Are Multinationals Exporting Jobs? The Case of Taiwan

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Abstract

Does offshore production always result in job-exportation? Using firm-level data for Taiwanese multinationals that allow us to avoid reverse causality issues, this research finds that while increasing offshore production has a negative impact on the demand for domestic manufacturing workers, this is not the case for domestic R&D workers, who are often more-skilled. The empirical study also suggests that for Taiwan, there is a geographical fragmentation of distinct production activities in a way that more skilled jobs are kept domestically, and less skilled jobs are exporting to other developing countries. These findings confirm the prediction of the knowledge capital model presented by Markusen *et al.* (1996) and Markusen (1997).

Keywords: Multinational; Offshore Production; Job-exportation

J.E.L. Classification numbers: F14; F16; F23

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1 Introduction

A prominent globalization phenomenon is that many firms move some or even all of their production activities abroad for different reasons. Many people in more developed countries are worried about losing jobs because cheaper foreign labor will prompt firms to relocate more production activities outside their home countries.

Taiwan, a newly industrialized country, has been among the top-ranking Asian countries in terms of both the outward foreign direct investment (FDI) flows and stocks since the 1990s, which is comparable to Singapore and just falls behind Hong Kong (UNCTAD, 2007) as shown in **Table 1-1**. In fact, a significant portion of Hong Kong's outward FDI may come from Taiwanese investment (Hsiao, 2004; UNCTAD, 2001). Developing countries are main destinations for Taiwan's outward FDI. More specifically, statistics from the Ministry of Economic Affairs (MOEA) of Taiwan show that in recent years, more than 80% of Taiwan's outward FDI went to China (MOEA, 2007a).

Many Taiwanese firms have established subsidiaries in developing countries to carry out the final assembly processes abroad, or subcontracted those activities to other firms there. For instance, recently more than 70% of Taiwan's exports to China are intermediate goods (MOEA, 2007a; MOEA, 2007b). Furthermore, anecdotal evidence suggests that firms may even move all of their production lines abroad and, at best, only keep domestic R&D activities. The fact that Taiwanese firms have engaged in more and more offshore production activities is confirmed in **Table 1-2.** For instance, in 1999, the offshore production of communication and electronic products accounted for 23.59% of total oversea sales. The corresponding number for electronic parts and components was 9.14%.[1] In 2007, these shares rose to 83.59% and 43.67%, respectively. The phenomena have raised a serious concern about whether offshore production has aggravated the domestic unemployment of less-skilled labor.

Using firm-level data for Taiwanese multinationals, this research confirms that over 80% of multinationals conduct offshore production in developing countries. Furthermore, after taking into account the issue of reverse causality, the empirical evidence also shows that multinationals with higher offshore production proportion tend to lay off domestic manufacturing workers (most of whom are less-skilled employees). Under the same scenario, the impact on the demand for domestic R&D workers (who are more skilled) is insignificant. These findings support the knowledge-capital model (Markusen *et al*., 1996; Markusen, 1997), which predicts that vertical multinationals headquartered in the home country will dominate if the home country is small and skilled-labor-abundant and trade costs are not prohibitively high, which is just the case of Taiwan (MOEA, 2008; 2010). Although the scope of this research is positive rather than normative, the empirical evidence may explain the dilemma of Taiwan in how to balance benefits from offshore production and the loss of domestic manufacturing jobs, which are often less-skilled-labor-intensive

[1] The total oversea sales come from those produced domestically, which is the exports of Taiwan, and also from those produced abroad by the foreign subsidiaries of Taiwanese firms, which are *not* the exports of Taiwan.

compared to those of R&D activities.

This research is organized as follows: Section 2 reviews relevant research regarding multinationals' motives in conducting offshore production and their potential impacts on domestic economy; Section 3 presents the data and the strategy to eliminate reverse causality issues, Section 4 introduces the estimation method and model settings; Section 5 first demonstrates how to avoid collinearity issues and then analyzes the empirical findings; and Section 6 provides conclusions and future research directions.

Table 1-1 Outward FDI Flow and Stock of Asian Countries

Unit: Millions of the US dollars	flows			stock		
Outward FDI	2004	2005	2006	1990	2000	2006
East Asia	62924	49836	74099	49032	509636	923403
China	5498	12261	16130	4455	27768	73330
Hong Kong	45716	27201	43459	11920	388380	688974
Korea, Republic of	4658	4298	7129	2301	26833	46760
Taiwan	**7145**	**6028**	**7399**	**30356**	**66655**	**113910**
Other East Asia countries	-93	48	-18	0	0	429
Japan	30951	45781	50266	201441	278442	449567
South Asia	2247	2579	9820	423	2503	14198
India	2179	2495	9676	124	1859	12964
Other South Asia countries	68	84	144	299	644	1234
South-East Asia	14212	11918	19095	9220	84045	171396
Indonesia	3408	3065	3418	86	6940	17350
Malaysia	2061	2972	6041	753	15878	27830
Singapore	8074	5034	8626	7808	56766	117580
Other South-East Asia countries	669	847	1010	573	4461	8636
West Asia	8078	13413	14053	7504	13861	42973
Kuwait	2526	5142	7892	3662	1677	4616
United Arab Emirates	2208	3750	2316	14	1938	11830
Other West Asia countries	3344	4521	3845	3828	10246	26527

Sources: Annex Table B.1 and B.2 in UNCTAD (2007).

Table 1-2 Sectoral Oversea Sales Structure of Taiwan

	unit: 1billionNT$(2006=100)	1999 Oversea Sales			2003 Oversea Sales			2007 Oversea Sales		
	Source of output : (Total = Domestic + Offshore)	Total (A)	Offshore (B)	Ranking for (B)	Total (A)	Ranking (B)	Ranking for (B)	Total (A)	Offshore (B)	Ranking for (B)
1	Food, Beverage, and Tobacco	30.66	4.44%	14	27.32	7.93%	13	18.07	1.25%	16
2	Textile Mills, Apparel & Other Textile Product	1113.31	7.24%	11	746.45	17.02%	9	371.41	20.00%	9
3	Leather Fur & Applied Product	93.28	22.19%	3	56.35	21.20%	7	33.52	19.79%	10
4	Wood & Bamboo Products	44.75	14.26%	7	27.51	27.39%	5	10.32	18.45%	11
5	Furniture & Fixtures	168.48	21.19%	4	86.27	36.44%	3	50.31	26.87%	6
6	Chemical Material & Chemical Product	308.42	1.66%	16	369.40	2.93%	16	469.50	25.65%	7
7	Rubber Products & Plastic Products	566.96	8.29%	10	523.36	9.85%	11	555.01	13.75%	13
8	Non-Metallic Mineral Products	78.92	9.01%	9	53.30	5.20%	14	43.05	5.88%	14
9	Basic Metal & Fabricated Metal Products	879.89	4.47%	13	864.42	8.19%	12	827.08	13.96%	12
10	Machinery & Equipment Mfg. & Repairing	606.74	5.95%	12	541.65	10.02%	10	462.44	23.74%	8
11	Computer Communication & Electronic Products	1921.34	23.59%	1	2015.80	44.98%	2	2213.24	83.59%	1
12	Electronic Parts & Components	1724.71	9.14%	8	1899.43	20.27%	8	2310.40	43.67%	5
13	Electrical Machinery, Equipment Mfg. & Repairing	345.08	16.30%	5	327.44	34.98%	4	523.44	52.30%	2
14	Transport Equipment Manufacturing & Repairing	379.12	2.17%	15	347.57	4.12%	15	297.55	4.55%	15
15	Precision Optical Medical Equipment Watches Clocks	197.23	22.46%	2	352.04	47.12%	1	806.08	47.32%	3
16	Other Industrial Products	1465.14	14.87%	6	1347.49	26.50%	6	1080.50	43.91%	4

Source: Taiwan Economic Statistical Databank System from Taiwan Economic Data Center (TEDC).

2 Relevant Research

Earlier empirical studies found that the outward FDI can have negative impacts on domestic output and employment (Singh, 1977; Frank and Freeman, 1978; and Glickman and Woodward, 1989). More recent studies, however, often find that the impact of outward FDI can be quite mixed and may vary across labor categories, industries, and countries (Lipsey, 1994; Mariotti *et al*., 2003; Hsieh and Woo, 2005; and Molnar *et al*., 2007).

Existing theories have provided explanations for the empirical findings by identifying horizontal and vertical motives of engaging in FDI. Under the horizontal motive, firms establish affiliates abroad that produce similar products as their domestic parent firms to avoid trade costs (Markusen, 1984; Helpman *et al*., 2004). Under the vertical motive, on the other hand, firms try to geographically fragment the production processes to take advantage of using the cheaper foreign production factors (Helpman, 1984). This classification suggests that, if the home country is relatively small and skilled-labor-abundant, conducting either horizontal or vertical outward FDI would not reduce the demand for domestic skilled labor. Whether horizontal outward FDI harms domestic less-skilled workers depends on if firms substitute offshore production for extant domestic production when trying to avoid trade costs. For vertical outward FDI, however, domestic less-skilled workers suffer as firms substitute cheaper foreign labor for domestic worker.

Many Taiwanese multinationals use developing countries such as China, Philippine, and Vietnam as export platforms to sell their products globally. Although export-platform FDIs by these multinationals are often both vertical and horizontal, earlier research often considers the two motives separately. To fill this gap, Markusen *et al*. (1996) and Markusen (1997) present the knowledge-capital model, a numerical general equilibrium model that considers the coexistence of a multinational's vertical and horizontal motives of engaging in offshore production . The key assumptions for the knowledge-capital model are: 1) the location of knowledge-based assets (such as blueprints or services from R&D activities) may be fragmented from production, and the cost of supplying the services of the assets to the foreign affiliates is low; 2) knowledge-based assets are skilled labor intensive relative to final production; and 3) knowledge-based services can be utilized simultaneously by multiple production facilities. While the first two assumptions are vertical motives that prompt a multinational to geographically fragment its production activities to take advantage of the cheaper foreign labor, the last assumption captures a multinational's horizontal motive to produce the final good in multiple countries. The knowledge capital model predicts that if the home country is small (so the domestic market is small) and skilled-labor-abundant, such as the case of Taiwan, multinationals would headquarter domestically and only produce abroad in developing countries with cheaper less-skilled labor if trade costs are not prohibitively high (in this case the home country will import the final good produced by its multinational's foreign affiliate). The model suggests that while domestic skilled labor might not suffer (since the headquarters activities are more skilled-labor-intensive), domestic less-skilled labor working on labor-intensive production would become unemployed.

Thus, the interesting questions would be whether multinationals from Taiwan tend to conduct offshore production in developing countries, and whether there exists a division of labor that reduces the demand for Taiwan's less-skilled labor rather than skilled labor, as suggested by the knowledge-capital model. Anecdotal evidence often suggests that Taiwanese domestic employees, especially those who are less-skilled, are laid off because firms shut down domestic production lines and move abroad. While relevant studies on Taiwan found some evidence which supports this argument (Sung, 2007; Hsu and Liu, 2002; Chen and Ku, 2000), perhaps due to the lack of data, most of studies used the cross-sectional data for the earlier year. One exception is Chen and Ku (2000), which extracted richer information from their panel data estimation. However, Chen and Ku classified the vertical and horizontal motives of a firm engaging in FDI by the average wage rate of the destination countries, which ruled out the possibility of the coexistence of these two motives and may oversimplify the whole story (MOEA, 2004a; Hanson *et al*., 2001).

As a result, to investigate multinationals' offshore production on domestic employment, this research takes advantage of the most recent firm-level panel data, which provides richer information including a multinational's motives of engaging in FDI. This will be explained in the following section.

3 Data

The firm-level data are from MOEA's annual survey on Taiwanese multinationals in manufacturing sectors (MOEA, 2002; 2003; 2004b). In the survey, each firm was asked to provide the information including: 1) the employment status (shortage, balance, or surplus) of domestic manufacturing and R&D sectors; 2) industry classification (metal and machinery, high-tech industry, chemical industry, and other livelihood industries); 3) total sales; 4) total assets; 5) domestic and foreign investments; 6) domestic and foreign R&D expenditures; 7) the location of its (main) foreign affiliate; 8) offshore production proportion of total oversea sales; 9) the motives to engage in offshore production;[2] and 10) the global employees (sum of domestic and foreign employees), etc.

There are, however, some deficiencies in MOEA's survey. For instance, although there is information about each firm's global employees, it cannot be disaggregated into: 1) domestic and foreign employees; and 2) skilled and less-skilled labor. This means that a quantitative dependent variable is not available. To overcome this limitation, this research uses each firm's domestic manufacturing and R&D employment statuses as the dependent variables of distinct regressions, respectively. Note that following MOEA's classification, manufacturing employees are less skilled than R&D employees. Adopting this strategy turns out to be an effective way to avoid reverse causality. For instance, if one observes a negative correlation between multinationals' offshore production levels and their domestic manufacturing employees, it could be because multinationals move their production lines abroad and lay off domestic manufacturing employees, or because domestic manufacturing employees are drawn to service sectors and multinationals have to move their production lines abroad since they have difficulties in finding enough manufacturing employees domestically. Finding an instrument variable to account for this issue while appropriately keeping information from the original firm-level data could be challenging. However, if one uses the domestic employment status of a firm's manufacturing sector as the dependent variable, for example, then an increase in offshore production level and a status of "surplus" in domestic manufacturing employees would suggest that multinationals move their production line abroad not because they cannot find enough manufacturing employees domestically. Furthermore, with this surplus status in manufacturing employees domestically, multinationals tend to lay off them later.

Although the MOEA annual survey continued until 2006, the employment status is only available for the years 2001 to 2003. Nevertheless, the 3-year firm-level panel data allow this

[2] MOEA's survey allows firms to choose multiple motives simultaneously, including the cost-saving, market expansion, and other motives (MOEA, 2002; 2003; 2004a).

research to draw much richer information than previous research does. There are 563, 552, and 544 multinationals with domestic manufacturing sectors in 2001, 2002, and 2003, respectively, and 538, 537, 526 multinationals with domestic R&D sectors in the three aforementioned years. These are observations without missing values or detectable errors in both the dependent and independent variables. **Table 3-1** shows that most multinationals in the sample have both manufacturing sectors and R&D sectors, and for each year, the total output from these multinationals in the sample constitutes about a quarter of total industrial output. Note that in MOEA's data, although around 90% of the firms responded the survey over the three years, the rest of existing firms may respond to the survey for simply one or two years. Since they are still alive, treating them as exiting the market at some time or excluding them completely would be inappropriate. Thus, this research adopts the imbalanced panel estimation to avoid any loss of efficiency from dropping firms with missing observations for some years (Baltagi, 2005; Cameron and Trivedi, 2009).

Table 3-1 MOEA Sample Structure and Output

Year Sample structure	2001	2002	2003
Number of multinationals with domestic manufacturing sector	563	552	544
Number of multinationals with domestic R&D sector	538	537	526
Number of multinationals with both domestic manufacturing and R&D sector	501	493	483
Year Output (NT$ in 2001 price)	2001	2002	2003
Output from multinationals in the sample with domestic manufacturing sector	2200.99	1950.87	2238.80
Output from multinationals in the sample with domestic R&D sector	2223.30	1974.64	2162.38
Output from manufacturing industry as a whole	8404.60	9079.42	9657.51

4 Model

Since in MOEA's data, the employment status is classified into shortage, balance, or surplus, let us denote firm i's shortage in manufacturing (or R&D) employees in year t by y_{it}^* (y_{it}^* is unobservable). When there is a shortage in labor ($y_{it}^* > 0$), the firm has an incentive to hire more employees. Otherwise, it may lay off some employees (or at least not to hire more employees). Thus, one can apply the following binary choice model:

$$y_{it} = \begin{cases} 1 & \text{(shortage)} & \text{if and only if} \quad y_{it}^* = \alpha_i + x_{it}'\beta + u_{it} > 0 \\ 0 & \text{(balance or surplus)} & \text{if and only if} \quad y_{it}^* = \alpha_i + x_{it}'\beta + u_{it} \leq 0 \end{cases} \quad (1)$$

The limitation of (1) is that it cannot distinguish the employment status "surplus" from "balance". To overcome this, one can set up the following three-alternative ordered model:

$$y_{it} = \begin{cases} 1 & \text{(shortage) if and only if } \gamma_0 < y_{it}^* = \alpha_i + x_{it}'\beta + u_{it} \le \gamma_1 \\ 0 & \text{(balance) if and only if } \gamma_{-1} < y_{it}^* = \alpha_i + x_{it}'\beta + u_{it} \le \gamma_0 \\ -1 & \text{(surplus) if and only if } \gamma_{-2} < y_{it}^* = \alpha_i + x_{it}'\beta + u_{it} \le \gamma_{-1} \end{cases} \quad (2)$$

In (2), we have $\gamma_{-2} = -\infty$ and $\gamma_1 = \infty$, and $\gamma_{-1} < \gamma_0$, which means that there will be a range for y_{it}^* which corresponds to the status "balance", which could be the drawback of applying the ordered model since the balance (equilibrium) status of a firm's employment level may correspond to a fixed quantity. Since the binary choice model and the three-alternative ordered model have their own advantage and limitation, in this research, the results from both of them will be reported.

In both models, x_{it} is the $K \times 1$ vector of independent variables, while α_i represents the unobserved individual specific effect. According to the knowledge-capital model, both the offshore production proportion of total oversea sales (representing the division of labor) and the location of foreign affiliate should be included as independent variables. (To utilize the cheaper foreign labor, multinationals may assemble their products in developing countries.) These variables are both presented in MOEA's survey. Other independent variables include: 1) total sales or total assets; 2) domestic and foreign investments; 3) domestic and foreign R&D expenses; 4) dummy variables for years; 5) dummy variables for industries; and 6) motives of engaging in offshore production.

For a discrete choice model with panel data, pooled estimation fails to account for the individual specific effect. In a nonlinear model, this can lead to inconsistent estimates of β (Cameron and Trivedi, 2005). To solve this issue, the fixed effect and random effect models are proposed. However, not every fixed effect model can have a consistent estimator due to the incidental parameters problem (Neyman and Scott, 1948). For instance, there is no consistent estimator for a fixed effect probit model (Hsiao, 1986; Wooldridge, 2002).

Similarly, most fixed effect logit models are inconsistent. One exception is within the class of binary choice logit models. Anderson (1973) and Chamberlain (1980) suggested the conditional likelihood approach and applied it on the binary choice logit model. They showed that their estimator is consistent. However, since this approach excludes those observations with $y_{it} = 1$ or $y_{it} = 0$ for every single period t, it is less efficient (Allison, 2008).

Alternatively, in a random effect model, α_i is treated as a random disturbance term under the specified distribution. Since the logit model inherits more restriction from the multivariate logistic distribution, the probit model is more popular when considering the random effect model (Maddala, 1987). The random effect probit model assumes $\alpha_i \sim IN(0, \sigma_\alpha^2)$, $u_{it} \sim IN(0, \sigma_u^2)$, and both of them are mutually independent as well as independent of x_{it} (Heckman and Willis, 1976). By conditioning on the individual specific random disturbance term α_i, the joint density function can be decomposed, which simplifies the joint probability and makes the log-likelihood function only involve a single integration over α_i. Thus, the corresponding estimator becomes computationally feasible. Interested readers may refer the details in Butler and Moffitt (1982).

In short, this research adopts the random effect probit estimation to estimate both models (1) and (2) since 1) for the binary choice model, when applying the fixed effect estimation in MOEA's data, the conditional likelihood approach will discard about two-thirds of the observations, which is a great loss of efficiency; 2) for the three-alternative ordered model, the random effect probit estimation is the most appropriate strategy as explained above; and 3) for both models, this research has included dummy variables for different industries and also for different years to control for industry-specific and year-specific fixed effects, respectively. The derivations for the log-likelihood functions of the binary choice and three-alternative random effect probit models used in this research are presented in Appendix A-01 and A-02, respectively.

5 Empirical Results

This section begins with the investigation regarding whether Taiwanese multinationals tend to conduct offshore production in developing countries, and then explores the impacts of multinationals' offshore production on the demand for domestic manufacturing and R&D employees. The definitions and summary statistics of variables are presented in **Table 5-1** and **Table 5-2**, respectively.

Let us begin with a test that examines the location of multinationals' offshore production. **Table 5-3** provides strong evidence (with significance level less than 1%) which shows that over 80% of multinationals conduct offshore production in developing countries during 2001 and 2003, and this number rises to 85% in 2003. As a result, in the regression analyses, to avoid collinearity between the offshore production proportion and its interaction with the location dummy, two independent variables considered, the author chooses the location dummy indicating if a foreign affiliate is in developed countries.[3] Let us turn to the impact of offshore production on the demand for domestic labor. **Table 5-4** shows that: 1) firms are more likely to report shortages in R&D employees than shortages in manufacturing employees; and 2) there is stronger evidence for the negative association between a firm's domestic manufacturing labor demand and its offshore production than the case for domestic R&D labor. The impact of offshore production on the demand for domestic manufacturing labor is presented in **Table 5-5**. Models M-1 and M-2 are random effect probit estimations with binary choice settings, while M-3 and M-4 are random effect probit estimations with three-alternative ordered settings. Year dummies have been included through M-1 to M-4 to control for the year fixed effect. The main findings are, first, the cost saving motive for offshore production is a significant factor in reducing the multinational's probability in

[3] Developed countries include the United States, Canada, European Union and other Western European countries, Japan, Australia, and New Zealand.

reporting a shortage in domestic manufacturing employees. This suggests that Taiwanese multinationals may substitute cheaper foreign production factors such as labor for domestic manufacturing employees. Second, increasing offshore production proportion of total oversea sales would decrease the multinational's probability in reporting a shortage in domestic manufacturing employees. This suggests that increasing the offshore production would reduce the demand for domestic manufacturing employees, which are often less-skilled than domestic R&D employees. The finding justifies the worry about job-exportation in less-skilled manufacturing jobs. One may expect those multinationals engaging in offshore production in developed countries would be less likely to replace the cheaper domestic manufacturing labor by its foreign counterpart. Although the coefficient for location dummy may suggest that, the estimates are all insignificant, however. Coefficients for the interaction term (location dummy and offshore production ratio) are insignificant as well with even higher p-values.

The results for domestic R&D employees are presented in **Table 5-6**, models R-1 and R-2 are random effect probit estimations with binary choice settings, while R-3 and R-4 apply the random effect probit estimations with three-alternative ordered settings. Similarly, year dummies are included through R-1 to R-4 to control for the year fixed effect. Table 5-6 reveals that, first, multinationals in high-tech sectors (computer, electronic parts and components, and electrical machinery) are most likely to report shortages in R&D employees. This shows that although compared to other sectors, multinationals in these sectors have, on average, even higher offshore production ratios, as shown in Table 1-2, they still look for more skilled labor domestically. This could suggest that multinationals in high-tech sectors are more likely to carry out different production stages in different countries. Second, there is no statistically significant evidence showing that increasing the offshore production proportion would reduce the demand for domestic R&D employees. These results are quite consistent from the estimates of R-1 through R-4 and could suggest a geographical fragmentation of manufacturing and R&D activities by Taiwanese multinationals. Finally, the coefficient for the interaction term (location dummy and offshore production ratio) is negative and has a larger absolute value than that for the location dummy, which may suggest that multinationals would substitute foreign R&D employees for domestic ones as their foreign business grow. However, these estimates are insignificant.

In short, this research finds that multinationals tend to fragment production activities such that skilled labor intensive jobs, like R&D activities, are kept in Taiwan, while less skilled labor intensive jobs are moved abroad especially to developing countries. These findings conform to the prediction of the knowledge-capital model.

Table 5-1 Variables Definition

d_man	:	Binary: = 1 if the firm has a shortage in domestic manufacturing employees; = 0 otherwise. 3-ordered: = -1 if the firm has a surplus in domestic manufacturing employees; = 0 if the firm's domestic manufacturing employment status is balance; = 1 if the firm has a shortage in domestic manufacturing employees.
d_rea	:	Binary: = 1 if the firm has a shortage in domestic R&D employees; = 0 otherwise. 3-ordered: = -1 if the firm has a surplus in domestic R&D employees; = 0 if the firm's domestic R&D employment status is balance; = 1 if the firm has a shortage in domestic R&D employees.
ssal	:	Total sales
stas	:	Total assets
indmet	:	= 1 if the firm belongs to metal and machinery sectors (metal, machinery, or transportation equipment) = 0 otherwise
indhit	:	= 1 if the firm belongs to high-tech sectors (computer, electronic parts and components, and electrical machinery) = 0 otherwise
indliv	:	= 1 if the firm belongs to livelihood sectors (food, tobacco, textile, apparel, wood and bamboo product, furniture and fixture, non-metallic mineral products manufacturing) = 0 otherwise
mexp	:	= 1 if the firm has the market expansion motive to engage in foreign production = 0 otherwise
mcos	:	= 1 if the firm has the cost-saving motive to engage in foreign production = 0 otherwise
ifdi	:	Amount of foreign investment
idom	:	Amount of domestic investment
rfor	:	R&D expenditures by the foreign affiliate
rdom	:	R&D expenditures in the home country
opp	:	Offshore production proportion of total oversea sales
oadv	:	= 1 if offshore production is in developed countries (The United States, Canada, European Union and other Western European countries, Japan, Australia, and New Zealand) = 0 otherwise
γ_{-1}	:	Lower bound of the interval for y_{it} which corresponds to the "balance" status
γ_0	:	Upper bound of the interval for y_{it} which corresponds to the "balance" status

Table 5-2 Summary Statistics for Firms with Domestic Manufacturing Sectors

		2001		2002		2003	
Firms with Manufacturing Employees							
$\underline{s}$: shortage; b: balance; $\bar{s}$: surplus.		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
d_man	($\underline{s}=1$; b or $\bar{s}=0$)	0.105	0.307	0.085	0.279	0.156	0.363
	($\underline{s}=1$; $b=0$; $\bar{s}=-1$)	-0.005	0.464	0.005	0.406	0.094	0.459
stas	(billion NT$)	5.230	28.854	4.655	18.175	4.980	19.864
ssal	(billion NT$)	3.909	27.532	3.534	14.878	4.115	19.943
indmet	(yes = 1; no = 0)	0.263	0.441	0.266	0.442	0.267	0.443
indhit	(yes = 1; no = 0)	0.364	0.482	0.362	0.481	0.366	0.482
indliv	(yes = 1; no = 0)	0.181	0.386	0.181	0.385	0.178	0.383
oadv	(yes = 1; no = 0)	0.147	0.355	0.132	0.339	0.112	0.316
opp	(proportion)	0.373	0.401	0.362	0.398	0.360	0.397
mexp	(yes = 1; no = 0)	0.686	0.465	0.665	0.472	0.688	0.464
mcos	(yes = 1; no = 0)	0.639	0.481	0.612	0.488	0.097	0.297
ifdi	(billion NT$)	0.167	1.140	0.176	1.160	0.120	0.860
idom	(billion NT$)	0.959	7.180	0.749	4.097	0.220	1.751
rfor	(billion NT$)	0.006	0.034	0.007	0.040	0.010	0.088
rdom	(billion NT$)	0.068	0.454	0.074	0.449	0.074	0.313
Global employees (1000 people)		0.897	2.354	0.605	1.295	0.836	2.117
Firms with R&D Employees							
d_rea	($\underline{s}=1$; b or $\bar{s}=0$)	0.325	0.469	0.302	0.459	0.329	0.470
	($\underline{s}=1$; $b=0$; $\bar{s}=-1$)	0.310	0.494	0.289	0.481	0.323	0.480
stas	(billion NT$)	5.464	29.496	4.773	18.404	4.609	16.056
sal	(billion NT$)	4.133	28.154	3.677	15.075	4.111	19.005
indmet	(yes = 1; no = 0)	0.236	0.425	0.240	0.428	0.241	0.428
indhit	(yes = 1; no = 0)	0.426	0.495	0.415	0.493	0.422	0.494
indliv	(yes = 1; no = 0)	0.162	0.369	0.155	0.362	0.150	0.358
oadv	(yes = 1; no = 0)	0.151	0.358	0.134	0.341	0.114	0.318
opp	(proportion)	0.379	0.405	0.390	0.411	0.391	0.406
mexp	(yes = 1; no = 0)	0.678	0.468	0.655	0.476	0.679	0.467
mcos	(yes = 1; no = 0)	0.641	0.480	0.628	0.484	0.108	0.311
ifdi	(billion NT$)	0.176	1.168	0.179	1.175	0.116	0.852
idom	(billion NT$)	0.995	7.343	0.759	4.153	0.206	1.719
rfor	(billion NT$)	0.007	0.035	0.008	0.040	0.011	0.089
rdom	(billion NT$)	0.072	0.464	0.077	0.455	0.075	0.302
Global employees (1000 people)		0.962	2.429	0.645	1.328	0.895	2.093

Std Dev = Standard deviation.

Table 5-3 Tests for Whether Offshore Production Concentrates in Developing Countries

$H_0: p = p_0$ vs. $H_a: p > p_0$	t-statistic for the case of firms with manufacturing sector			t-statistic for the case of firms with R&D sector		
$p_0(= 1 - \text{oadv})$	2001	2002	2003	2001	2002	2003
0.70	7.92	8.70	9.73	7.71	8.60	9.63
0.75	5.64	6.47	7.56	5.42	6.36	7.45
0.80	3.14	4.03	5.22	2.91	3.92	5.10
0.85	0.20	1.20	2.53	-0.07	1.06	2.39
0.90	-3.72	-2.53	-0.95	-4.03	-2.69	-1.11
0.95	-10.56	-8.93	-6.75	-11.00	-9.15	-6.97

$p_0 =$ the proportion of multinationals with foreign affiliate in developing countries.

Table 5-4 Means of Dependent Variables under Distinct Offshore Production Proportions

	2001	2002	2003
$\text{d\_man}\vert[f_{fpr} \le \text{opp}_{median}]$ [A]	0.035 (0.468)	0.036 (0.407)	0.162 (0.458)
$\text{d\_man}\vert[f_{fpr} > \text{opp}_{median}]$ [B]	-0.046 (0.457)	-0.025 (0.404)	0.026 (0.450)
t-statistic for $H_0: [B] = [A]$ vs. $H_a: [B] < [A]$	-2.096	-1.783	-3.494
p-value	0.0185	0.0378	0.0003
$\text{d\_rea}\vert[f_{fpr} \le \text{opp}_{Q1}]$ [C]	0.323 (0.477)	0.320 (0.483)	0.360 (0.489)
$\text{d\_rea}\vert[f_{fpr} \ge \text{opp}_{Q3}]$ [D]	0.297 (0.512)	0.257 (0.479)	0.286 (0.469)
t-statistic for $H_0: [D] = [C]$ vs. $H_a: [D] < [C]$	-0.610	-1.500	-1.761
p-value	0.2711	0.0675	0.0397

Table 5-5 The Impact of Offshore Production on the Demand for Manufacturing Employees

Dependent variable : d_man ; Number of firms (in 2001; 2002; 2003) = (563; 552; 544)				
Random effect probit with: (1) Binary choice (M-1 and M-2); (2) Three-ordered (M-3 and M-4)				
Model:	M- 1	M- 2	M- 3	M- 4
ssal	-0.012 (0.011)		-0.005 (0.004)	
stas		-0.023 (0.013)*		-0.004 (0.003)
indmet	0.452 (0.223)**	0.446 (0.222)**	-0.018 (0.140)	-0.019 (0.140)
indhit	0.219 (0.217)	0.211 (0.216)	-0.029 (0.134)	-0.031 (0.134)
indliv	0.266 (0.248)	0.282 (0.247)	-0.072 (0.153)	-0.068 (0.153)
mexp	-0.148 (0.131)	-0.142 (0.131)	-0.011 (0.089)	-0.012 (0.089)
mcos	-0.307 (0.119)***	-0.315 (0.119)***	-0.251 (0.079)***	-0.252 (0.079)***
ifdi	-0.049 (0.108)	0.025 (0.120)	-0.031 (0.061)	-0.015 (0.065)
idom	0.034 (0.019)*	0.056 (0.026)**	0.010 (0.012)	0.012 (0.012)
rfor	2.282 (2.515)	1.655 (1.809)	0.985 (1.034)	0.304 (0.894)
rdom	-0.590 (0.514)	-0.337 (0.528)	-0.047 (0.143)	-0.009 (0.152)
opp	-0.360 (0.198)*	-0.371 (0.197)*	-0.284 (0.124)**	-0.289 (0.124)**
oadv	0.322 (0.227)	0.329 (0.226)	0.194 (0.159)	0.206 (0.158)
oadv×opp	0.039 (0.592)	0.066 (0.589)	-0.041 (0.407)	-0.037 (0.406)
constant	-1.643 (0.242)***	-1.616 (0.240)***		
γ_{-1}			-1.955 (0.157)***	-1.959 (0.157)***
γ_0			1.257 (0.148)***	1.252 (0.147)***
Log-likelihood =	-540.095	-538.728	-999.127	-999.154
p-value (LR test for $\beta = 0$)	<0.01	<0.005	<0.01	<0.01

***(**;*): Significant at 1% (5%; 10%) level for a two-tailed test. Year dummies (not shown) are included.

Table 5-6 The Impact of Offshore Production on the Demand for R&D Employees

Dependent variable : d_rea ; Number of firms (in 2001; 2002; 2003) = (538; 537; 526) Random effect probit with: (1) Binary choice (R-1 and R-2); (2) Three-ordered (R-3 and R-4)				
Model:	R- 1	R- 2	R- 3	R- 4
ssal	-0.016 (0.008)**		-0.003 (0.003)	
stas		-0.017 (0.008)**		-0.002 (0.004)
indmet	0.434 (0.206)**	0.430 (0.206)**	0.328 (0.181)*	0.328 (0.182)*
indhit	0.581 (0.190)***	0.578 (0.190)***	0.443 (0.166)***	0.442 (0.167)***
indliv	-0.007 (0.233)	0.009 (0.233)	-0.048 (0.203)	-0.045 (0.203)
mexp	-0.102 (0.113)	-0.106 (0.113)	-0.099 (0.103)	-0.101 (0.103)
mcos	0.032 (0.095)	0.033 (0.095)	-0.014 (0.088)	-0.015 (0.088)
ifdi	-0.094 (0.091)	-0.069 (0.097)	-0.117 (0.072)*	-0.110 (0.074)
idom	0.029 (0.019)	0.041 (0.023)*	0.008 (0.014)	0.009 (0.014)
rfor	3.216 (1.783)*	1.575 (1.282)	1.135 (1.137)	0.732 (1.069)
rdom	-0.336 (0.279)	-0.213 (0.280)	-0.029 (0.157)	-0.039 (0.175)
opp	-0.093 (0.172)	-0.112 (0.172)	-0.124 (0.153)	-0.127 (0.153)
oadv	0.301 (0.209)	0.323 (0.209)	0.289 (0.191)	0.299 (0.190)
oadv×opp	-0.622 (0.539)	-0.608 (0.540)	-0.727 (0.480)	-0.724 (0.480)
constant	-0.982 (0.204)***	-0.968 (0.204)***		
γ_{-1}			-3.172 (0.239)***	-3.177 (0.240)***
γ_0			0.840 (0.180)***	0.837 (0.180)***
Log-likelihood =	-893.844	-893.660	-991.045	-991.270
p-value (LR test for $\beta = 0$)	<0.005	<0.005	<0.025	<0.025

***(**;*): Significant at 1% (5%; 10%) level for a two-tailed test. Year dummies (not shown) are included.

6 Conclusion

There have been serious concerns about the fragmentation of multinationals' production processes since it may hurt domestic employees, especially those who are less-skilled. This has been confirmed by research on more developed countries; however, few studies have focused on less-developed countries. This research bridges this gap by using data for Taiwanese multinationals, which are among the most active participants in offshore production activities. It finds that Taiwanese multinationals tend to geographically fragment distinct production activities in a way that more skilled jobs are kept domestically, and less skilled jobs are exporting to other developing countries. As shown in Section 5, this phenomenon is even more obvious for those multinationals in high-tech sectors. Further, this research also finds that while domestic less-skilled workers would suffer from multinationals' increasing offshore production activities, this is not the case for skilled workers, such as those in the R&D sector. These findings are comparable to the case of Hong-Kong, where outsourcing to China benefits Hong-Kong's skilled labor but hurts its less-skilled labor (Hsieh and Woo, 2005), and confirm the prediction of the knowledge-capital model, which argues that for a small open economy that is skilled-labor-abundant, multinationals tend to headquarter domestically and engage in offshore production in countries with cheaper less-skilled labor.Future research may take advantage of more comprehensive data once available. For example, MOEA's data this research used only included larger multinationals. However, there are also many smaller firms that are headquartered domestically and moving their production activities abroad. Anecdotal evidence from Taiwan suggests that for smaller multinationals, which are not included in the dataset of MOEA's survey, the offshore production proportion of total oversea sales could be higher. Thus the negative impact on the demand for domestic manufacturing employees who are often less-skilled may be larger than estimated here.

Finally, in Taiwan, despite promising economic growth in recent years, people often complain that even their nominal salaries are stagnant regardless of the continuing inflation. It seems that the economic improvement is only enjoyed by a small group of people, such as capital owners and more skilled workers who work in the high-tech sectors. In fact, this can be verified by the worsening income distribution of Taiwan in recent years. Many empirical studies for other countries have found that offshore production by multinationals could also be a channel for factor price equalization, which caps the domestic wage rates of more developed countries.[4] Thus, in addition to studying the impact of multinational offshore production on the demand for domestic employees, the impact on domestic wages is also worth investigating. More comprehensive surveys will benefit future research.

[4] For example, see Feenstra and Hanson (1996a; 1996b; 2001), Hsieh and Woo (2005), and Goldberg and Pavcnik (2007).

Appendix

A-01 Random Effect Probit Estimation with Binary Choice Model

Let us consider the following binary choice model with x_{it} being the $K \times 1$ vector of independent variables and α_i representing the unobserved individual specific effect

$$y_{it} = \begin{cases} 1 & \text{(shortage)} & \text{if and only if} & y^*_{it} = \alpha_i + x'_{it}\beta + u_{it} > 0 \\ 0 & \text{(balance or surplus)} & \text{if and only if} & y^*_{it} = \alpha_i + x'_{it}\beta + u_{it} \leq 0 \end{cases} \quad \text{(A01)}$$

In a random effect probit setting, α_i is a random disturbance term under a normal distribution. By integrating over that distribution, α_i can be cancelled out. Let us follow the assumption by Heckman and Willis (1976) such that in (A01): 1) $\alpha_i \sim IN(0, \sigma^2_\alpha)$; 2) $u_{it} \sim IN(0, \sigma^2_u)$; and 3) both of them are mutually independent as well as independent of x_{it}.[5] Let us reformulate (A01) as:

$$y_{it} = \begin{cases} 1 & \text{(shortage)} & \text{if and only if} & y^*_{it} = x'_{it}\beta + \epsilon_{it} > 0 \\ 0 & \text{(balance or surplus)} & \text{if and only if} & y^*_{it} = x'_{it}\beta + \epsilon_{it} \leq 0 \end{cases} \quad \text{(A02)}$$

where $\epsilon_{it} = \alpha_i + u_{it} \sim N(0, \sigma^2)$ with $\sigma^2 = \sigma^2_\alpha + \sigma^2_u$. Since there are three periods in this research, the joint probability becomes:

$$P(y_{i1}, y_{i2}, y_{i3}) = \int_{a_{i1}}^{b_{i1}} \int_{a_{i2}}^{b_{i2}} \int_{a_{i3}}^{b_{i3}} f(\epsilon_{i1}, \epsilon_{i2}, \epsilon_{i3}) d\epsilon_{i3} d\epsilon_{i2} d\epsilon_{i1} \quad \text{(A03)}$$

where $a_{it} = -x'_{it}\beta$ and $b_{it} = \infty$ if $y_{it} = 1$ and $a_{it} = -\infty$ and $b_{it} = -x'_{it}\beta$ if $y_{it} = 0$. Following the approach proposed by Butler and Moffitt (1982), when conditioning on the random disturbance term α_i, the joint density function in (A03) can be decomposed into (A04) since $\epsilon_{it}|\alpha_i$ and $\epsilon_{is}|\alpha_i$ $(t \neq s)$ are independent:[6]

$$f(\epsilon_{i1}, \epsilon_{i2}, \epsilon_{i3}) = f(\alpha_i) f(\epsilon_{i1}, \epsilon_{i2}, \epsilon_{i3}|\alpha_i) = f(\alpha_i) f(\epsilon_{i1}|\alpha_i) f(\epsilon_{i2}|\alpha_i) f(\epsilon_{i3}|\alpha_i) \quad \text{(A04)}$$

This implies (A03) can be expressed as:

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[5] See Maddala (1987).

[6] Note that the variances of $\epsilon_{it}|\alpha_i$ and $\epsilon_{is}|\alpha_i$ only come from the contributions of u_{it} and u_{is}, respectively, and u_{it} and u_{is} are independent by assumption.

$$P(y_{i1}, y_{i2}, y_{i3}) = \int_{-\infty}^{\infty} f(\alpha_i) \int_{a_{i1}}^{b_{i1}} f(\epsilon_{i1}|\alpha_i) d\epsilon_{i1} \int_{a_{i2}}^{b_{i2}} f(\epsilon_{i2}|\alpha_i) d\epsilon_{i2} \int_{a_{i3}}^{b_{i3}} f(\epsilon_{i3}|\alpha_i) d\epsilon_{i3}\, d\alpha_i$$

$$= \int_{-\infty}^{\infty} \prod_{t=1}^{3} [F(b_{it}|\alpha_i) - F(a_{it}|\alpha_i)]\, f(\alpha_i)\, d\alpha_i \qquad \text{(A05)}$$

Thus, the log-likelihood function becomes:

$$\ln L = \sum_{i=1}^{N} \ln\left\{\int_{-\infty}^{\infty} \prod_{t=1}^{3} [F(b_{it}|\alpha_i) - F(a_{it}|\alpha_i)]\, f(\alpha_i)\, d\alpha_i\right\} \qquad \text{(A06)}$$

A-02 Random Effect Probit Estimation with 3-Alternative Ordered Model

Let us consider the following three-alternative ordered model:

$$y_{it} = \begin{cases} 1 & \text{(shortage) if and only if } \gamma_0 < y_{it}^* = \alpha_i + x_{it}'\beta + u_{it} \leq \gamma_1 \\ 0 & \text{(balance) if and only if } \gamma_{-1} < y_{it}^* = \alpha_i + x_{it}'\beta + u_{it} \leq \gamma_0 \\ -1 & \text{(surplus) if and only if } \gamma_{-2} < y_{it}^* = \alpha_i + x_{it}'\beta + u_{it} \leq \gamma_{-1} \end{cases} \qquad \text{(A07)}$$

Note that in the above expression, $\gamma_{-2} = -\infty$ and $\gamma_1 = \infty$. Let us follow the assumption by Heckman and Willis (1976) such that in (A07): 1) $\alpha_i \sim IN(0, \sigma_\alpha^2)$; 2) $u_{it} \sim IN(0, \sigma_u^2)$; and 3) both of them are mutually independent as well as independent of x_{it}. Let us denote the probability that firm i chooses alternative j = J (J= $-1; 0; 1$) in year t by $P(y_{it} = J)$ and reformulate (A07) as:

$$y_{it} = \begin{cases} 1 & \text{(shortage) if and only if } \gamma_0 < y_{it}^* = x_{it}'\beta + \epsilon_{it} \leq \gamma_1 \\ 0 & \text{(balance) if and only if } \gamma_{-1} < y_{it}^* = x_{it}'\beta + \epsilon_{it} \leq \gamma_0 \\ -1 & \text{(surplus) if and only if } \gamma_{-2} < y_{it}^* = x_{it}'\beta + \epsilon_{it} \leq \gamma_{-1} \end{cases} \qquad \text{(A08)}$$

where $\epsilon_{it} = \alpha_i + u_{it} \sim N(0, \sigma^2)$ with $\sigma^2 = \sigma_\alpha^2 + \sigma_u^2$. Then, we have:

$$P(y_{it} = J) = F(\gamma_J - x_{it}'\beta) - F(\gamma_{J-1} - x_{it}'\beta) \qquad \text{(A08)}$$

where $F(\cdot)$ is the c.d.f. of ϵ_{it}. Note that for the same firm, the choices of different years are correlated since ϵ_{i1}; ϵ_{i2}; ϵ_{i3} are correlated because of the presence of α_i. Thus, we need to use the approach proposed by Butler and Moffitt as in the binary choice case. Let us consider the conditional joint probability $P(y_{i1}, y_{i2}, y_{i3}|\alpha_i)$. Since $\epsilon_{i1}|\alpha_i$; $\epsilon_{i2}|\alpha_i$; $\epsilon_{i3}|\alpha_i$ are independent, we have:

$$P(y_{i1}, y_{i2}, y_{i3}|\alpha_i) = \prod_{t=1}^{3} P(y_{it} = j|\alpha_i) \quad \text{(A08)}$$

After integrating over α_i, we have:

$$P(y_{i1}, y_{i2}, y_{i3}) = \int_{-\infty}^{\infty} [\prod_{t=1}^{3} P(y_{it} = j|\alpha_i)] f(\alpha_i) d\alpha_i \quad \text{(A09)}$$

Thus, the log-likelihood function becomes:

$$\ln L = \sum_{i=1}^{N} \ln\{\int_{-\infty}^{\infty} [\prod_{t=1}^{3} P(y_{it} = j|\alpha_i)] f(\alpha_i) d\alpha_i\} \quad \text{(A10)}$$

References

[1] Allison, P. D. (2008) *Logistic Regression Using the SAS System: Theory and Application*, Cary, NC: SAS Institute Inc.

[2] Anderson, E. B. (1973) *Conditional Inference and Models for Measuring*, Copenhagen: Mentalhygiejnisk Forlag.

[3] Baltagi, B. H., (2005) *Econometric Analysis of Panel Data*. John Wiley & Sons, Chichester, England.

[4] Butler, J. S. and Moffitt, R. (1982) "A Computationally Efficient Quadrature Procedure for the One-Factor Multinomial Probit Model", *Econometrica*, 50(3), 761-764.

[5] Cameron, A. C. and Trivedi, P. K. (2009) *Microeconometrics Using Stata*. Stata Press, College Station, Texas.

[6] Cameron, A. C. and Trivedi, P. K. (2005) *Microeconometrics: Method and Applications*, Cambridge University Press.

[7] Chen, T.-J. and Ku, Y.-H. (2000) "The Effect of Foreign Direct Investment on Firm Growth: The Case of Taiwan's manufacturers." *Japan and the World Economy,* 12, 153-172.

[8] Feestra, R. C. and Hanson, G. H. (1996a) "Foreign Investment, Outsourcing and Relative Wages." *The political economy of trade policy*: Papers in honor of Jagdish Bhagwati, 1996, pp. 89-127, Cambridge and London: MIT Press.

[9] ____________ and ____________ (1996b) "Globalization, Outsourcing, and Wage Inequality." *AEA Papers and Proceedings*, 86(2). 240-245.

[10] ____________ and ____________ (2001) "Global Production Sharing and Rising Inequality: A Survey of Trade and Wages." *NBER Working Paper*, No. 8372.

[11] Frank, R. and Freeman, R. (1978) "The Distributional Consequences of Direct Foreign Investment." Academic Press, New York.

[12] Glickman, N. and Woodward, D. (1989) "The New Competitors: How Foreign Investors Are Changing the US Economy." Basic Books, New York.

[13] Goldberg, P. K. and Pavcnick, N. (2007) "Distributional Effects of Globalization in Developing Countries." *Journal of Economic Literature*, XLV, 39-82.

[14] Hanson, G. H.; Mataloni, R. J. and Slaughter, M. J. (2001) "Expansion Strategies of U.S. Multinational Firms." in D. Rodrik and S. Collins (eds.) *Brookings Trade Forum*, 245-294.

[15] Heckman, J. J. and Willis, R. J. (1976) "Estimation of a Stochastic Model of Reproduction: An Econometric Approach." In *Household Production and Consumption*, ed. N. Terleckyj. New York: National Bureau of Economic Research, 99-146.

[16] Helpman, E. (1984) "A Simple Theory of International Trade with Multinational Corporations." *Journal of Political Economy*, 92(3), 451-471.

[17] Helpman, E.; Melitz, M. and Yeaple, S. (2004) "Export Versus FDI with Heterogeneous Firms." *American Economic Review*, 94(1), 300-316.

[18] Hsiao, C. (1986) *Analysis of Panel Data*, Cambridge University Press.

[19] Hsiao, F. S. T. and Hsiao, M. C. W. (2004). "The Chaotic Attractor of Foreign Direct Investment—Why China? A Panel Data Analysis." *Journal of Asian Economics*, 15, 641–670.

[20] Hsieh, C.-T. and Woo, K. T. (2005) "The Impact of Outsourcing to China on Hong Kong's Labor Market." *American Economic Review*, 95(5), 1673-1687.

[21] Hsu, C.-M. and Liu, W.-C. (2002) "The Role of Taiwanese Foreign Direct Investment in China: Economic Integration or Hollowing-Out." National Policy Foundation Research Report, No. 091-071, Taiwan.

[22] Lipsey, R. (1994) "Outward Direct Investment and the US Economy.", National Bureau of Economic Research Working Paper No. 4691.

[23] Maddala, G. S. (1987) "Limited Dependent Variable Models Using Panel Data", *The Journal of Human Resources*, 22(3), 307-338.

[24] Mariotti, S.; Mutinelli, M. and Piscitello, L. (2003) "Home Country Employment and Foreign Direct Investment: Evidence from the Italian Case." *Cambridge Journal of Economics*, 27(3), 419-31.

[25] Markusen, J. R. (1984) "Multinationals, Multi-plant Economies, and the Gains from Trade." *Journal of International Economics*, 16(3-4), 205-226.

[26] _____________; Venables, A. J.; Eby-Konan, D. and Zhang, K. H. (1996) "A Unified Treatment of Horizontal Direct Investment, Vertical Direct Investment, and the Pattern of Trade in Goods and Services." *NBER Working Paper*, No. 5696.

[27] _____________ (1997) "The Role of Multinational Firms in the Wage-Gap Debate." *Review of International Economics*, 5(4), 435-451.

[28] Ministry of Economic Affairs (MOEA) (2004a) *The Report on Foreign Investment Strategies of the Manufacturers*, Department of Statistics, Ministry of Economic Affairs, Taiwan.

[29] _______ (2002,2003,2004b) *The Annual Survey on Taiwanese Multinational's FDI and offshore production*, Department of Statistics, Ministry of Economic Affairs, Taiwan.

[30] _______ (2007a) *Inward and Outward Direct Investment Statistics (December, 2007)* (In Traditional Chinese), Investment Commission, Ministry of Economic Affairs, Taiwan. http://www.moeaic.gov.tw/system_external/home.html

[31] _______ (2007b) *The Analysis of Trade Between Taiwan and China (December, 2007)* (In Traditional Chinese), Bureau of Foreign Trade, Ministry of Economic Affairs, Taiwan.

[32] _______ (2008) *The Investigation of Trade Relationship Between Taiwan and China* (In Traditional Chinese), Department of Statistics, Ministry of Economic Affairs, Taiwan.

[33] _______ (2010) *The Reponse for the warning by the EU officials about Taiwan's Exports Depend Too Much on China* (In Traditional Chinese), Bureau of Foreign Trade, Ministry of Economic Affairs, Taiwan.

[34] Molnar, M.; Pain, N. and Taglioni, D. (2007) "The Internationalisation of Production, International Outsourcing and Employment in the OECD." OECD Economics Department,

OECD Economics Department Working Papers: No. 561, 1-71.

[35] Neyman, J. and Scott, E. (1948) “Consistent Estimates Based on Partially Consistent Observations.” *Econometrica* 16(1), 1-32.

[36] Singh, A. (1977) “UK Industry and the World Economy: A Case of Deindustrialization?” *Cambridge Journal of Economics*, 1, 113-134.

[37] Sung, J.-S. (2007) “The Effect of Foreign Investment and Foreign Outsourcing on the Employment of Manufacturing and R&D Sectors: The Case of Taiwan’s Large Manufacturers (In Traditional Chinese).” Department of Industrial Economics, National Central University, Chung-Li, Taiwan, 1-93.

[38] United Nations Conference on Trade and Development (UNCTAD) (2001) World Investment Report: The Global Picture. New York and Geneva, United Nations.

[39] _________ (2007) World Investment Report 2007: Annex B. New York and Geneva, United Nations.

[40] Wooldridge, J. M. (2002) *Econometric Analysis of Cross Section and Panel Data*, The MIT Press.