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Causal Relation between Sino-Korea FDI and Exports*

Doowon Lee** · Hyeon-Seung Huh*** · Seonghoon Cho****

The two ways to penetrate a foreign market are exports and FDI (Foreign Direct Investment). Both channels are important for Korean firms to sell products in the Chinese market. There is increasing concern in Korea that FDI into China is substituting Korean exports to China causing the fear of the 'hollowing-out' of Korean export industries. It is also claimed that Korean FDI into China would eventually induce more exports from Korea to China. The first objective of this paper is to examine which hypothesis is true using quarterly data of Korea-China FDI and exports from 1992 to 2005. To find causal relationship between FDI and export, Granger causality tests using a modified Wald test are carried out. Empirical study based on manufacturing industry data concludes that exports have influenced FDI from Korea to China during the given period. Secondly, the authors have decomposed the manufacturing industry into labor-intensive and capital intensive industries. According to existing literature on the rivalry between export and FDI in penetrating a foreign market it is possible to set up a hypothesis that the labor-intensive industry (which does not require large initial fixed investment cost) would carry out FDI more easily in the early stage of penetration than capital-intensive industry. On the other hand, capital-intensive industry would be more reluctant to make an early commitment of a large scale FDI. Capital-intensive industry would export products first; only after they gain confidence and experience to carry out FDI later. The authors examine these hypotheses, and conclude that the empirical study support the hypotheses. The result of this paper implies that the causal relation between FDI and export has to be

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** Author for Correspondence, Tel: 02-2123-2489, Fax: 02-313-2893, E-mail: leedw104 @yonsei.ac.kr
*** School of Economics, Yonsei University, Seoul, Korea.
**** School of Economics, Yonsei University, Seoul, Korea.

examined industry by industry, and the fear of 'hollowing-out' varies across industries.

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1. INTRODUCTION

Since diplomatic normalization between Korea and China in 1992 the trade and investment relationships between the two countries have deepened profoundly. China is the largest export market to Korean firms and the largest recipient of the Korean FDI (foreign direct investment) thanks to the continuous increase of the Sino-Korea economic relationship. Korean FDI into China is concentrated in the manufacturing industry as it is shown in table 1. China is the largest Korean trading partner and Korea enjoys a trade surplus with China as shown in table 2.[1] The importance of Korean FDI and export to China has drawn much attention. The relationship between these two variables is a subject of continuous study.

As it is shown in figure 1 the Korean FDI into China has increased rapidly since the mid-1990s. Even though it had been slightly reduced from the 1997 financial crisis, it is since 2001 on the way to recovery. Encouraging in recent years is the mere size of Korean FDI into China and the relative importance of Korean FDI. While Korea has reduced overall FDI activities into the rest of the world in 2002 and 2003 the FDI into China has steadily increased in absolute term throughout the year. As of 2005 FDI into China accounted for over 1/3 of total overseas Korean FDI, and China is the fastest growing region in terms of hosting the Korean FDI. Thanks to this rapid expansion, China has become the largest recipient of Korean FDI since 2002 and has surpassed the U.S.A.

[1] The chronic trade surplus of Korea in bilateral trade with China is due to the complementary nature of the trade structures of the two countries. For a detailed analysis of trade structures between Korea and China, refer to Yoon and Yeo (2007).

Table 1 Industrial Composition of Korea's Annual FDI into China

(unit: $ mn)

Years	Agriculture, Fishery & Forestry	Manufac-turing	Cons-truction	Retail	Telecommu-nication	Hotels & Restaurants	Real Estates	Others (Finance, Logistics)	Total
1990	0.0	15.5	0.0	0.0	0.0	0.2	0.0	0.5	16.2
1991	0.5	41.2	0.0	0.1	0.0	0.5	0.2	0.0	42.5
1992	1.6	117.3	0.0	0.2	0.0	22.0	0.0	0.0	141.1
1993	3.1	251.2	1.7	1.6	0.0	1.0	2.3	2.8	263.7
1994	9.8	581.4	12.3	3.7	0.0	8.3	10.5	7.2	633.2
1995	5.3	713.8	25.9	11.6	0.0	14.8	53.8	16.0	841.2
1996	10.1	709.1	51.7	41.3	5.9	48.9	24.3	5.5	896.8
1997	1.9	492.4	43.9	15.3	39.0	85.1	40.3	6.6	724.5
1998	2.2	585.3	17.9	3.2	31.5	2.6	30.4	4.7	677.8
1999	4.5	287.6	12.5	1.4	1.5	5.3	33.2	2.0	348.0
2000	2.0	460.0	16.3	28.5	17.1	54.4	17.0	16.7	612.0
2001	2.2	532.7	0.7	13.2	0.3	2.8	21.4	1.9	575.2
2002	4.1	771.9	30.2	23.6	0.2	4.2	42.8	4.3	881.3
2003	13.1	1508.9	12.3	75.9	6.8	6.3	16.1	4.2	1643.6
2004	14.2	2078.0	35.5	88.8	0.5	20.7	7.8	1.9	2247.4
2005	24.0	2179.9	62.0	208.7	0.3	25.0	31.4	27.3	2558.6
Total	98.6	11326.2	322.9	517.1	103.1	302.1	331.5	101.6	13103.1

Source: The Export Import Bank of Korea.

While the growing trend of Korean FDI into China reflects the integration of the Korean economy with that of China, this phenomena has concerned many people in both positive and negative ways. Some have endorsed it as they believe that it would eventually improve the competitiveness of the Korean economy, while the others have warned that the FDI can cause the so-called 'hollowing-out effect'. A similar concern had been raised in Japan when Japanese firms began to invest heavily in foreign countries after the mid-1980s.[2)] Recently many Taiwanese academics and policy makers have had similar worries as more Taiwanese firms move production facilities into

[2)] Refer to Park and Yoon (in Korean, 1997) for the Japanese policy responses toward industrial hollow-out. Refer to Lee and Kang (in Korean, 2004) for the summary of industrial hollowing-out of Japan and Taiwan caused by their FDI into China.

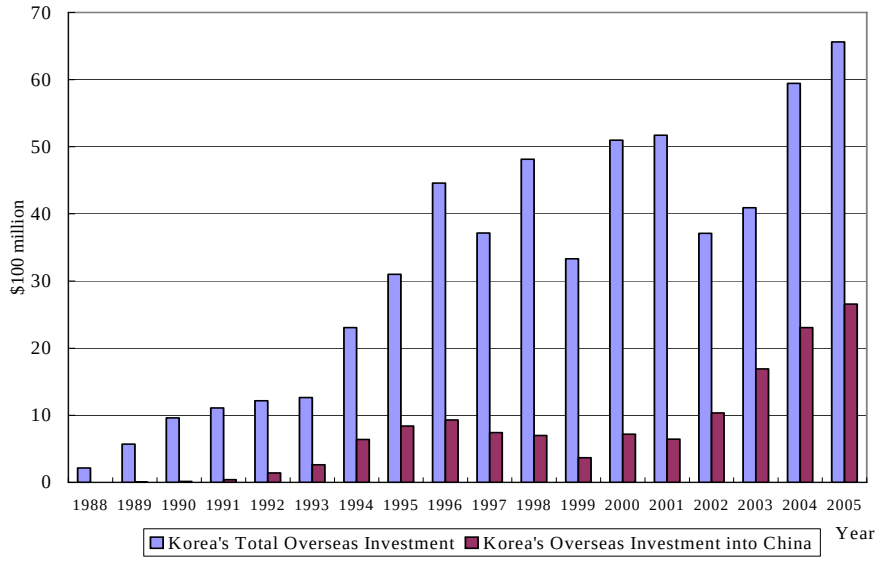
Table 2 Korea's Export, Import, and Trade Balance with China and World

(unit: $ mn)

Years	Korea's Bilateral Trade with China			Korea's Total Trade with World		
	Exports	Imports	Balance	Exports	Imports	Balance
1993	5,151	3,929	1,222	82,236	83,800	-1,564
1994	6,203	5,463	740	96,013	102,348	-6,335
1995	9,144	7,401	1,742	125,058	135,119	-10,061
1996	11,377	8,539	2,839	129,715	150,339	-20,624
1997	13,572	10,117	3,456	136,164	144,616	-8,452
1998	11,944	6,484	5,460	132,313	93,282	39,031
1999	13,685	8,867	4,818	143,685	119,752	23,933
2000	18,455	12,799	5,656	172,268	160,481	11,786
2001	18,190	13,303	4,888	150,439	141,098	9,341
2002	23,754	17,400	6,354	162,471	152,126	10,344
2003	35,109	21,909	13,200	193,817	178,826	14,990
2004	49,763	29,584	20,179	253,844	224,462	29,381
2005	61,914	38,648	23,266	284,418	261,238	23,180

Source: Korea International Trade Association.

Figure 1 Korea's FDI into the World and China (investment base)



Source: The Export Import Bank of Korea.

China.[3)]

The reason to analyze the effect of Korean FDI into China separately from those in other countries is not simply because of its relative importance out of the Korean total FDI. One of the major conclusions of Shin (1999) was that the causal relationship between FDI and trade varied across the regions and industries. Seo and Lee (in Korean, 2002) show the diversified investment motives and structures of Korean firms across different countries. Findings reflect the necessity of studying country-specific effect of FDI on bilateral trade with Korea.

The core part of the debate whether the FDI into China would have a positive effect on the Korean economy depends on the effect of the Korean bilateral trade balance with China. FDI can affect the trade balance of a home country (Korea in this study) with the host country (China in this study). FDI can affect bilateral trade between the home country and the host country through three ways: the export substitution effect, export inducement effect, and import boomerang effect. It can substitute the existing export from home country to host country as products produced in the host country can replace exports from the home country, and this effect will lower the export volume from the home country to host country. Export from home country to the rest of the world can also be replaced by products produced in the host country. This effect will reduce the exports of the home country and it is partially materialized between Korea and China according to Kim, Kim, and Lee (2004). When FDI substitutes exports the concern of 'hollowing-out' will grow. Second, it can induce more exports from the home country to host country as firms in the host country (whose production are vertically integrated with the parent company of the home country) need to import intermediate inputs from the home country. Third, firms in the host country can not only replace the exports of the home country but also export products to the home country. This last effect is

[3)] Hsu and Liu (2004) concluded that Taiwan FDI into China has little substitution effect on domestic investment, even though a microeconomic perspective by surveyed data could not refute the concern of hollowing-out.

called a import boomerang effect. These three effects affect the Sino-Korea trade balance. This paper focuses on the relationship between FDI and export as the third effect of the 'import boomerang effect' has not fully materialized between Korea and China. It is hypothesized that the FDI may increase the exports of a home country to the host country while it can eventually substitute the exports of a home country to the host country as the localization of the production progresses. This paper will examine whether FDI has induced more exports from Korea to China in order to examine whether the Korean FDI into China has passed through this initial stage. This paper will also examine the causal relationship of the literature that claims that exports can cause FDI. The main purpose of this paper is to find the causal relationship between the Korean FDI into China and the Korean exports to China.

This paper is composed of five sections with section two will reviewing existing literature on FDI and exports. Based on existing literature the authors set up a empirically tested hypotheses. Section three introduces theoretical models that will be used in the empirical studies of Section four. Section five is the concluding section that summarizes the major findings of this paper.

2. LITERATURE REVIEW AND HYPOTHESES

Existing literatures conclude that FDI has a positive effect on the economy of the host country and the effects of the FDI on the economy of the home country (or source) are mixed.[4] Existing literatures conclude that FDI can have positive effects FDI on the exports of a home country to the host country in the initial stage. The initial positive effect will slowly vanish as FDI substitutes the exports to the home country over time. Existing literatures on the effect of Korean FDI on exports conclude that FDI

[4] Heo and DeRouen (2002) has a well-reviewed summary of existing literature on the effects of FDI on host country's economic growth.

increased Korean exports. For example, Lee, Chang-Soo (2002), Shin (1999), Seo and Lee (in Korean, 2002), Kim and Kim (in Korean, 1997), Kim and Kim (in Korean, 2005), Shin and Oh (in Korean, 2005), Kang (in Korean, 2006) and Kim (in Korean, 1997) analyzed the effect of FDI on Korean trade to reach a similar conclusion. Wilamoski and Tinkler (1999) conducted similar studies on U.S. FDI into Mexico. Desai, Fritz Foley, and Hines (2005) examined the effect of U.S. FDI on the U.S. economy, and concluded that overseas FDI has increased domestic employment. These literatures lead us to set up a hypothesis that FDI can cause more exports.

There is a hypothesis that export can cause FDI over time. Two choices exist when firms penetrate a foreign market as they can export products from the home country to the foreign country or set up a factory in the foreign country and sell products locally. In the former case, it is likely that firms will carry out FDI after they gain experience and confidence in the foreign market. In the latter case, FDI initially induces more exports from the home country to the foreign country as discussed above. Capital-intensive industry (which requires substantial amount of initial fixed investment) will fall into the first case. Labor-intensive industry, which does not require large initial fixed investment will be more willing to first carry out FDI. Rob and Vettas (2003) claim that MNC (multinational companies) serve foreign demand by export and FDI. The advantage of FDI is the lower marginal cost. The disadvantage is that FDI is irreversible and the risk of creating an under-utilized capacity is high. Capital intensive industries (such as heavy industry and chemicals) will export first, and carry out FDI later. In this case exports will cause the FDI over time. A labor intensive industry such as light industry will carry out FDI first to exploit the low marginal production costs and in this case FDI leads to exports. It is now possible to set up a hypothesis where exports causes FDI in a capital intensive industry and FDI will cause exports in a labor intensive industry. The effects of two causalities are mixed in terms of the overall manufacturing industry. As the volume of Korean FDI into the capital intensive industry outweighs the volume of Korean FDI into a labor intensive industry, we can

expect that export would cause FDI in the overall manufacturing industry. Yu (in Korean, 2003) performed econometric study using VECM (vector error correction model) to find the causal relationship between FDI and global Korean exports. According to Yu (in Korean, 2003), there exists a short run causal relationship from FDI to exports, while there exists a causal relationship from exports to FDI in the long run.

A Granger non-causality test is done to examine the hypotheses set up in this paper. The next section provides theoretical models of these tests. In the following section the authors will first carry out conventional method of Granger non-causality test and will modify the Wald test introduced by Dolado and Lütkepohl (1996).

3. GRANGER NON-CAUSALITY TESTS

The Granger non-causality test is considered to x_{1t} from x_{2t} in a two-variable VAR (*p*) model

$$\prod(L)X_t = \gamma + \varepsilon_t, \tag{1}$$

where $X_t = (x_{1t}, x_{2t})$, $\Pi(L) = [I_2 - \sum_{i=1}^{p} \Pi_i L^i]$, and L is the lag operator. If the variables in the model are stationary, the null hypothesis of Granger non-causality can be tested in the usual manner by examining $\Pi_1^{12} = \Pi_2^{12} = \cdots = \Pi_p^{12} = 0$ where Π_i^{12} is the (1, 2) element of Π_i. There is a difficulty in performing this test when the variables are *I* (1) processes. Sims *et al*. (1990) and Toda and Phillips (1993) show that the usual Wald test (performed in levels) has a nonstandard limiting distribution that depends on nuisance parameters.

When there is no co-integration in the model, an obvious resolution is to convert (1) into a VAR in differences. The polynomial matrix $\Pi(L)$ in (1) can be decomposed as $\prod(L) = [\prod(1)L + \Gamma(L)(1-L)]$, where $\Pi(1) = I_2 - \sum_{i=1}^{p} \Pi_i$ and $\Gamma(L) = (1-L)^{-1}[\Pi(L) - \Pi(1)L]$. The (2x2) matrix $\Pi(1)$ conveys the

information about the long-run relationships between the variables, and it is the rank of $\Pi(1)$ that determines the number of co-integrating relations present in the system. In the case that there is no co-integration between the variables, $\Pi(1)$ is a null matrix and (1) can be written as the usual VAR model in first difference

$$\Gamma(L)\Delta X_t = \gamma + \varepsilon_t, \tag{2}$$

where $\Delta = (1-L)$, $\Gamma(L) = I_2 - \sum_{i=1}^{p-1} \Gamma_i L^i$ and $\Gamma_i = -\sum_{j=i+1}^{p} \Pi_j$. The Granger non-causality to x_{1t} from x_{2t} can be tested by constructing the usual Wald test statistic for the null hypothesis that $\Gamma_1^{12} = \Gamma_2^{12} = \cdots = \Gamma_{p-1}^{12} = 0$ where Γ_i^{12} is the (1, 2) element of Γ_i.

When non stationary variables are co-integrated, the rank of $\Pi(1)$ is nonzero and the VAR model in differences becomes miss-specified. Instead, (2) can be re-parameterized as a vector error correction model (VEC)

$$\Gamma(L)\Delta X_t = \gamma - \Pi(1) X_{t-1} + \varepsilon_t. \tag{3}$$

Because there exists only one co-integrating relation between the two variables the rank of $\Pi(1)$ is one. For a given rank, $\Pi(1)$ can be factored as $\Pi(1) = \alpha\beta'$, where α and β are (2x1) matrices of error correction coefficients and co-integrating vectors. In the VEC model there exists two channels of Granger causality to x_{1t} from x_{2t}: short-run and long-run causality. The short-run causality corresponds to the standard Granger causality and then the null hypothesis of non-causality in (3) is

$$\Gamma_1^{12} = \Gamma_2^{12} = \cdots = \Gamma_{p-1}^{12} = 0.$$

The long-run causality comes from the co-integrated relationships between the variables in that x_{1t} can be affected by x_{2t} through $\beta' X_{t-1}$. The first element of α, denoted by α_1, contains the error correction coefficient for the x_{1t} equation. If α_1 is different from zero, x_{1t} would be adjusted in

order to correct deviations from the long-run co-integrated relation. Accordingly, the test of long-run non-causality can be conducted on the basis of the null hypothesis that α_1 is zero.[5] Toda and Phillips (1993 and 1994) suggest the sequential procedure of long-run non-causality and then, the short-run non-causality. In a simulation study, Shukur and Mantalos (2000) find that this sequential test produces better power relative to other testing procedures.[6]

Other testing procedures are suggested to overcome the problem encountered in performing Granger non-causality with non-stationary variables. Here, the one proposed by Dolado and Lütkepohl (1996) is implemented as a means of checking consistency. The idea of the test is to use a deliberate over-parameterized VAR model (in levels) to ensure that the usual Wald test for Granger non-causality has standard asymptotic χ^2 distributions. A VAR(p+$d_{\max}$) is proposed to fit when the true generating process is a VAR(p) to the data and perform a Wald test on the coefficients of the first p lags only where $d_{\max}$ is the maximum order of integration of the model. For the application in hand the paper estimates

$$\Phi(L)X_t = \gamma + \varepsilon_t, \tag{4}$$

where $\Phi(L) = [I_2 - \sum_{i=1}^{p+d\max} \Phi_i L^i]$. The Granger non-causality to x_{1t} from x_{2t} amounts to testing that $\Phi_1^{12} = \Phi_2^{12} = \cdots = \Phi_p^{12} = 0$ where Φ_i^{12} is the (1, 2) element of Φ_i. Dolado and Lütkepohl show that this method leads to a Wald tests with standard asymptotic χ^2 distributions. The modified Wald test can be applicable regardless of the integration of the model or co-integration properties.

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[5] See Johansen and Juselius (1990) for a likelihood ratio test on α.

[6] Mosconi and Giannini (1992) suggest a LR procedure that can test jointly the null hypotheses of long- and short-run causality in VEC models. The virtues of simplicity and ease of application have been lost compared to other tests for Granger causality.

4. EMPIRICAL RESULTS

The analysis outlined above is applied to quarterly Korean data on export and FDI to China in the manufacturing sector for the sample period of 1992:Q1-2005:Q4. The causal relationship between the two is examined in each industry. Based on the SITC two digit classification the industries under consideration are: Electronic, Machinery, Metal, Nonmetal, Paper-Printing, Petrochemical, Shoes-Leather, Textile-Apparel, Transportation, and Wood-Furniture. These industries account for 99% and 90% of total exports and FDI to China. They are categorized into two broad groups: Labor-Intensive and Capital-Intensive. The former includes Paper-Printing, Shoes-Leather, Textile-Apparel and Wood-Furniture, while the remaining six industries belong to the latter. Data on export and FDI were obtained from the Korea International Trade Association website at http://global.kita.net and the Korea Eximbank website at http://www.koreaexim.go.kr, respectively. Both series are expressed as a ratio of the domestic GDP to control for scale effects and GDP data is downloadable from the Bank of Korea website at http://www.bok.or.kr.

The order of the integration of the series is examined using the Augmented Dickey-Fuller (ADF) test, and the results are reported in table 3. Figures in parentheses are the lag lengths chosen on the basis of the Schwarz Information Criterion. The test statistics indicate that most of exports and FDIs can be represented as $I(1)$ processes. All the export series are shown to be $I(1)$ processes. The FDIs of Electronics, Nonmetal and Shoes-Leather reject the null hypothesis of a unit root at the one percent significance level and those of Metal-Nonmetal and Paper-Printing at the five percent level. They appear to be better characterized as an $I(0)$ process.

Since at least one variable among export and FDI is an $I(1)$ process there is a need to check for the presence of co-integration prior to performing the pair-wise Granger non-causality test. The fourth column of table 3 shows the testing results, which were obtained from applying the ADF test to the residual of OLS regression between export and FDI. The null hypothesis of

Table 3 Tests for Unit Roots and Co-integration Analysis Using the ADF Procedure

Industry	Unit Root Test Statistics		Co-integration Test Statistics
	Exports	FDI	
Manufacturing	1.03 (5)	–1.84 (3)	–1.05
Capital Intensive	0.46 (4)	–1.82 (1)	–1.29
Electronic	–0.03 (2)	–3.61 (1)***	–1.32
Machinery	1.90 (3)	–2.18 (1)	0.81
Metal	0.07 (3)	–1.41 (1)	–2.43
Nonmetal	–1.46 (1)	–5.17 (1)***	–1.27
Metal-Nonmetal	0.06 (3)	–3.45 (1)**	–1.74
Petrochemical	–0.51 (1)	–2.29 (1)	–1.27
Transportation	0.63 (4)	–1.74 (1)	–1.72
Labor Intensive	–2.13 (4)	–1.39 (1)	–3.40*
Paper and Printing	–1.60 (2)	–3.41 (1)**	–2.29
Textile and Apparel	–2.34 (5)	–1.54 (3)	–3.30*
Wood and Furniture	2.58 (6)	–2.45 (3)	2.97
Shoes and Leather	–1.39 (5)	–4.13 (1)***	–1.88

Notes: Figures in parentheses are the number of lags used in estimation. *, **, and *** denote significance at the 10%, 5% and 1% levels.

a unit root cannot be rejected at the five percent significance level, pointing to no evidence of co-integration. Labor-Intensive and Textile-Apparel show some evidence of co-integration, but only at the ten percent significance level. If there is no co-integration in the model, the Granger non-causality can be performed using a VAR model in differences. The second and third columns of table 4 show the marginal significance levels (*p*-values) of the tests. In general, there is no strong evidence supporting the causal relationship between exports and FDIs. Two exceptions are in Petrochemicals and Manufacturing in which the exports and FDIs cause each other.

These causality results may be a bit misleading for two reasons. First, the FDI series in Electronic, Non-metal, Metal-Nonmetal, Paper-Printing, and Shoes-Leather are shown to be stationary (see table 3). The use of the first differences in VAR models encounters the problem of over-differencing.

Table 4 Short-run and Long-run Granger Non-causality Tests

Industry	No co-integration		Co-integration			
	Short-run		Short-run		Long-run	
	EX ≠> FDI	FDI ≠> EX	EX ≠> FDI	FDI ≠> EX	EX ≠> FDI	FDI ≠> EX
Manufacturing	0.02**	0.10*				
Capital Intensive	0.19	0.14				
Electronic	0.45	0.39	0.44	0.17	0.00***	0.26
Machinery	0.27	0.77	0.02**	0.42	0.00***	0.07*
Metal	0.54	0.06*				
Nonmetal	0.25	0.75	0.19	0.16	0.00***	0.00***
Metal-Nonmetal	0.95	0.30	0.60	0.71	0.00***	0.51
Petrochemical	0.00***	0.07**	0.00***	0.45	0.00***	0.00***
Transportation	0.83	0.93				
Labor Intensive	0.17	0.66	0.03**	0.12	0.01**	0.02**
Paper and Printing	0.18	0.92	0.20	0.89	0.00***	0.04**
Textile and Apparel	0.25	0.85	0.07*	0.31	0.05*	0.03**
Wood and Furniture	0.67	0.50	0.49	0.46	0.04**	0.18
Shoes and Leather	0.14	0.54	0.00***	0.44	0.00***	0.37

Notes: Figures reported the marginal significance levels (*p*-values) of the tests. *, **, and *** denote significance at the 10%, 5% and 1% levels.

Second, there should be one co-integration relation in these five sectors because a stationary variable becomes a co-integrating relation itself. In all cases the ADF test failed to detect any evidence of co-integration. This should be mainly associated with low power of the ADF test. Therefore the Johansen procedure is used as an alternative co-integration test. Table 4 reports that the results are quite different from those from the ADF test. There is a strong evidence for co-integration in 10 cases including the five sectors where the FDI series are stationary.

When there is co-integration in the model, two channels of Granger causality exist: short-run and long-run causality (see section 3). Empirical results show that the long-run causality runs to both directions in Machinery,

Nonmetal, Petrochemical, Paper-Printing, Textile-Apparel, and Labor-Intensive. Export causes FDI but not *vice versa* for the cases of Electronic, Metal-Nonmetal, Wood-Furniture, and Shoes-Leather. Turning to short-run non-causality tests, none of the cases reject the null hypothesis that FDI does not cause exports. In contrast, exports do cause FDI for Machinery, Petrochemical, Textile-Apparel, and Shoes-Leather.

Given that the results are mixed, we check for evidence of Granger causality using the modified Wald test by Dolado and Lütkepohl (1996), which fits the VAR in levels (see section 3). The modified Wald test can be applicable irrespective of the integration of the model or co-integration properties. As such, possible pretest biases are avoided. The results of a unit root test in table 3 indicated that the maximum order of integration of the series is one (i.e. d_{max}=1). Accordingly, the bivariate VAR models in levels

Table 5 Granger Non-causality Tests Using the Dolado and Lütkepohl Procedure

Industry	EX ≠> FDI	FDI ≠> EX
Manufacturing	3.61 (0.00)***	1.58 (0.17)
Capital Intensive	3.26 (0.01)**	1.19 (0.37)
Electronic	2.35 (0.08)*	0.77 (0.52)
Machinery	2.13 (0.06)*	0.65 (0.71)
Metal	0.62 (0.71)	1.84 (0.12)
Nonmetal	0.72 (0.54)	4.60 (0.00)***
Metal-Nonmetal	1.59 (0.20)	0.28 (0.83)
Petrochemical	4.18 (0.00)***	5.24 (0.00)***
Transportation	3.31 (0.04)**	0.78 (0.46)
Labor Intensive	0.74 (0.48)	5.38 (0.00)***
Paper and Printing	0.58 (0.62)	0.41 (0.74)
Textile and Apparel	0.99 (0.38)	2.74 (0.07)*
Wood and Furniture	0.86 (0.56)	1.08 (0.40)
Shoes and Leather	0.81 (0.44)	5.28 (0.00)***

Notes: Figures reported are *F* test statistics for the null hypothesis of Granger non-causality. Those in parentheses are the marginal significance levels (*p*-values) of the tests. *, **, and *** denote significance at the 10%, 5% and 1% levels.

are deliberately over-parameterized with one additional lag, as prescribed by Dolado and Lütkepohl. An *F* statistic is used for testing Granger non-causality with a view to improving size and power properties in small samples. The results are reported in table 5 and are clearer relative to those results from the conventional Granger non-causality tests reported above.

For Manufacturing, exports caused FDI, as the null hypothesis of non-causality from export to FDI is strongly rejected, but not *vice versa*. The analysis also suggests the causality from export to FDI in capital-intensive industries. The effect is particularly evident for Machinery and Transportation. The labor-intensive industry indicates the opposite direction that FDI causes export. In this case, the null hypothesis of non-causality from export to FDI cannot be rejected at conventional significance levels. Shoes-Leather shows strongest evidence in favor of the unilateral causality from FDI to export, followed by Textile-Apparel.

The results are in accordance with the existing literature on the rivalry between export and FDI in penetrating foreign markets. In particular, they support the theoretical hypotheses set up in section 2. The capital-intensive industry typically involves a large-scale fixed investment so that firms may be reluctant to make a commitment for FDI in an initial stage. Instead, they would export products first and carry out FDI later when firms gain confidence and experiences for the local markets. Therefore, it was hypothesized that exports would cause FDI in capital-intensive industry. In contrast, the labor-intensive industry does not require such a large initial investment. Firms may carry out FDI in the early stage of penetration than the capital-intensive industry. Cheaper wages in China should strengthen this prediction as labor costs take the largest share of total production costs in labor-intensive industries. These hypotheses provide theoretical support to the findings in the paper that export causes FDI in the capital-intensive industry, whereas in the labor-intensive industry the FDI causes export.

5. CONCLUSION

This paper examined the causal relationship between Korean FDI into China and Korean exports to China. The Granger non-causality test was performed using quarterly data of FDI and export between Korea and China from 1992 to 2005. At first the conventional method of Granger non-causality test was performed. A modified Wald test introduced by Dolado and Lütkepohl (1996) was also performed. Empirical studies based on manufacturing industry data conclude that export has affected FDI from Korea to China during the given period. Secondly, the authors have decomposed manufacturing industry into the labor-intensive and capital intensive industries. According to existing literatures on the rivalry between exports and FDI in penetrating a foreign market, it is possible to set up a hypothesis that labor-intensive industry (which does not require large initial fixed investment cost) would carry out FDI more easily in the early stage of penetration than capital-intensive industry. On the other hand the capital-intensive industry would be more reluctant to make an early commitment of a large scale FDI. A capital-intensive industry would first export products and carry out FDI only after they gain confidence. The authors examine these hypotheses, and conclude that the empirical study in fact support the hypotheses. Lastly empirical test are performed on a couple of individual industries which represent the labor-intensive industry and capital-intensive industry. This empirical test verifies that, in an industry like textile and apparel (which represents labor-intensive industry) FDI has caused exports. It implies that FDI has actually induced more exports from Korea to China in these industries, defying the fear of ‘hollowing-out’. Also, in capital-intensive industries such as machinery, and transportation exports have caused FDI over time. Even though it would be possible that FDI would substitute export in the long run in these industries, empirical data of continuously surging export show that this export substitution effect has not materialized yet. The result of this paper implies that the causal relation between FDI and export has to be examined industry by industry. Also, the

fear of 'hollowing-out' varies across industries, and this fear is largely exaggerated.

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