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Licai Lyu
Corresponding author
South China Agricultural University,
Department of Economics,
Guangzhou,
China
✉ licail@scau.edu.cn

David Blandford
The Pennsylvania State University,
Department of Agricultural Economics,
Sociology and Education;
University Park,
USA
✉ dblandford@psu.edu

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The Relationship between Intra-Industry Foreign Direct Investment and Intra-Industry Trade in China

Summary: This paper explores the relationship between intra-industry investment (III) and intra-industry trade (IIT) using cointegration and the Granger causality test. The empirical results indicate that there is a long-run equilibrium cointegration relationship between III and IIT in Chinese agriculture, manufacturing, the service sector and industry as a whole, and that this relationship is negative. Unidirectional Granger causality runs from III to IIT in manufacturing, the service sector and industry as a whole, but there is no strong evidence of causality running from IIT to III in any industry in China.

Key words: Intra-industry foreign direct investment, Intra-industry trade, Cointegration, Granger causality.

JEL: F14, F21, F23.

Since World War Two, and especially in the 1950s and 1960s, the growing importance of intra-industry trade (IIT) between countries stimulated the development of international trade theory. Intra-industry investment (III) also tended to increase among developed countries with similar economic structure (John H. Dunning 1981a). Alan M. Rugman (1985) observed that III is typically characterized by two-way foreign direct investment in the same industry by multinational enterprises (MNEs). For example, in the automobile industry, III has been reflected by investment by the Japan-owned Honda Company in the United States and investment by the US-owned Ford Company in Japan. Asim Erdilek (1985) describes multinationals engaging in III as "mutual invaders".

III and IIT are important symbols of increasing interdependency in the international economy, resulting from a progression in the international division of labor from inter-industry to intra-industry. It is generally accepted that III can occur in both manufacturing and service sectors (Mark Casson 1985). In the long-run, efficient industrial development is highly dependent upon the acceptance of III (Rugman 1985). The development of the phenomenon in China, in conjunction with its rapid economic growth, reflects this.

The aim of this paper is to examine empirically the relationship between III and IIT in China. The paper is organized as follows: The next section provides a brief review of the literature on III and IIT. Section 2 describes the development of III and IIT. In Section 3, the methods of unit root, cointegration and Granger causality test are used to examine the relationship between them. Finally, some concluding remarks are presented.

1. Literature Review

There is a considerable literature on IIT and one-way FDI (e.g. Stephen Hymer 1960; Bela A. Balassa 1966; Herbert G. Grubel and Peter J. Lloyd 1975; Dunning 2001; Michael Benarroch and James Gaisford 2014; Abdul Jalil, Amina Qureshi, and Mete Feridun 2016). Another large body of literature investigates the relationship between FDI and international trade (Goran Nikolić 2011; Rudra P. Pradhan 2011; Kwangsuk Han and Jaeho Lee 2012; Mihaela Simionescu 2014). However, only limited research has addressed III. Hymer (1960) addressed the determinants and likely causes of FDI and considered III. But his work was largely ignored in the literature for some time. Nigel Driffield and James H. Love (2005) portray III as very much a developed country phenomenon, focusing on the example of the UK. Laura Alfaro and Andrew Charlton (2009), using a firm level data set on the location, ownership, and activity of 65 thousand multinational subsidiaries, find that multinationals tend to own the stages of production proximate to their final production, giving rise to a class of high-skill intra-industry vertical FDI. Edward M. Graham (1974) indicates that the entry of European firms into the United States followed the entry of US rivals into several industries in Europe. This suggests that III can increase effective rivalry and seller interdependence even in cases where it has no effect on industry concentration. Dunning and George Norman (1983) speculate that III may be the final stage in the evolution of international economic transactions and that, together with its complement, intra-firm trade, will continue to flourish and grow in significance.

Dunning (1981b) argues that III is broadly determined by the same factors as IIT and that III patterns follow those of IIT, with product-differentiation, scale-economies and converging consumer-tastes as key variables determining IIT. Grubel (1979) finds a very high correlation between III and IIT for Germany in 1976 and his results indicate there is close relationship between them. Dunning and Norman (1983) argued that III has common feature with IIT. Rugman (1985) also concludes that III has the same basis as IIT and there is a natural and close linkage between them. Both III and most IIT are being undertaken by MNEs, which are responding to exogenous market imperfections.

David Greenaway, Lloyd, and Chris Milner (2001) argue that III is more important than IIT; the levels of III penetration of markets are even higher than the levels of IIT. James R. Markusen and Keith E. Maskus (2001) show that the intra-industry affiliate sales index increases relative to the intra-industry trade index as countries become richer and more similar in size and relative endowments. Francesca Di Mauro (2001) finds a positive and significant relationship between III and IIT in three out of four manufacturing sectors in Germany. Jung-Soo Seo, Jong-Soon Kang, and Deck-Ki Kim (2002) find a positive, but statistically insignificant, overall relationship between III and IIT in Korea. However, Kiyoshi Kojima (1977) has argued that some III has resulted from efforts by firms to circumvent government-imposed trade restrictions. Rugman (1985) concludes that some developed countries, like the United States, benefit from III, since it is a replacement for international trade, with MNEs as a vehicle for efficient world-wide allocation and distribution. In summary, the literature reveals differences of view on the relationship between III and IIT.

2. Intra-Industry FDI and Intra-Industry Trade in China

2.1 Intra-Industry Trade in China

The Chinese government only began to publish data at the industry level on outward FDI in 2004. Given the data limitations, we investigate the relationship between III and IIT in agriculture, manufacturing and the service sector over the period 2004-2014.

The most widely used measure of IIT is the Grubel-Lloyd (G-L) index (Grubel and Lloyd 1975). The index is calculated as follows:

$$IIT_{ij} = 1 - \left|X_{ij} - M_{ij}\right| / (X_{ij} + M_{ij}), \quad (1)$$

where IIT_{ij} is the intra-industry trade index with country j in industry i; X_{ij} is the home country's exports of industry i to country j; and M_{ij} is the home country's imports of industry i to country j. The index varies between 0 (perfect inter-industry trade) and 1 (perfect intra-industry trade). It has a value of one when $X_i = M_i$ in industry i, and a value of zero when $X_i = 0$ or $M_i = 0$ in industry i. If $1 \geq IIT > 0.5$, industry i is more oriented toward intra-industry trade, and if $0.5 \geq IIT > 0$, industry i is more oriented toward inter-industry trade. We can see from Table 1 that the IIT indices of agriculture, manufacturing and the service sector for China are more than 0.5 over the period 2004-2014. The results indicate that all three industries are more oriented toward IIT. The calculation results of Table 1 also show that IIT has been decreasing over time.

Table 1 Intra-Industry Trade in China

Year	Agriculture	Manufacturing	Services
2004	0.904	0.747	0.672
2005	0.974	0.758	0.725
2006	0.985	0.763	0.671
2007	0.944	0.763	0.677
2008	0.816	0.685	0.714
2009	0.858	0.722	0.689
2010	0.809	0.647	0.637
2011	0.781	0.615	0.600
2012	0.719	0.591	0.598
2013	0.725	0.583	0.588
2014	0.740	0.586	0.600

Source: National Bureau of Statistics of the People's Republic of China (2016)[1].

[1] **National Bureau of Statistics of the People's Republic of China.** 2016. China Statistical Yearbook. http://www.stats.gov.cn/tjsj/ndsj/ (accessed March 09, 2016).

2.2 Intra-Industry FDI in China

As in previous papers (e.g. Antoni Aquino 1978; Norman and Dunning 1984; Greenaway, Lloyd, and Milner 2001; Driffield and Love 2005), we use the following measure of III:

$$III_{ij} = 1 - \left|OFDI_{ij} - IFDI_{ij}\right| \Big/ (OFDI_{ij} + IFDI_{ij}), \quad (2)$$

where *III* is the intra-industry FDI index (improved G-L index). *OFDI* is outward FDI, *IFDI* is inward FDI, i = industries 1, …, n and j = countries 1, …, m. The index varies between 0 and 1. It has a value of one when $OFDI_i = IFDI_i$ in industry i, and a value of zero when $OFDI_i = 0$ or $IFDI_i = 0$ in industry i. If $1 \geq III \succ 0.5$, industry i is more oriented toward intra-industry FDI. Similarly, if $0.5 \geq III \succ 0$, industry i is more oriented toward inter-industry FDI. This is similar to the Grubel-Lloyd index of IIT, and is the standard measure of intra-industry FDI (Greenaway, Lloyd, and Milner 2001). Calculations (Table 2) show that Chinese agriculture was more oriented toward inter-industry FDI over the period 2004-2010. On the whole, manufacturing was more oriented toward inter-industry FDI and the service sector was more oriented toward inter-industry FDI except in 2013, 2014 (see Table 2). The calculations also show that III has been increasing over time.

Table 2 Intra-Industry FDI in China

Year	Agriculture	Manufacturing	Services
2004	0.411	0.035	0.238
2005	0.256	0.102	0.251
2006	0.472	0.044	0.325
2007	0.454	0.099	0.314
2008	0.252	0.068	0.333
2009	0.387	0.091	0.333
2010	0.437	0.172	0.434
2011	0.568	0.238	0.427
2012	0.829	0.301	0.491
2013	0.996	0.273	0.545
2014	0.856	0.387	0.693

Source: National Bureau of Statistics of the People's Republic of China (2016).

2.3 Horizontal Difference between III and IIT in China

The difference between III and IIT can be measured by the horizontal difference between the values of these two indices from 2004 to 2014. If $III_{ij} \succ IIT_{ij}$, then industry i is more oriented toward III, and if $III_{ij} \leq IIT_{ij}$, then industry i is more oriented toward IIT. From Table 3, we can see that $III_{ij} \leq IIT_{ij}$in agriculture over the period 2004-2011; in manufacturing $III_{ij} \leq IIT_{ij}$ over the period from 2004 to 2014 and $III_{ij} \leq IIT_{ij}$ in the service sector, except in 2014. On the whole, the results show that there is greater orientation toward intra-industry trade rather than intra-industry investment in agriculture, manufacturing and the service sector in China.

Table 3 Horizontal Difference between III and IIT in China

Year	Agriculture	Manufacturing	Services
2004	-0.493	-0.712	-0.434
2005	-0.718	-0.656	-0.474
2006	-0.513	-0.719	-0.346
2007	-0.490	-0.664	-0.363
2008	-0.564	-0.617	-0.381
2009	-0.471	-0.631	-0.356
2010	-0.372	-0.475	-0.203
2011	-0.213	-0.377	-0.173
2012	0.110	-0.290	-0.107
2013	0.271	-0.310	-0.043
2014	0.116	-0.199	0.093

Source: Authors' calculations.

3. Econometric Analysis

3.1 Unit Root Test

Testing the stationarity of economic time series is of great importance since standard econometric methods assume stationarity in time series while, in fact, non-stationarity applies. Consequently the usual statistical tests are likely to be inappropriate and the inferences drawn are likely to be erroneous and misleading. For example, ordinary least squares (OLS) in the presence of non-stationarity gives rise to the risk of spurious regressions if the variables are not cointegrated. In this paper, the augmented Dickey-Fuller (ADF) test is employed to test for the stationarity of the variables. The ADF test is based on the following three models. Model (3) has no constant and no trend. Model (4) has a constant and no trend. Model (5) has a constant and trend:

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta y_{t-i} + \varepsilon_t, \tag{3}$$

$$\Delta y_t = \alpha + \gamma y_{t-1} \sum_{i=1}^{p} \varphi_i \Delta y_{t-i} + \varepsilon_t, \tag{4}$$

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{p} \varphi_i \Delta y_{t-i} + \varepsilon_t, \tag{5}$$

where y_t is a time series; Δ is the difference operator and $\Delta y_t = y_t - y_{t-1}$; ε_t is the stochastic error term; p is the number lags in the dependent variable. The optimum lag length is selected using Akaike's information criterion (AIC) and the Schwartz criterion (SC). The result of the unit root test is presented in Table 4. The ADF test strongly supports the null unit root hypothesis of non-stationarity before differencing the variables. The first difference series of III and IIT are stationary based on the unit root tests. The ADF test statistics for all the variables are less than the critical values at the 1% and 5% levels of confidence. Accordingly, the variables are expressed as first-order I(1).

Table 4 Unit Root Test

Variables	Test type	ADF *t*-statistic	Critical value
LnIII1	(C, 0, 0)	-1.004	-2.748*
LnIII2	(C, 0, 0)	0.198	-2.771*
LnIII3	(C, 0, 0)	0.394	-2.771*
LnIIT1	(C, 0, 0)	-0.586	-2.748*
LnIIT2	(C, 0, 0)	-0.427	-2.748*
LnIIT3	(C, 0, 0)	-0.781	-2.748*
ΔLnIII1	(C, 0, 0)	-4.259	-3.260**
ΔLnIII2	(C, 0, 0)	-9.046	-4.421***
ΔLnIII3	(C, 0, 0)	-4.580	-4.421***
ΔLnIIT1	(C, 0, 0)	-3.560	-3.260**
ΔLnIIT2	(C, 0, 0)	-4.275	-3.260**
ΔLnIIT3	(C, 0, 0)	-3.679	-3.260**

Notes: (*c*, *t*, *n*) indicates the inclusion of a constant (*c*), the inclusion of a time trend (*t*) and the number of lags (*n*) in the ADF regression. Δ denotes first difference of the variable. All variables are in natural logarithms. ***, **, * indicate that the null hypothesis of the unit root in the ADF tests is rejected at 1%, 5%, 10% significance level, respectively. In the variables, 1, 2, 3 denote agriculture, manufacturing and service sector, respectively.

Source: Authors' calculations using EViews 7.0 version.

Before conducting cointegration analysis of the panel data, we conduct a panel unit root test. The traditional ADF unit root is characterized by low power in rejecting the null of no stationarity of the series, especially for short time series. Recent developments in the literature suggest that panel data unit root tests provide a more powerful alternative to those based on individual time series unit root tests (Andrew Levin, Chien-Fu Lin, and Chia-Shang James Chu 2002). Of the different panel data unit root tests developed in the literature, we adopt two different ones, namely those of Levin, Lin, and Chu (2002) (herein referred to as LLC), and Kyung So Im, M. Hashem Pesaran, and Yongcheol Shin (2003) (herein referred to as IPS). In addition, we follow the procedure of Gangadharrao S. Maddala and Shaowen Wu (1999) who propose a more straightforward nonparametric unit root test and suggest using the Fisher-ADF and Fisher-PP (Phillips-Perron) statistics. Table 5 shows the panel unit root test results at the 1% significance level. The results indicate that the two series of III and IIT are an I(1) process.

Table 5 Panel Data Unit Root Test

	LLC	IPS	ADF	PP
Ln(IIT)	0.345 (0.635)	1.518 (0.936)	1.146 (0.980)	0.974 (0.986)
Ln(III)	1.487 (0.932)	2.01 (0.978)	0.851 (0.991)	1.896 (0.931)
Δ(LnIIT)	-4.135*** (0.000)	-3.420*** (0.000)	22.832*** (0.001)	34.577*** (0.000)

ΔLn(III)	-10.509*** (0.000)	-6.545*** (0.000)	37.809*** (0.000)	44.094*** (0.000)

Notes: *** indicates that the null hypothesis of the unit root in the ADF tests is rejected at the 1% significance level. Δ denotes the first difference of the variable. The *p*-values are in the parentheses.

Source: Authors' estimations using EViews 7.0 version.

3.2 Cointegration Test

Having tested the stationarity of each time series, the next step is to test for the existence of a long-run relationship between III and IIT in China. A cointegration test helps to indentify a long-run economic relationship between two or more variables. It is generally conducted by using the Robert F. Engle and Clive W. J. Granger (1987) (E-G hereafter) two-step procedure and Johansen-Juselius cointegration technique. In this paper, we apply E-G two-step procedure to determine whether III is cointegrated with IIT.

First, having tested the stationarity of each time series by unit root tests (see above), two cointegration regressions between III and IIT (both variables are expressed in logarithmic form) are estimated using OLS. That is, the following model is estimated and the OLS results are presented in Table 6:

$$y_t = \alpha + \beta x_t + \varepsilon_t \,. \tag{6}$$

Table 6 OLS Regression Results

Variables	(1)	(2)	(3)
	Ln(IIT1)	Ln(IIT2)	Ln(IIT3)
C	-0.305*** (0.049)	-0.642*** (0.049)	-0.622*** (0.042)
Ln(III1)	-0.176** (0.058)		
Ln(III2)		-0.118*** (0.022)	
Ln(III3)			-0.197*** (0.041)
R-squared	0.505	0.767	0.714
Adj. *R*-squared	0.450	0.741	0.683
F-statistic	9.171**	29.612***	22.513***

Notes: ***, ** indicates that the estimation of a parameter is significant at the 1% and 5% confidence level, respectively. Standard errors are in parentheses.

Source: Authors' estimations using EViews 7.0 version.

The second step involves directly testing the stationarity of residual processes of the two cointegration regressions from the previous step. The stationarity of the residual series is tested using the above test Equations (1), (2) and (3). The results of the ADF tests are presented in Table 7. The estimated ADF statistics for the residuals are greater than their corresponding critical values for all three industries and the null hypothesis of the unit root in the ADF tests is rejected at the 5% significance level. That is, III and IIT series are cointegrated for agriculture, manufacturing and the service sector.

Table 7 Calculations of ADF for Residuals

	Test type	ADF *t*-statistics	Critical value
Resid1	(0, 0, 0)	-2.342	-1.982**
Resid2	(0, 0, 0)	-5.110	-2.817***
Resid3	(0, 0, 0)	-2.758	-1.982**

Notes: (*c*, *t*, *n*) indicates the inclusion of a constant (*c*), the inclusion of a time trend (*t*) and the number of lags (*n*) in the ADF regression and the lag lengths are selected using Akaike's information criterion (AIC criterion). *** indicates that the null hypothesis of the unit root in the ADF tests is rejected at the 1% significance level.

Source: Authors' calculations using EViews 7.0 version.

3.3 Panel Cointegration

Once the existence of a panel unit root has been established, the issue arises as to whether there is a long-run relationship between the variables. Given that each variable is integrated of order one, we test for panel cointegration. Earlier tests of cointegration include the simple E-G two-step test, but this method can not deal with situations where more than one cointegration relationship is possible. Peter Pedroni (1999) proposes seven tests that can be used to test for panel cointegration: the panel v-statistic, panel rho-statistic, panel PP-statistic, panel ADF-statistic, group rho-statistic, group PP-statistic and group ADF statistic. The results of applying Pedroni's panel cointegration tests are presented in Table 8. Except for the group rho-statistic and the group ADF-statistic, all the statistics imply rejection of the null of no cointegration. Thus, we can infer that there exists a long-run relationship between III and IIT as a whole. The next step is to estimate this relationship. According to the Hausman test, the model should be estimated with random effects as follows:

$$y_t = c + \alpha_i^* + \beta x_i + \mu_i , \qquad (7)$$

where i represents each industry. The results from applying this equation are given in Table 9. They support cointegration between III and IIT, with the null hypothesis of no cointegration relationship being rejected at the 1% significance level. That is, there is strong evidence of a long-run relationship between III and IIT as a whole. The negative coefficient implies that there is a substitution relationship between III and IIT.

Table 8 Results of the Pedroni Test

Test statistics	Statistic
Panel v-statistic	1.595**
Panel rho-statistic	-2.686***
Panel PP-statistic	-8.243***
Panel ADF-statistic	1.385*
Group rho-statistic	-1.050
Group PP-statistic	-9.995***
Group ADF-statistic	-0.833

Notes: The lag lengths are selected using AIC criterion. ***, **, * indicates that the estimation of a parameter is significant at the 1%, 5% and 10% significance level, respectively.

Source: Authors' estimations using EViews 7.0 Version.

Table 9 Estimation Results for Panel Cointegration

	Ln(IIT)
C	-0.454***(0.023)
Ln(III)*α*	-0.095***(0.017)
$α_1$	0.207
$α_2$	-0.139
$α_3$	-0.069
R-squared	0.864
Adj. *R*-squared	0.850
F-statistic	61.630***

Notes: *** indicates that the estimation of a parameter is significant at the 1% significance level. Standard errors are in parentheses.

Source: Authors' estimations using EViews 7.0 version.

3.4 Error-Correction Model

When variables are cointegrated, a corresponding error-correction representation exists (E. M. Ekanayake 1999). Engle and Granger (1987) show that in a system of two variables, if there is a long-run equilibrium relationship, the short-term disequilibrium relationship between the two variables can be represented by an error-correction model (ECM). Such an ECM can accommodate an adjustment process that prevents economic variables from drifting too far away from their long-run equilibrium time path. The error-correction model is:

$$\Delta y_t = \alpha_0 + \lambda e_{t-1} + \sum_{i=0}^{p} \alpha_{1i} \Delta x_{t-i} + \sum_{i=1}^{p} \alpha_{2i} \Delta y_{t-i} + \mu_t , \qquad (8)$$

where e_{t-1} denotes the lagged error-correction terms and the residual cointegrating regression equations; p is the optimal lag length. The coefficient λ in Equation (8) represents the response of the dependent variable in each period to departure from equilibrium. The results from applying the error-correction model are shown in Table 10. There is a statistically significant coefficient for the error-correction term with the

Table 10 Estimation Results of Error-Correction Model

Variables	(1) ΔLn(IIT1)	(2) ΔLn(IIT2)	(3) ΔLn(IIT3)	(4) ΔLn(IIT)
C	-0.019 (0.022)	-0.011 (0.015)	0.003 (0.019)	-0.013 (0.008)
e_{t-1}	-0.290 (0.325)	-0.915** (0.331)	-0.821** (0.340)	-0.480** (0.173)
ΔLn(III1)	-0.004 (0.710)			
ΔLn(III2)		-0.050 (0.031)		
ΔLn(III3)			-0.164 (0.122)	
ΔLn(III)				-0.021 (0.022)

Notes: ** indicates that the estimation of a parameter is significant at the 5% significance level. Standard errors are in parentheses.

Source: Authors' estimations using EViews 7.0 version.

expected negative sign in Equations (2), (3) and (4). This coefficient gives a measure of the average speed at which IIT adjusts to a change in equilibrium conditions in manufacturing, the service sector and industry as a whole (the three sectors taken together).

3.5 Granger Causality Test

We now conduct a Granger causality test. This is a common method for investigating causal relationships. It is standard to say that the time series y_t causes another time series x_t in the Granger sense if past observations of y_t help to predict the current observation for x_t. Thus, it is natural to perform causality tests before constructing forecasting models, and indeed causality tests can be viewed as tests of predictive ability. More specifically, x_t is said to cause y_t, provided some β_i is not zero in the following models:

$$y_t = \delta_0 + \sum_{i=1}^{n} \alpha_i y_{t-i} + \sum_{i=1}^{k} \beta_i x_{t-i} + \varepsilon_t, \tag{9}$$

$$y_t = c_0 + \sum_{i=1}^{n} \alpha_i y_{t-i} + \mu_t, \tag{10}$$

where (9) is the restricted model and (10) is the unrestricted model. The test for causality is based on the F-statistic calculated by estimating the unrestricted and restricted forms:

$$F = \frac{(ESSR - ESSUR)/k}{ESSUR/(T-k)}, \tag{11}$$

where $ESSR$ and $ESSUR$ are residual sum squares from the restricted and unrestricted models, respectively; T is the total number of observations; and k is the number of lags. The results of applying this test in Table 11 show that there is unidirectional causality from III to IIT in the manufacturing and service sectors and for industry as a whole in China. The unidirectional causalities indicate that an increase in III causes a decrease in IIT. For agriculture, we did not find any causality relationship.

Table 11 Results of Causality Test

Null hypotheses	*F*-statistic	*p*-value
Δ(LnIIT1) does not cause Δ(LnIII1)	0.029	0.871
Δ(LnIII1) does not cause Δ(LnIIT1)	0.831	0.397
Δ(LnIIT2) does not cause Δ(LnIII2)	0.313	0.753
Δ(LnIII2) does not cause Δ(LnIIT2)	9.906	0.048**
Δ(LnIIT)3 does not cause Δ(LnIII3)	0.376	0.715
Δ(LnIII3) does not cause Δ(LnIIT3)	13.578	0.031**
Δ(LnIIT) does not cause Δ(LnIII)	0.087	0.770
Δ(LnIII) does not cause Δ(LnIIT)	3.245	0.084*

Notes: **, * indicates that the estimation of a parameter is significant at the 5% and 10% significance level, respectively.

Source: Authors' estimations using EViews 7.0 version.

4. Summary and Implications

Previous literature on the relationship between intra-industry investment and intra-industry trade has generated mixed results. In this study we have empirically investigated the relationship for China. Cointegration tests, ECM and causality test are performed using widely-applied techniques in the time series literature. To summarize, the time series properties of the data are analysed by way of unit root test before applying tests for cointegration. Once the cointegration relationships are identified, the error-correction terms are extracted and the causal relationships are examined by using the Granger causality test.

Some interesting results emerged from this analysis. We find that the relationship between III and IIT is cointegrated for agriculture, manufacturing, the service sector and industry as a whole. The data suggest that there has been a long-run and equilibrium relationship between III and IIT. The cointegrated relationship is negative, implying that III exerts a significant adverse long-run effect on IIT. This is at variance with some previous results (e.g. Francesca Di Mauro 2001). The estimation results for ECM indicate that coefficients for the error-correction terms have the correct sign (negative) and are statistically significant at the 5% level, with the exception of agriculture. This suggests that in any case of disequilibrium, the system will converge towards the equilibrium path. The speed of restoration to equilibrium path is very rapid because the absolute value of the coefficient on the error-correction term is quite large (see Table 10). Furthermore, unidirectional Granger causality runs from III to IIT in manufacturing, the service sector and industry as a whole. IIT does not cause III (in a Granger causality sense) in any industry in China.

From a theoretical perspective, there are two types of possible relationship between III and IIT: as complements or substitutes. Norman and Dunning (1984) suggest that the relationship will depend on the types of goods being traded. For substitute goods in production and consumption, III is likely to be IIT inhibiting rather than IIT creating. IIT is more likely where economies of scale are "strong" and transfer costs are "low", while III is more likely where economies of scale are "weak" and transfer costs are "high". For other types of goods, such as goods that are complementary in consumption, or goods that are substitutes in production but not in consumption, there is likely to be a complementary relationship between III and IIT. Robert A. Mundell (1957) states that in a two-country two-commodity two-factor (2x2x2) model, trade and factor flows are substitutes. That is, an increase in trade impediments stimulates factor movements and that an increase in restrictions on factor movements stimulates trade. When a particular country is both a source and recipient of FDI in a particular industrial sector in the 2x2x2 model, a substitution relationship between III and IIT will apply. In this paper, the results of cointegration and the Granger causality analysis suggest that there is a close substitution relationship between III and IIT in most industries in China. This implies that if there are restrictions on IIT, III will increase. Given the substitution relationship between III and IIT found in this study, this also implies that if IIT is constrained by tariff and non-tariff barriers, this will lead to an increase in the level of III.

We must acknowledge some limitations in our research. First, it is generally accepted that IIT and III should be analysed at the SITC 3 level of disaggregation.

Erdilek (1985) argues that III depends on the "industry" definition of the statistical classification used. In this paper aggregated data were used because of the lack of disaggregation of available FDI data for China. In-depth testing of the relationship between III and IIT will have to await more disaggregated data than those currently available. Second, our analysis has not examined aspects such as intra-industry links between China and the rest of the world, with developed *versus* developing countries or by geographical area. Our initial analysis leaves open the possibility for further in-depth research on the relationship between III and IIT for China.

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