012.

3.2.3. Per capita GDP gap between China and each of ASEAN countries In this paper, the per capita GDP gap between China and each of ASEAN countries is used as the proxy variable of the per capita income gap. Its data is based on the per capita GDP at 2000 current price (in US dollar) from the World Bank World Development Indicators (WDI) database.

3.3. Model Estimates

In order to eliminate heteroscedasticity and data volatility and enable flexible interpretation of the variable, the ADF test is conducted on Ln (HIIT), Ln (VIIT), Ln (FDI) and Ln (AGDP) (see Table 7).

Table 7 ADF test results

Variables	Form	P value	Stationary or not
Ln(HIIT)	(C,0,0)	0.2464	>0.05, non-stationary
DLn(HIIT)	(C,0,0)	0.0000	<0.05, stationary
Ln(VIIT)	(C,0,0)	0.0010	<0.05, stationary
DLn(VIIT)	(C,0,0)	0.0000	<0.05, stationary
Ln(FDI)	(C,0,0)	0.7576	>0.05, non-stationary
DLn(FDI)	(C,0,0)	0.0000	<0.05, stationary
LnAGDP	(C,0,0)	0.3922	>0.05, non-stationary
DLnAGDP	(C,0,0)	0.0178	<0.05, stationary

It can be concluded from Table 2 that Ln (HIIT), Ln (VIIT), Ln (FDI) and Ln (AGDP) are non-stationary. However, their first difference, Ln (HIIT), Ln (VIIT), DLn(FDI) and DLn(AGDP), are stationary. These variables can be integrated of the same order (order 1).

3.3.1. Regression results We adopt GLS method that uses cross-section weights based on cross-section residual variances. We also choose the White cross-section method to calculate the coefficient covariance to overcome the heteroscedasticity and contemporaneous correlation for cross-sections with random error term. The regression models for HIIT and VIIT are then obtained as follows:

$Ln(HIIT_{it}) = \sum [0.428683 + \beta_{1\mathrm{it}} Ln(FDI_{it}) + \gamma_{1\mathrm{it}} Ln(AGDP_{\mathrm{it}}) + \mu_{1it}]\, D_{\mathrm{it}}$ Equation (5)

$Ln(VIIT_{it}) = \sum [-8.377815 + \beta_{2\mathrm{it}} Ln(FDI_{it}) + \gamma_{2\mathrm{it}} Ln(AGDP_{\mathrm{it}}) + \mu_{2it}]\, D_{\mathrm{it}}$ Equation (6)

Where, D_{it} is a dummy variable, the value of which is defined as below:
1, if it is the t-th year of i-th country; where i=1, 2...10; t=1, 2...10.
D_{it}=
0, in other conditions

And β_{1it}, γ_{1it}, μ_{1it},β_{2it}, γ_{2it}, and $\mu_{2it}$are variables varying with the cross-section members (see Table 8).

Table 8 Values of β, γ and μ

	β_{1it}	β_{2it}	γ_{1it}	γ_{2it}	μ_{1it}	μ_{2it}
Singapore	0.565	-0.101	-3.117	0.535	27.928	3.034
Indonesia	0.628	-0.023	-0.877	-0.049	1.471	7.822
Myanmar	-0.842	0.040	4.434	0.403	-32.867	2.788
Cambodia	2.763	-1.588	-6.257	4.099	30.483	-17.850
Thailand	0.337	-0.007	-0.691	0.083	1.231	7.110
Laos	-0.870	0.714	4.994	-1.644	-37.548	15.049
Vietnam	-2.655	0.005	6.962	-0.149	-37.935	8.342
Malay	0.700	-0.091	-1.617	0.510	8.226	3.879
Philippines	3.254	-0.058	-7.797	0.913	39.655	0.793
Brunei	0.161	0.208	-0.413	3.440	-0.645	-30.958

As the regression analysis results show, when China's OFDI increases by 1%, the HIIT index for China and Singapore, India, Singapore, Cambodia, Thailand, Malaysia and the Philippines will increased by 0.565%, 0.628%, 2.763%, 0.337%, 0.700% and 3.254%, respectively; and the VIIT index for them will reduce by 0.101%, 0.023%, 1.588%, 0.007%, 0.091% and 0.058%, respectively. On the contrary, when China's OFDI increases by 1%, the HIIT index for China and Myanmar, Laos and Vietnam will decrease by 0.842%, 0.870% and 2.655% respectively, and the VIIT for them will increase by 0.040% 0.714% and 0.005% respectively. Moreover, when China's OFDI increases by 1%, the HIIT index for China and Brunei will increase by 0.161% and the corresponding VIIT index will change in the same way with an increase of 0.208%.

4. Conclusions and Implications

4.1. Conclusions

The economic development level varies greatly among ASEAN countries. Through our empirical analysis of the impact of Chinese OFDI into ASEAN countries on bilateral IIT, HIIT and VIIT, the following conclusions are obtained:

4.1.1 The effect of China's OFDI on bilateral intra-industry trade with ASEAN varies from country to country; specifically, China's OFDI promotes its bilateral IIT with Singapore, Indonesia, Cambodia, the Philippines, Laos and Brunei, but to some extent inhibits its bilateral IIT with Myanmar, Thailand, Vietnam and Malaysia.

4.1.1.1 China's OFDI into Singapore ranks first among ASEAN countries, and the bilateral IIT between these two countries has been boosted continuously.

4.1.1.2 Indonesia, Cambodia, the Philippines and Brunei are also the key destinations of increased Chinese OFDI; and thus there is a positive impact on the bilateral IIT between China and them.

4.1.1.3 China's OFDI into Laotian has been seen steady and accelerated growth

in recent years, which provides the biggest driving force for the bilateral IIT.

4.1.1.4 Due to the change in China's direct investment type in Myanmar, Thailand, Vietnam and Malaysia (from resource-oriented and production-oriented into market-oriented gradually), OFDI has an inhibiting effect on the bilateral IIT between China and these countries.

4.1.2 The change in the proportions of horizontally integrated investments (HIIs) and vertically integrated investments (VIIs) in the total investments can lead to corresponding shift between HIIT and VIIT. When the proportion of HIIs in total investments increase, HIIT is encouraged, crowding out VIIT based on VIIs; and the proportion increase of VIIs will bring reverse results. And IIT is determined by the sum total of HIIT and VIIT[2]. targeted industries easily.

4.2. Implications

Based on the above analysis, in terms of outward foreign direct investment, we propose that, China should both consider the different economic level of ASEAN countries and their actual national conditions, and actively develop and promote technology-intensive and competitive industrial investments. Appropriate adjustments should be made to the investment direction of China's investors. Instead of the existing general preferential policies, more targeted measures should be taken to introduce investment incentives based on specific industries[3]. In such a way, China's OFDI into ASEAN will be able to promote China's industrial structure upgrading while also positively affecting the development of bilateral HIIT and upgrading of IIT.

References

[1] Su. Hao: *China and ASEAN will be closely linked by the Maritime Silk Road.* Retrieved from Http://www.chinanews.com/(2013).

[2] Li. Ji, Zhao. Fang: *An Empirical Study on FDI and Vertical Intra-industry Trade: A Granger-Causality Test Based on the Statistical Data of China and Japan.*World Economy Research *7* (2011),81–87.

[3] Wang. Sanxing: *Analysis on Difference of Influencing Factors of Intra-industry Trade between China and ASEAN Based on Probit Model.* Journal of International Trade*2* (2012), 72–80.

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