Are FDI in China and Parent Firm Exports Substitutes or Complements? An Empirical Study of Taiwanese Manufacturing Firms

Loretta Fung, Jin-Tan Liu and Fa-Min Wang*

In recent years, an increasing number of Taiwanese firms have invested overseas and the foreign direct investment (FDI) has gone predominately to China. With growing importance of operations in China, it is essential to understand how FDI in China affects operation of the parent firms and their mode of serving foreign markets. This paper addresses this issue by empirically investigating whether FDI in China displaces or promotes parent firms' exports. By using a unique firm-level data set that links approved investment projects and realized amount of FDI in China to financial statements and exports data of firms listed on Taiwan Stock Exchange from 1992 to 2006, a period of sharp increase in FDI in China, we are able to examine whether FDI in China substitutes or complements exports from home. We adopt three alternative empirical models: panel regressions with fixed effects, a panel Tobit model and a dynamic panel model. We find that FDI in China reduces parent firms' exports, suggesting a substitutive relationship. Interestingly enough, the effect pertains to firms in both non-electronics industries and the electronics industry – which is characterized by dense production networks and surging investment in China in recent years. The results are robust to choice of empirical models.

Keywords: foreign direct investment, exports, Taiwan, China
JEL classification: F1

*Department of Economics, National Tsing Hua University, Department of Economics, National Taiwan University and MA student, Department of Economics, National Taiwan University.

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1 Introduction

In the research on multinational activities, considerable efforts have been devoted to understanding the relation between exports and FDI in theoretical and empirical perspectives. Implications of foreign operations on parent firm exports depend on organization of foreign affiliates with parent firms. Theories on vertical integration developed by Helpman (1984) and Helpman and Krugman (1985) suggest that when firms are *vertically* integrated, investment from a capital abundant country to a labor abundant country can promote intra-firm trade. Under this circumstance, exports and FDI are likely to be *complements* as FDI causes multinationals to export intermediate inputs to the foreign affiliates. According to Ekholm et al. (2003), complementary relation between trade and FDI also pertains in the case of export platform FDI.[1] On the other hand, if subsidiaries are *horizontally* integrated with the parent firms as discussed in numerous studies such as Markusen (1995), sales of foreign affiliates displace exports from the parent firms so that exports and FDI are *substitutes*.[2]

Earlier empirical research on the relation between exports and FDI often uses aggregate data (at the industry or country level). Among them, most studies find a complementary relation between exports and FDI–for instance, studies by Lipsey and Weiss (1981) and Clausing (2000) using the US data and by Blomsöm and Kokko (1994) using Swedish firms. Using data on the US and Japan, Eaton and Tamura (1994) find that the residuals of exports and FDI are correlated. In particular, Japan's FDI is positively correlated with future exports, indicating that foreign production of Japanese firms promote home exports. Kim and Kang (1997) compare the relation between FDI and exports for Korea to the relation for Japan and find insignificant effect for both countries. In addition, using a dynamic panel model, Pfaffermayr (1996) finds a complementary relation for Austrian manufacturing industries and Egger (2001) finds an insignificant effect of FDI on exports for European Union countries. Blonigen (2001) has discussed that earlier empirical studies at the aggregate level (industry or country level) and at the micro level (firm level) tend to find a complemen-

[1] Export platform FDI is defined as the situation where the output of the foreign affiliates is primarily sold in third markets.

[2] Also, Caves (1971) discusses the relation between horizontal FDI, vertical FDI and organization of multinationals.

tary relation between exports and FDI. He also indicates that using data on Japanese exports and FDI to the United States, at the product level, there is evidence for both complementary and substitution effect of FDI on exports. Using Swedish firm-level data, Svensson (1996) finds that FDI displaces exports of final goods and complements the exports of intermediate goods and that the net effect is negative. Also, Oberhofer and Pfaffermayr (2008) find a complementary relation in general among European firms. Employing data on Japanese manufacturing firms, Head and Ries (2001) find an overall complementary relation between exports and FDI but direction of the relation varies across firms and depends on the importance of vertical integration. In a further investigation, Head and Ries (2004) suggest a difference between *statistical* complementarity and *economic* complementarity. Statistical complementarity can occur because of economic complementarity or because firms that produce multiple products may choose to export some products while producing some other products abroad. Their theory is coherent with Blonigen (2001) findings that a substitution relation is more likely to be found at the product level.[3]

As multinationals are primarily from industrial countries, to date, empirical studies of the impact of FDI on parent exports predominately focus on developed economies (such as the United States, Japan and European countries). However, with increasing importance of FDI from middle income countries (Debaere, 2004), it would be important to understand the effect of outward FDI on these countries and whether the effects on middle income countries are different as compared to developed countries. In this paper, we address this important, yet rarely explored, issue by studying the relation between FDI in China and exports of Taiwanese parent firms using data on firms listed on Taiwan Stock Exchange from 1992–2006–a period with substantial changes in macroeconomic environment and government policies on outward FDI in China that caused surging multinational activities of Taiwanese firms. Taiwan's FDI in China offers a unique lens through which to study the impact of FDI on exports for three reasons. First, it plays a crucial role from the perspective of both the parent and the host countries – China has been the predominant recipient of Taiwan's FDI and Taiwan is among the top four investors in China (Kang and Lee, 2007).[4] Secondly, firms engaged in FDI are from a wide range of industries: while early FDI is

[3]See the summary in Falk and Hake (2008, p. 10).

[4]After year 2001, China has comprised around two-thirds of Taiwan's outward FDI.

primarily from labor intensive industries such as textiles, later FDI is dominated by the electronics industry, making it possible to observe differing relation between parent firm exports and foreign activities. Thirdly, as Taiwan and China share a common official language and have similar cultural background, making operation and technology transfer easier, studying the relation of Taiwan's FDI in China and exports of parent firms over time can inform us about how technology transfer and expansion of foreign production affect organization of production. Unlike earlier works mentioned above that usually find a complementary relation, our findings suggest a *substitutive* relation, and it pertains to both electronics and non-electronics industries. These findings also differ from earlier studies of the impact of FDI on firm growth and growth in Taiwan by Chen and Ku (2000) that find a positive effect on firm survival and growth. The difference possibly results from the recent expansion of production networks of Taiwanese firms in China that displaces parent firms' exports of intermediate inputs or the reduction in exports of final goods outweighing increased exports of intermediate inputs.

This paper contributes to the literature in two respects. First, with the fact that FDI from middle income countries is becoming increasingly important and that its effects are still not well-understood, findings of this paper provide much needed empirical evidence on how FDI affects parent exports for middle income countries. Secondly, this study covers a period from the beginning to the rapid expansion of FDI in China, making it possible to examine if behaviors of multinationals in an unfamiliar environment differ from behaviors in an environment with dense production networks from Taiwan (and from other countries as well).

This paper proceeds as follows. Section 2 describes background of Taiwan's FDI in China. Section 3 describes the data and Section 4 reports the empirical results. Section 5 draws a conclusion.

2 Background

In the late 1980s, a series of significant changes in macroeconomic environment adversely affected Taiwanese firms' competitive position. The major changes include a large appreciation of the NT dollar against the US dollar and a significant increase in land and labor costs that resulted from changes in environment and labor regulations. Firms can react to adverse changes in business environment by exiting the market, adjusting production (and

exports), and investing to other countries. With relaxation of controls on foreign exchange and investment, it became possible for Taiwanese firms to establish foreign affiliates and become a multinational enterprise. Similar to the pattern found by Debaere (2004) for firms from South Korea (another middle income country), Taiwanese firms are also engaged in two-way investment to both higher and lower income countries. According to the survey results from the Investment Commission, Ministry of Economic Affairs (MOEAIC hereafter), the first and second most important destinations of investment are respectively China and the United States. Firms invested to higher-income countries are primarily from electronics industries. Firms invested to lower-income countries, on the other hand, have significant changes in industry composition and have become increasingly concentrated in China. According to Liu et al. (2007) (in Chinese), back in the early 1990s, investment to ASEAN countries played a significant role in Taiwanese firms' investment to lower income countries. However, China quickly surpassed other lower income countries and, in 2008, Taiwan's investment to China was about 10.69 billion US dollars which is more than twice as much as the investment to all other countries combined (approximately 4.5 billion US dollars). From China's perspective, Taiwan is also among the top investors.[5]

Although Taiwan is a late starter as compared to Japan and other developed countries (that have invested abroad for more than three decades), Taiwanese firms have expanded their investment abroad quickly. While Taiwan's FDI to other countries is unrestricted, the FDI to China is regulated. On July 17, 1996, owing to the unstable relationship between Taiwan and China, Taiwanese government adopted what is known as "no haste, be patient" policy to prevent companies from "over-investing" in China. Regulations based on this policy prohibited many domestic industries, primarily high technology industries, to directly invest in China, and strictly limited the amount that an individual company could invest. However, since that policy was first implemented, Taiwanese manufacturing sector experienced significant structural adjustments with production becoming increasingly capital-intensive and international competition intensified. In response to

[5]According to Liu et al. (2007) (in Chinese), the importance of Taiwan as an investor to China varies across data sources (MOEA, OECD and *China Statistical Yearbook*). In all data sources, Taiwan is among the top four investors. The other three major investors are: Japan, South Korea, and the United States.

these changes, the Taiwanese government introduced a new policy called "proactive liberalization with effective management" on November 7, 2001. The new policy relaxed restrictions both on industry types and allowable amount of FDI to China. As a result, the number of projects and amount of FDI to China soared, and reached a peak around 2002. The greatest change occurred among electronics firms.

Under both policy regimes, approval by the MOEAIC is required for investment projects in China (but not in other countries).During the period of 1991 to 2008, the amount of FDI (excluding China) approved by MOEAIC almost doubled. In the same period, approved FDI to China grew by more than 60 times.[6] Rapid growth has made FDI of greater relative importance to the Taiwanese economy than to many other countries in similar stage of development. Liu et al. (2007) find that the FDI-GDP ratio for Taiwan increased from 1.17 percent in 1996 to 2.22 percent in 2004. In 2004, the ratio was 2.15 percent for the United States and 0.71 percent for South Korea. The composition of firms engaged in FDI has also changed over time. While earlier investors primarily comprised small and medium enterprises in labor intensive industries, electronics firms play an increasingly important role in later investment, especially after the relaxation of restrictions on high-tech firms' investment to China (Liu et al., 2007).

Figure 1 reports the share of FDI in China in Taiwan's total outward FDI from 1991 to 2006 and the share of Taiwan's exports to China from 1994 to 2006. FDI in China comprised 11% of Taiwan's outward FDI in 1991, the share rapidly grew to 65% in 1995 and it has been above 80 percent in recent years.[7] At the same time, the share of exports to China has been climbing from 0.14% in 1994 to 23% in 2006. These statistics suggest that China has become increasingly important both as a destination of investment and exports. The relation between FDI and exports among firms, however, will require a detailed analysis.

[6]Source: Liu et al. (2007) (in Chinese) and Investment Commission, MOEA. Approval is not required for investment to countries other than China, therefore, the MOEA statistics may understate the investment to other countries but the data on investment to China should be more accurate.

[7]The FDI data are the approved amount from MOEAIC. Although approval from MOEAIC is required, some firms did not obtain it when investing in China. MOEAIC allowed these firms to submit applications after the fact in 1993, 1997 and 2002 (with a small fine) and this caused the spikes in FDI in China. At the same time, FDI in other countries is not regulated so the approved amount to other countries may be an underestimation.

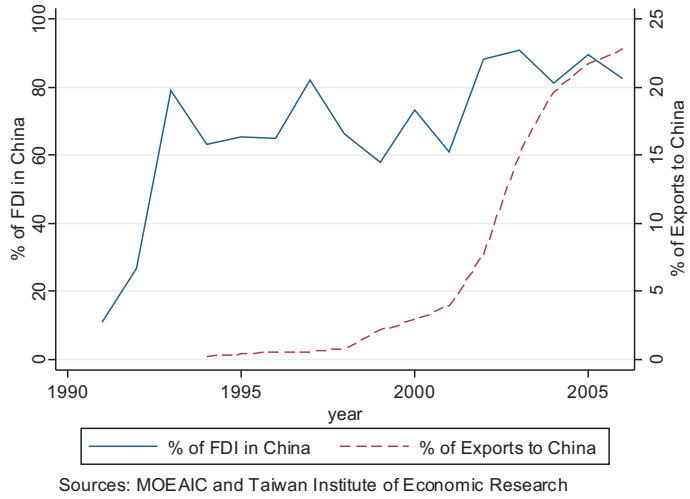

Figure 1: Percentage of Manufacturing FDI and Exports to China

As FDI in China requires approval from the MOEAIC, the records provide an excellent source of micro-level data on FDI in China.This data set has a good coverage for larger firms.[8] In this paper, we use the investment data set of firms that are listed on Taiwan Stock Exchange from 1991 to 2006.[9] The data set includes information on the date of approval, the location of project (at the province or municipality level), the amount approved, the amount realized, and the purpose of investment.[10] Figure 2 summarizes the total number of realized projects for firms listed on Taiwan Stock Exchange.[11] The number of projects reached a peak in 2002 following the policy regime change in late 2001.

[8]Chen and Ku (2000) discuss that official FDI statistics are more reliable for large firms. Since large firms are more visible and their investment projects are often too large to escape from government monitoring, they tend to comply to the regulations set forth by the Taiwanese government while small firms often fail to report their investment to avoid regulations and tax liability.

[9]This subset of firms comprises around 30 percent of the approved investment in China in recent years.

[10]The approved and realized amount of FDI is in US dollars and they are converted to NT dollars using annual exchange rates from the Central Bank of ROC. Overall, around 75% of the amount of approved FDI was realized.

[11]Here, we only count the projects that were both approved and realized. The number of

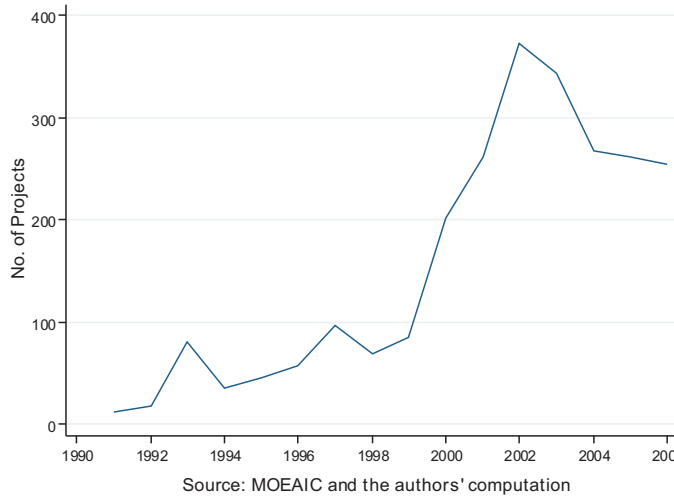

Figure 2: Number of Projects, 1991–2006

3 Data

3.1 Data Description

The data set used in this paper is created by linking three data sources: (1) data on approved investment projects in China from the MOEAIC (described in Section 2); (2) firm total imports and exports data from the customs; and (3) characteristics for firms listed on Taiwan Stock Exchange from the Taiwan Economic Journal (TEJ) database. The investment project data were aggregated from projects to the firm level by the year of approval. We have data on both the approved and realized amount of FDI in China for firms listed on Taiwan Stock Exchange. As the realized amount is a more accurate measure of the investment that actually entered China, we will use it as the primary measure of FDI in the empirical analysis. The customs data are at the firm level and record firm exports and imports from Taiwan only. In this paper, we focus on the impact of FDI on the total exports of parent firm. This is a choice based on data availability.[12] More importantly, since

approved-only projects is even larger.

[12]The firm-level customs data only consist of the total amount of imports and exports, making it impossible to identify export destinations and product types.

a substantial portion of production and export activities in China involves processing trade – processing imported intermediate inputs and the outputs are re-exported to other countries (Manova and Yu, 2011; Yu, 2011), it is reasonable to assume that FDI in China can potentially affect exports of the parent firms to *all* destinations.

To identify industry classification of the firms that invest in China and their share in total FDI, we combine the MOEAIC data with the TEJ data (which contains industry classification for the company's main operation). There are 1,010 firms in seven industries: food processing, plastics, textile & synthetic fiber, machinery, chemicals, metals & products and electronics.[13] Approximately 70% of firms in the TEJ database are in the electronics industry. Table 1 presents the share of each industry (Taiwan Economic Journal classification) in total realized FDI (in percentage).While earlier FDI was dominated by labor-intensive industries such as food processing and textile, the importance of electronics industry increased over time. In the recent years, electronics industry comprised approximately 70% of the total FDI.[14] As the electronics industry has been the most important contributor to FDI in recent years and it is also the industry affected by the regime change in 2001, we will analyze electronics and non-electronics industries separately in the empirical analysis. The combined data set covers large firms that are listed on Taiwan Stock Exchange over the period from 1992 to 2006 (excluding 2001).[15] Chen and Ku (2000) suggest that the FDI of large firms is more traceable since those firms are more likely to comply with government regulations and register their investments. And since large firms are expected to register their FDI projects in China, it is reasonable to define observations with zero in cumulative amount of FDI as the ones that did not invest in China. Similarly, observations with zero in exports are defined as non-exporters. Table 2 summarizes the percentage of firms engaged in FDI in China (FDI firms hereafter) as well as percentage of exporters and exports-sales ratios among all firms and FDI firms from 1992 to 2006.[16]

[13]Industries with few firms listed on Taiwan Stock Exchange and few investment projects (cement, non-metallic mineral, tire and rubber) are excluded from non-electronics.

[14]The percentage of electronics FDI is higher in our sample as compared to the industry level data published by MOEAIC. The electronics FDI may be over-represented because electronics firms are usually larger and more likely to be publicly traded.

[15]Export data is not available in 2001 and it was a year of severe recession. As a result, we drop the year 2001 from our analysis.

[16]Firms with positive exports are defined as exporters.

Table 1: Share of FDI by Industry (%)

	Food	Plastics	Textile & Synthetic Fiber	Machinery	Chemicals	Metal & Products	Electronics
1992	87	0	5	0	0	0	8
1993	38	1	10	6	3	3	38
1994	30	19	0	36	13	0	2
1995	25	10	0	33	6	1	24
1996	20	25	6	5	2	8	34
1997	25	18	1	9	8	0	40
1998	10	2	1	6	2	0	79
1999	1	25	0	3	1	0	69
2000	0	29	2	5	4	2	59
2002	3	19	1	5	4	2	66
2003	2	21	3	10	4	1	59
2004	2	5	4	7	1	1	81
2005	2	8	2	15	5	2	66
2006	4	0	3	11	7	1	74
Total	5	13	2	9	4	1	65

Sources: MOEAIC and authors' computation.
Notes: The share is defined as an industry's share in realized amount of FDI.

Here, a firm is classified as a FDI firm after its first recorded realized FDI in China.[17] Column 1 shows that the percentage of firms invested in China increased from 8% in 1992 to 69% in 2006. The largest jump occurred in 2002, following the policy regime change. At the same time, columns 2 and 4 show that the percentage of firms that export and their exports-sales ratio both declined over the period studied. In 1992, 76% of firms in our data were exporters and, on average, they exported one-thirds of their outputs. The percentage of exporting firms declined since then while the exports-sales ratio increased from 1992 to 2000 and then declined.When analyzing the export behavior of FDI firms, we observe from column 3 that while

[17] Our primary measure of firm FDI is the realized amount as it is the amount that actually entered China.

Table 2: Firms Invest in China, Exporters and their Exports-Sales Ratio

		Exporters		Exports-sales ratio	
	FDI Firms (1)	All Firms (2)	FDI Firms (3)	All Firms (4)	FDI Firms (5)
1992	0.08	0.76	1.00	0.34	0.27
1993	0.10	0.71	0.87	0.35	0.39
1994	0.09	0.67	0.83	0.35	0.30
1995	0.11	0.62	0.82	0.36	0.35
1996	0.13	0.59	0.83	0.38	0.33
1997	0.15	0.55	0.78	0.38	0.33
1998	0.18	0.52	0.75	0.37	0.34
1999	0.21	0.51	0.70	0.31	0.33
2000	0.31	0.50	0.63	0.37	0.36
2002	0.52	0.48	0.55	0.20	0.18
2003	0.58	0.48	0.54	0.19	0.17
2004	0.62	0.48	0.53	0.23	0.21
2005	0.66	0.47	0.52	0.19	0.17
2006	0.69	0.47	0.52	0.19	0.17
Total	0.36	0.54	0.59	0.28	0.23

Sources: MOEAIC, Customs, TEJ database, and authors' computation.
Notes: 1. FDI firms are defined as firms that have invested in China.
2. Exporters are defined as firms with positive exports from Taiwan.
3. Exports-sales ratio is the average among exporters.

earlier parent firms that invested in China were predominately exporters, the share of exporting parent firms declined over the years from the peak of 100% in 1992 to 52% in 2006. At the same time, column 5 presents that the exports-sales ratio among exporting parent firms also declined from 36% in 2000 to 17% in 2005.

3.2 Variable Definitions and Descriptive Statistics

Table 3 summarizes variable definitions and descriptive statistics. In the first row of each section, we report the summary statistics for the entire

sample. And then in the second and third rows, we report electronics and non-electronics statistics respectively. Exports are measured by total exports deflated using industry specific export price index (denoted as REX). Here, FDI in China is measured by cumulative realized amount of FDI divided by common stock (denoted as FDIC_*stock*). In the empirical analysis, we also control firm characteristics by including capital-labor ratio, labor productivity and firm size. Capital (K) is measured by fixed assets with exclusion of land and then deflated by wholesale price index of capital goods. Number of employees is used as a measure of firm size and for the construction of capital-labor ratio. Labor productivity is defined as real value added per employee where the value-added is deflated by industry specific wholesale price index. In addition, we control macroeconomic environment by including real exchange rate, which is measured by industry-specific trade weighted real exchange rate. It is the weighted average of normalized real exchange rate of Taiwan's top ten trading partners for each industry and expressed as the number of domestic currency per foreign currency unit. Please refer to Appendix A for a detailed description on variable construction and Appendix B for data sources.

To further explore the difference between FDI and non-FDI firms, we compare the means of key variables between these two groups of firms. Column 1 of Table 4 reports means of key variables, columns 2 and 3 summarize the means for FDI firms and non-FDI firms separately, and column 4 indicates if the means of these two groups are significantly different at the 5% level. Overall, FDI firms are larger, more productive, and less capital intensive.[18] With regard to export market participation, FDI firms are more likely to be exporters and have lower exports-sales ratios.

[18]Owing to data limitation, we are unable to distinguish between production and non-production workers. Lower capital intensity of FDI firm can either result from lower capital-production worker ratio or more non-production workers.

Table 3: Variable Definition and Descriptive Statistics

	Definition	Industry	No. of Observations	Mean	Standard Deviation	Minimum	Maximum	Median
lnREX	ln (real exports)	Total	11,587	8.730	9.875	0	25.44	0
		Electronics	8,634	7.459	9.613	0	25.44	0
		Non-Electronics	2,953	12.445	9.693	0	25.17	18.190
lnL	ln (number of	Total	10,191	5.599	1.214	0	10.48	5.529
	employees)	Electronics	7,426	5.509	1.218	0	10.48	5.429
		Non-Electronics	2,765	5.839	1.171	0.693	9.843	5.759
lnKL	ln (capital-labor	Total	10,178	13.53	1.335	6.090	18.30	13.57
	ratio)	Electronics	7,416	13.13	1.213	6.090	17.82	13.18
		Non-Electronics	2,762	14.60	1.019	9.500	18.30	14.53
lnFDIC_stock	ln (cumulative	Total	11,586	−1.005	1.527	−7.571	0.641	0
	realized FDI/	Electronics	8,633	−1.051	1.539	−7.571	0.641	0
	common stock)	Non-Electronics	2,953	−0.872	1.486	−7.132	0	0
lnproductivity	ln (value–added	Total	10,086	13.98	2.305	−0.653	18.35	14.30
	per employee)	Electronics	7,344	13.83	2.225	−0.653	18.35	14.12
		Non-Electronics	2,742	14.38	2.465	−0.104	18.06	14.64
lnRER	ln (real exchange	Total	11,587	4.30	0.345	3.616	4.891	4.401
	rate)	Electronics	8,634	4.20	0.342	3.616	4.689	4.261
		Non-Electronics	2,953	4.59	0.106	4.308	4.891	4.597

Sources: MOEAIC, customs, TEJ database, World Trade Flows, National Statistics (Taiwan), World Development Indicators, and the authors' computation.

Notes: 1. 0's in FDIC_*stock* and REX are replaced with 1 before taking logarithm.

2. Before taking logarithms, real exports and cumulative FDI are in NT dollars while productivity and capital-labor ratio are in thousands of NT dollars. Real exchange rate is industry-specific trade weighted real exchange rate and it is expressed as the number of domestic currency per foreign currency unit (see Appendix A for details).

4 Empirical Implementation

4.1 Empirical Specification

The first empirical model estimated follows from Head and Ries (2001).[19] Based on this model, the exports of a firm can be specified as:

$$\ln \mathrm{REX}_{it} = \beta_0 + \delta_1 \ln(\mathrm{FDIC\_}stock_{it-1}) + \gamma x_{it-1} + \eta \mathrm{RER}_{jt-1} + v_i + \varepsilon_{it}, \quad (1)$$

[19]Head and Ries (2001) empirical model is derived from a model of vertical linkage with exports of both intermediate inputs and final goods. Recognizing a common data limitation that exports of final goods and intermediate inputs often cannot be disentangled at the firm

Table 4: Means of Key Variables

	Overall (1)	FDI Firms (2)	Non-FDI Firms (3)	Significant at the 5% level (4)
Labor Productivity	2,833.28	3,109.12	2,648.20	Yes
Capital (excl. Land)	1,970,000	2,320,000	1,780,000	Yes
No. of Employees	651.10	828.83	532.67	Yes
Capital-Labor Ratio	1,811.38	1,456.02	2,048.15	Yes
Exporter Dummy	0.54	0.59	0.51	Yes
Exports-Sales Ratio	0.28	0.23	0.33	Yes

Sources: MOEAIC, Customs, TEJ database, and authors' computation.
Notes: Labor productivity, capital, and capital-labor ratio are in thousands of N.T. dollars.

Where i indexes firms, j industries and t years. REX_{it} is the real exports of firm i in year t. Since foreign affiliate activities are likely to affect parent exports in subsequent years, we use cumulative amount of FDI to China up to the year $t-1$ (FDIC_{t-1}) divided by common stock as a measure of FDI. Following Head and Ries (2001), $\text{FDIC\_}stock_{it-1}$ can be set to 1 when it equals to 0 so that we can analyze the effect of the first year of investment to China as well as the firms that do not invest in China. If the FDI effect on exports is positive, the results indicate that exports and FDI are complements. Conversely, if it is negative, the results imply that exports and FDI are substitutes. x_{it-1} is a vector of firm-level controls that include size (measured by the number of employees), capital intensity and labor productivity.[20] RER_{jt-1} is lagged real exchange rate which is used to control for changes in macroeconomic environment.[21]

4.2 Results

Equation (1) is first estimated using panel regression with fixed effects and the results are summarized in Table 5. As firms may adjust their exports

level, Head and Ries (2001) model makes prediction on total exports.

[20] Firm-level control variables are lagged to prevent endogeneity problems.

[21] Real exchange rate is lagged because it takes time for exports shipments to react to exchange rate movements.

Table 5: Regression Results – Panel Regression with Fixed Effects

	Dependent Variable: ln (Exports)		
VARIABLES	Positive Exports (1)	Exporter Only (2)	All Firms (3)
FDI in China = ln (cumulative realized FDI in China/common stock in $t-1$)	−0.063* (0.036)	−0.529*** (0.109)	−0.406*** (0.080)
Firm Size = ln (no. of employees in $t-1$)	0.973*** (0.108)	2.697*** (0.284)	1.642*** (0.188)
Capital Intensity = ln (capital/no. of employee in $t-1$)	0.074 (0.091)	0.043 (0.256)	0.099 (0.149)
Labor Productivity = ln (value added per employee in $t-1$)	0.014 (0.020)	−0.019 (0.085)	−0.022 (0.052)
Exchange Rate = ln (trade weighted ER in $t-1$)	−0.635** (0.295)	3.314*** (0.890)	1.576*** (0.525)
Firm Fixed Effects	Yes	Yes	Yes
Observations	4,789	5,397	9,352
R-squared	0.115	0.223	0.137
Number of Firms	480	480	1,010

Notes: 1. Robust standard errors (adjusted for clusters at the firm level) in parentheses.
2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
3. "Exporters" are firms that have exported at least once during the period studied.

in response to FDI on both extensive (number of exporters) and intensive margins (volume of exports), we begin with examining the effect of FDI in China on observations with positive exports – which reflects change solely on the intensive margin. Column 1 reports the results. The coefficient estimate for FDI in China is negative and significant, suggesting that FDI in China *substitutes* exports of the parent firms. Column 2 reports the re-

sults with all exporters (defined as firms that have exported at least once during the period studied). As all exporters include firms that have entered or exited the export market, this is a combination of impact on the extensive and intensive margins. The size of the FDI effect on exporters is much larger than on firms with positive exports, indicating that part of the export response is on the extensive margin (entry and exit in export market). Column 3 summarizes results after including both exporters and non-exporters. The coefficient estimate for FDI in China remains negative and significant. Turning our attention to the coefficients of control variables, larger firms export more while capital intensity and labor productivity have little impact on exports.[22] Real exchange rate has a positive effect on all firms and the exporter subsamples – meaning that substantial currency depreciation increases exports. However, the sign was negative and significant for observations with positive exports. This result differs from Fung and Liu (2009) findings using the TEJ database before 2001 that substantial currency depreciation increases exports. A further investigation into the relation between exports and exchange rate for different periods and industry groups (reported in Appendix C) shows that the counter-intuitive and negative relation between currency depreciation and exports is primarily driven by electronics firms after 2001. This puzzling result may be caused by increased reliance on production networks in China after 2001.[23]

Among the exporter subsamples and the full samples, there are some firms and years without exports. To cope with the censoring issue, we estimate equation (1) using panel Tobit model with random effects. Table 6 reports the marginal effects on censored means (E(ln REX|X)) evaluated at means. Results in column 1 suggest that the marginal effect of FDI in China for exporters remains negative and significant. The marginal effect of FDI on exports for all firms reported in column 2 is smaller as compared to the effect on exportersbut remains significant. With regard to the control variables, larger and more capital intensive firms export more and a real depreciation of the home currency increases exports.

Compared to other industries in our study, the electronics industry is distinctively characterized by vertical integration and dense production network. Since it is also the driving force of outward FDI in China after 2001,

[22]The insignificant effect of capital intensity and labor productivity may be attributable to the inclusion of firm fixed effects.

[23]Alternatively, we use current exchange rate and the results are qualitatively very similar.

Table 6: Marginal Effects

Model: Panel Tobit with Random Effects

VARIABLES	Exporter Only (1)	All Firms (2)	Non-Electronics (3)	Electronics (4)
FDI in China = ln (cumulative realized FDI in China/common stock in $t-1$)	−0.525*** (0.062)	−0.237*** (0.025)	−0.218*** (0.057)	−0.228*** (0.028)
Firm Size = ln (no. of employees in $t-1$)	2.684*** (0.121)	1.323*** (0.067)	2.406*** (0.218)	1.019*** (0.062)
Capital Intensity = ln (capital/no. of employee in $t-1$)	0.319** (0.131)	0.099* (0.057)	−0.169 (0.154)	0.186*** (0.060)
Labor Productivity = ln (value added per employee in $t-1$)	−0.027 (0.037)	−0.010 (0.015)	−0.095*** (0.030)	0.039** (0.018)
Exchange Rate = ln (trade weighted ER in $t-1$)	3.588*** (0.462)	0.964*** (0.191)	5.377*** (0.826)	0.269 (0.188)
Industry Fixed Effects	Yes	Yes	Yes	Yes
Observations	5,397	9,352	3,463	5,889
Log-Likelihood	−15,774	−16,848	−7,517	−9,227

Notes: 1. Standard errors in parentheses.
2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
3. "Exporters" are firms that have exported at least once during the period studied.

we are curious to learn if electronics firms behave differently as compared to non-electronics firms. Owing to the vertical integration between parent and affiliate production, the relation between exports and FDI varies with the location of upstream and downstream plants. If they locate in different countries, FDI and exports of intermediate inputs are complements. How-

ever, if they both move to the host country and form a supply chain, and the goods produced are exported to a third market from China, production abroad can displace parent exports. We then divide the sample into electronics and non-electronics subsamples and the results are reported in columns 3 and 4. Interestingly, the marginal effect is negative and significant for both electronics and non-electronics. This is a quite surprising finding as electronics is an industry known for vertical FDI. This surprising finding can be caused by relocation of upstream electronics production to China in the recent years (MOEA, 2007)[24] or Taiwan's exports of intermediate inputs to China (stimulated by FDI) being outweighed by displacement of final good exports. However, owing to data limitation, we are unable to distinguish between these two possible causes. The negative effect of FDI in China on exports also differs from Chen and Ku (2000) finding in earlier years that outward FDI has a positive effect on firm survival and growth.[25]

4.3 Alternative Model: Dynamic Panel Analysis

Previous studies such as Roberts and Tybout (1997) and Bernard and Jensen (1999) discuss that when there is a sunk cost of exports, firm export decision will be persistent – firms that exported in year $t-1$ are more likely to export in year t.[26] To account for the role of past export activities on current exports, we adopt a dynamic panel model. The model can be specified as:

$$\ln \mathrm{REX}_{it} = \rho \ln \mathrm{REX}_{it-1} + \beta_0 + \delta_1 \ln (\mathrm{FDIC\_}stock_{it-1}) + \gamma x_{it} + \eta \mathrm{RER}_{jt-1} + v_i + \varepsilon_{it}, \quad (2)$$

[24]According to the MOEA survey on outward foreign direct investment in 2007, one of the important motivations to invest abroad is to follow Taiwanese or foreign clients. Also, the survey indicates that the importance of intermediate inputs from Taiwan in oversea production declined over time.

[25]The difference between our findings and Chen and Ku (2000) may be attributable to difference in the period and host countries studied. Chen and Ku (2000) assess effects of FDI in both low-wage and high-wage countries from 1986 to 1991 (beginning of Taiwan's outward FDI), while we study the impact of FDI in China in particular from 1992 to 2006 (a period with massive outward FDI).

[26]Pfaffermayr (1996) and Egger (2001) also use a dynamic panel model to examine the interrelation between exports and FDI. In addition, dynamic panel models were used by Jayawickrama and Thangavelu (2010) in an analysis of the impact of FDI on growth and by Foad (2007) to examine the role of exports in FDI.

where $\ln \mathrm{REX}_{it-1}$ is lagged dependent variable. As discussed in Section 4.1, effects of FDI and exchange rate on exports are expected to be lagged. We estimate equation (2) using Arellano and Bond (1991) first-differenced GMM estimator which involves first differencing equation (2) to remove the firm fixed-effects (v_i) and the use of lagged levels as instruments for endogenous variables in the first differenced equation. Since FDI in China and real exchange rate can be weakly exogenous, they are instrumented using subsequent lags.[27] As the firm level controls (size, capital intensity and labor productivity) are likely to be contemporaneously endogenous, levels of the endogeneous variables lagged two or more years are used as instruments. We use two-step GMM estimator.[28] The results are reported in Table 7.[29] Column 1 reports the results with exporters only. Consistent with previous predictions from theoretical models and empirical evidence, current exports are positively associated with past exports. The effect of FDI in China on exports remains negative and significant – similar to the results in previous section. And our findings suggest a substitutive relation between exports and FDI. Similar pattern is found when all firms are included (reported in column 2). Furthermore, we examine non-electronics and electronics firms separately and the results are reported in columns 3 and 4 respectively. For both subsamples, the FDI effect is negative and significant. Turning our attention to the control variables, overall, larger and more productive firms export more. However, the effect of exchange rate is either insignificant or have a negative sign. This puzzling result is possibly caused by the inclusion of lagged exports in the regression. The results above suggest that the negative relation between exports and FDI in China is robust to choice of models and remain significant after controlling for the dynamic adjustment of exports and endogeneity of firm level control variables.

4.4 Discussion of Results

So far, we focus on our primary measure of FDI in China – cumulative realized FDI as a fraction of common stock. To investigate if the results are

[27] These two variables remain lagged to account for the delayed response of exports to the investment in China and exchange rate changes.

[28] Windmeijer (2005) WC-robust estimator is used to prevent downward bias in standard errors.

[29] Alternatively, we include lagged control variables x_{it-1} as in equation (1), the results are qualitatively similar.

Table 7: Dynamic Panel Model

Dependent Variable: ln (Exports)

VARIABLES	(1) Exporter Only	(2) All Firms	(3) Non-Electronics	(4) Electronics
Lagged Exports = ln (exports in $t-1$)	0.251*** (0.065)	0.293*** (0.076)	0.176** (0.078)	0.184*** (0.068)
FDI in China = ln (cumulative realized FDI in China/common stock in $t-1$)	−0.287*** (0.109)	−0.226*** (0.068)	−0.398* (0.232)	−0.217* (0.114)
Exchange Rate = ln (trade weighted ER in $t-1$)	−0.469 (0.585)	−0.547** (0.263)	2.337 (1.568)	−1.380*** (0.367)
Firm Size = ln (no. of employees in t)	1.487*** (0.284)	0.539*** (0.178)	0.423 (0.358)	0.926*** (0.222)
Capital Intensity = ln (capital/no. of employee in t)	−0.418 (0.257)	−0.078 (0.125)	−0.881** (0.350)	0.177 (0.201)
Labor Productivity = ln(value added per employee in t)	0.148 (0.094)	0.149** (0.073)	0.163 (0.139)	0.198** (0.093)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	4,009	6,928	2,556	4,372
Number of Firms	480	1,006	298	708

Notes: 1. WC-robust standard errors (adjusted for clustering at the firm level) in parentheses.

2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3. "Exporters" are firms that have exported at least once during the period studied.

4. Firm size, capital intensity and labor productivity are instrumented using additional lags.

robust to the choice of FDI measures, we have used cumulative approved amount of FDI and the results are qualitatively very similar. In addition, we have examined if the choice of denominator affects the results by replacing common stock with total assets and the results are also qualitatively similar.

In this paper, we used three estimation methods: panel regression with fixed effects, panel Tobit model with random effects, and dynamic panel model. We use panel regressions with fixed effects to establish baseline analysis. We then address the data censoring issue using a panel Tobit model with random effects and the influence of lagged exports on current exports using a dynamic panel model. In our opinion, dynamic export decision may be a more important issue to address than censoring. Therefore, we would trust the dynamic panel results more.

5 Concluding Remarks

This paper investigates empirically the relation between FDI in China and parent firmexports. With increasing number of Taiwanese firms establishing production facilities in foreign countries (predominately in China), the implications of multinational operation on parent firms has become an important issue for research. In particular, whether FDI (especially in lower wage countries) displaces or complements parent exports is an essential question both from policy perspectives and in understanding organization of multinational activities.

Using a unique data set that combines parent firm characteristics, exports and amount of investment in China from 1992 to 2006, we find that FDI in China causes a reduction in exports of parent firms, suggesting a substitutive relation between exports and FDI, and that the negative effect of FDI is stronger for electronics as compared to non-electronics firms. Stronger substitutive relation for electronics firms suggests that although electronics industries are characterized by vertical integration, either increased reliance on input production in China or the displacement of final good exports outweighing increased exports of intermediate inputs makes production in China substitute parent firm exports. The results are robust to the choice of empirical models.

Yet, there are three caveats to this research. First, owing to data limitation, we can only examine the effect on overall exports from Taiwan without differentiating the effect on different products and destination countries. It is possible that FDI in China may have differing effects on final goods and

intermediate inputs, and on exports to China as compared to other countries. Also, without exports data from affiliates, we are unable to examine the impact on affiliate exports from China. Secondly, data limitation also prevents us from identifying if the investment projects are for manufacturing or distribution purposes and we are thus unable to examine their differing effects. Finally, the financial statements are only for parent firms. This limitation precludes us from investigating the interaction of parent and affiliate characteristics. Further research in this direction is warranted.

Appendix

A. Trade Weight Real Exchange Rate

As industries face different price movements and composition of trading partners, we use industry-specific trade-weighted real exchange rate (denoted as RER_{jt}) to measure the real exchange rate changes facing each industry. The construction of this variable has been discussed in numerous studies such as Head and Ries (1999), Bernard and Jensen (2004), and Baggs et al. (2009). Here, we follow the formula used in Fung and Liu (2009) and construct the real exchange rate weighted by trade shares with Taiwan's top ten trading partners. The variable construction can be summarized in three steps. As a first step, we construct real exchange rate of each country using nominal exchange rate and price indexes and then we normalize the real exchange rates for each country ($2005 = 100$).[30] Secondly, we calculate the weights of Taiwan's top ten trading partners. Here, the weight is a country's share in the volume of trade for each industry from 1991 to 1996.[31] Finally, we weight each trading partner's normalized real exchange rate by its share and construct the trade weighted real exchange rate.

B. Data Sources

Data on Taiwan's industry specific wholesale price index, wholesale price for capital goods and consumer price index are from National Statistics (Taiwan) database. Exchange rate against the US dollar and GDP deflator that are

[30]The price index for Taiwan is industry specific wholesale price index. As foreign price index at the industry level may not be available, we use GDP deflator instead.

[31]Member countries of European Monetary Union (Germany, France and Italy) are excluded as their individual exchange rates were not available after 2001.

used for the construction of trade weighted real exchange rate are from the World Development Indicator database.[32] The volume of trade data is from the World Trade Flows database from the Center for International Data, Institute of Governmental Affairs, UC Davis and is described in Feenstra (2000).

C. Additional Results with Finer Subsamples

In Section 4.2, we find a counter-intuitive negative relation between exports and real exchange rate among observations with positive exports. To find out the source of these puzzling results, we split the sample both by industry group (non-electronics and electronics) and by year (before and after 2001). The results are reported in Table A1. Columns 1 and 3 summarize the results for non-electronics and electronics firms respectively before 2001. The real exchange rate coefficient estimates are positive and significant for both industry groups before 2001, which is consistent with the substantial exchange rate effect found in Fung and Liu (2009) study of Taiwanese firms from 1992 to 2000. However, results in columns 2 and 4 show that the exchange rate effect becomes insignificant (and negative for electronics) after 2001. Interestingly, when comparing the FDI effect across subsamples, we find that the substitutive relation between exports and FDI is primarily driven by electronics exporting firms after 2001. The results indicate a substantial change in the behavior of electronics exporters after 2001. The change is likely to be associated with China's joining WTO and expansion of electronics FDI after the regime change, and it warrants further analysis.

[32]Since the direct exchange rate of some foreign currencies against the NT dollar are not available, we use the exchange rate of foreign currencies against the US dollar and the bilateral exchange rate of the NT dollar against the US dollar to compute the cross rate.

Table A1: Regression Results by Industry Group and Year
Model: Panel Regression with Fixed Effects

	Non-Electronics		Electronics	
VARIABLES	Before 2001 (1)	After 2001 (2)	Before 2001 (3)	After 2001 (4)
FDI in China = ln(cumulative realized FDI in China/common stock in $t-1$)	−0.034 (0.027)	−0.016 (0.043)	0.056 (0.055)	−0.056* (0.032)
Firm Size = ln (no. of employees in $t-1$)	0.980*** (0.180)	0.856*** (0.231)	0.881*** (0.095)	0.841*** (0.195)
Capital Intensity = ln (capital/no. of employee in $t-1$)	0.135 (0.104)	0.0911 (0.209)	0.166** (0.082)	0.117 (0.113)
Labor Productivity = ln (value added per employee in $t-1$)	0.031** (0.013)	−0.013 (0.018)	−0.003 (0.014)	0.022 (0.014)
Exchange Rate = ln (trade weighted ER in $t-1$)	1.712*** (0.565)	0.650 (0.780)	1.658*** (0.364)	−0.233 (0.350)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	1,343	964	1,079	1,403
R-squared	0.141	0.036	0.526	0.121
Number of Firms	172	195	162	285

Notes: 1. Robust standard errors (adjusted for clustering at the firm level) in parentheses.
2. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
3. All observations here have positive exports.

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對中國大陸直接投資與母公司出口: 互補關係或替代關係? 台灣製造業廠商實證分析

馮炳萱
國立清華大學經濟學系
劉錦添
國立台灣大學經濟學系
王法閔
國立台灣大學經濟學系 (碩士生)

近年來台商大舉至國外投資, 其中以投資中國爲最大宗。台商至中國投資, 對母公司的營運以及供應國外市場方式的影響係一值得研究的議題。本文主要是針對台商至中國投資後對母公司外銷金額究竟是有替代或促進的效果進行探討。我們利用1992年至2006年間上市公司核准赴中國投資項目及實行金額、財務報表與公司外銷相互連結的資料進行實證分析, 在這段期間上市公司至中國的投資急劇增加, 我們將檢視在中國的投資對母公司在台灣的外銷是替代或互補關係。我們分別利用三種計量模型: 固定效果的追蹤資料迴歸 (panel regressions with fixed effects), panel Tobit 與動態追蹤資料模型 (dynamic panel model)。實證結果大致相同, 發現上市公司至中國的投資將減少母公司的外銷金額, 換言之, 對中國投資與外銷金額有替代的關係。值得注意的是, 不論是電子業或非電子業廠商皆有類似的結果 — 然而電子業廠商具有密集生產網絡及近年大量投資中國之特點。此外, 結果的穩健性不受實證模型選擇的影響。

關鍵詞: 外人直接投資, 出口, 台灣, 中國
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