THE EFFECTS OF TAIWAN'S OUTWARD FDI ON HOME COUNTRY R&D ACTIVITIES: THE ROLES OF LOCATION AND INDUSTRY CHARACTERISTICS

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ABSTRACT

This paper has examined the effects of OFDI on R&D in the source country. The results show that the impact of outward FDI by Taiwanese MNEs on R&D in Taiwan is in general neutral. This study concludes that Taiwanese FDI does not significantly upgrade, harm or substitute domestic R&D in Taiwan. This paper has considered the effects of OFDI in China and other countries and finds that the insignificant effect does not vary with the location of investment. Furthermore, this paper has analysed the OFDI effect in high and low technology opportunity industries separately. The results show that while OFDI in China exerts a negligible impact on R&D in Taiwan in both groups of industries, OFDI in other countries produces a significant impact on R&D in Taiwan in high technology opportunity sectors. The contrasting pattern of findings corroborates the argument that the nature of the investment by multinationals varies between different host countries, leading to different patterns of relationship between OFDI and R&D in the source country. It also illustrates that industry-specific effects have to be considered for a full understanding of the relationship between OFDI and home R&D. Although theories do not provide any clear-cut answers, the empirical analysis in this study pinpoints situations under which OFDI can and cannot stimulate R&D in the source country.

Keywords：Emerging market MNCs; inward and outward FDI to and from emerging market economies; foreign direct investment and R&D

INTRODUCTION

Technological progress has long been regarded as a critical ingredient for a country to achieve sustained economic growth and catch-up (Porter, 1990; Coe and Helpman, 1995; Hu et al., 2005). The industry has come a long way from inward bulk R&D to outward formulations to regulated innovation in the developing country. Many industry's drive from being an technological import dependent industry to becoming an inventor of original industry, then go to foreign market(Vernon, 1966). Since late 1960 Taiwan has initiated the process of economic growth by emphasizing technology-led industrialization and then outward oriented development strategies through exports and outward FDI. The dramatic growth of FDI from Taiwan in the last two decades has, however, sparked widespread concerns among policy-makers and the media in Taiwan. The Taiwanese government fears that its domestic enterprises that have invested overseas transfer too much technology or capital to foreign countries, especially China, thereby hampering the R&D base in Taiwan, and thus the long-run technological competitiveness of the Taiwanese economy. On the other hand, some scholars suggest that Taiwan has in recent years accelerated the increase in technology-seeking FDI (Poon & MacPherson, 2005), meaning that Taiwanese outward FDI(OFDI) may benefit R&D at home. R&D is important insomuch as it indicates variation in the level of innovation which is almost the only form of activity that leads to sustained improvements in productivity (Griffiths & Webster, 2004).

Classical theories of MNEs explore the relationship between R&D efforts and multinational activity (e.g., Hymer, 1976; Caves, 1982). Since knowledge about new products and processes is among the important intangible assets giving rise to multinational activity (Dunning, 1988, 1993; Konings & Murphy, 2006), MNEs are likely to devote above average resources to R&D. As such, the literature on the role of inward FDI has focused on technology spillovers from foreign-invested firms to host country locally-owned enterprises (Young & Lan, 1997; Fors, 1997; Gupta & Govindarajan, 2000), then provides technology development and foster innovation opportunity (Hobday, 1995). Compared with this stream of literature, however, the role of OFDI in technology upgrading of the home industry has largely been neglected in the literature (Song & Shin, 2008). It is widely recognized that OFDI offers the home country the opportunity to be exposed to new technology and work practices, which can be readily transplanted homewards, thus aiding the domestic economy in terms of restructuring and being au fait with important technological advances. However, although Song & Shin (2008) have investigated how overseas R&D activities of MNEs can influence R&D activities at home, it remains unclear how outward FDI in general, which may involve substantial R&D activities abroad, in turn affects the R&D base of the home industry.

This study aims to examine whether and to what extent outward FDI by Taiwanese firms impacts upon the R&D base in Taiwan. Relative to other studies in the area, the analysis of this research has two contrasting features. On the one hand, it investigates how the relationship between OFDI and home R&D varies between different locations of investment. On the other hand, it explores how this relationship is moderated by technological characteristics of the industries. In doing so, we hope to contribute to the literature by highlighting the conditions in which OFDI affects the R&D base of the home country industries.

LITERATURE REVIEW

OFDI and home-country R&D

It is widely accepted that multinational enterprises are important economic agents with respect to the generation, commercialisation and international transfer of technology (Siler et al., 2003). It is estimated that between 75 and 80 percent of all global civilian R&D expenditure, the basic input into the technology generation process, is attributed to multinational firms (Brewer & Young, 1998). It is therefore frequently argued that the nature of foreign direct investment is not flow of capital but of technology or knowledge across national borders.

The theory on multinational enterprises focuses on the motivation of firms to conduct investment overseas (Buckley & Casson, 1976, 1988; Dunning, 1977; Rugman, 1986) . A classic stream of the theory argues that knowledge-based assets, in particular, state-of-the-art technology achieved through vast investment in R&D, are the key source of firm-specific advantages (Hymer, 1976) , cost advantages (Teece, 1977) held by MNEs (Hymer, 1976) . The exploitation of such knowledge is recognized as the main motivation of investing overseas by multinational firms (e.g., Dunning, 1988, 1993; Cantwell, 1995; Patel & Vegz, 1999; Pearce & Papanastassiou, 1999), usually referred to as the internationalization of R&D. Ownership of these intangible assets is thought to be able to offset the disadvantages for firms to coordinate subsidiary activity in a foreign country. This is the so-called asset-exploitation type of FDI (Driffield & Love, 2003), knowledge intensity of firm internationalization. There are reasons for believing that this type of FDI will produce a limited positive impact, if any, on the level of home R&D because of the generally low level of technological development of the host country.

Recent literature, however, suggests that a possible motive for MNEs to conduct cross border investments is not to exploit their unique firm-specific assets, but rather to access the superior resources, knowledge or capabilities of local firms in the host country (e.g., Cantwell, 1994; Luo, 2000). In this regard, scholars have responded to MNE's globalization of R&D by focusing more extensively on how MNEs use FDI not only to 'push' their existing advantages in exploiting foreign markets but also to 'pull' new resources and capabilities from centres of innovation by acquiring or learning about complementary technologies (Almeida et al., 2002; Singh, 2004). Particularly with the rise of Asian multinationals, an asset-augmenting or asset-seeking perspective has been advocated to explain how these latecomers are employing international expansion as a way to seek resources and overcome their competitive disadvantages (Makino et al., 2002; Mathews, 2006; Child & Rodrigues, 2005). In an analysis of thirteen industrialized countries from 1971 to 1990, Van Pottelsbergh & Lichtenberg (2001) found that outward FDI made a positive contribution to domestic total factor productivity through spillover effects from accessing foreign R&D capital stock in target countries. Therefore, they concluded that FDI flows are predominantly technology-sourcing in nature, and that FDI is motivated principally by the desire to take advantage of the technological base of host countries.

Turning to the literature on the host country effects of inward FDI, a large body of studies has examined the effects of inward FDI on the technological development of the host country. As Pain (2000) notes, after foreign investors have established a presence in the host economy, tacit and codified firm-specific knowledge can be transferred from parent companies independent of other financial transactions. Similarly, Das (1987) points out that multinationals transfer new technology from their parent headquarters to their overseas subsidiaries and the host country firms then learn from these subsidiaries. Therefore, in the presence of FDI inflows, an open (developing) economy may achieve economic growth substantially through technology diffusion (Borensztein et al., 1998). The most important channel of technology transfer is not licensing or any other formal market transactions. Rather, it is spillover effects of FDI, meaning that host country firms acquire technology through mechanisms such as demonstration effects, labour movement and competition between foreign and local firms (Görg & Greenaway, 2002).

Equally, outward investments by multinationals may be beneficial to the R&D base of the home country through similar channels such as technology transfer or spillover effects. This is most obvious in the cases of strategic asset-seeking FDI, where the implicit motive is to get access to foreign technology rather than exploit a MNE's own existing advantage (Kuemmerle, 1997; Dunning & Narula, 1995). Highly integrated MNEs may use centres of excellence and scanning units in foreign locations as a means of tapping into the ideas and knowledge bases in distant locations (Frost, et al., 2002). From a micro-perspective, concerns are often raised as to what happens to a firm's home R&D after it engages in OFDI. The effect of OFDI on a firm's home R&D can be indirectly derived from its FDI motivation or strategic intention. According to the linkage approach, a growing number of studies have suggested that the purpose for many MNEs to conduct FDI is to develop firm-specific advantages or to acquire strategic assets in the host countries (Teece, 1992; Dunning, 1993; Almeida, 1996; Shan & Song, 1997; Kuemmerle, 1999). Thus, FDI should produce a positive effect in various ways on a firm's home R&D.

The literature on knowledge creation suggests that MNEs use foreign subsidiaries to acquire and create knowledge locally (Frost, 2001; Almeida & Phene, 2004; Zhao & Luo, 2005). For example, Frost (2001) argues that "a potentially important source of competitive advantage for multinational firms is the capacity of their foreign subsidiaries to generate innovations based on stimuli and resources resident in the heterogeneous host country environments in which they operate". While much of the knowledge gained is kept within the subsidiary, part of the knowledge is transferred to the subsidiary's parent in the home country (Bjorkamn et al., 2004; Zhao & Luo, 2005), potentially improving R&D of the home industries.

Other scholars, however, argue that outward investment activities may create an industrial hollowing-out effect, thereby hampering the R&D base in the home country. There are both direct and indirect effects. The direct effect occurs when firms' investments overseas involve technology transfers to host countries, which depresses R&D at home[1]. The indirect effect occurs where OFDI is a substitute for domestic investment. In this case, OFDI may reduce the opportunities for developing technologies at headquarters, and thereby negatively impacting the overall technological competitiveness of the home country (Singh, 1977; Thirlwall & Hussain, 1982).

OFDI, home-country R&D and industry characteristics

The creation and exploitation of technology is the main reason explaining the success and growth of MNEs over time (Caves, 1996; Dunning, 1988). This explains why MNEs often have a high ratio of intangible assets to market value (Markusen, 1995). The ownership of the knowledge-based assets allows MNEs to overcome the problems associated with the 'liabilities of foreignness' in the foreign market and compete with indigenous firms through development of new and differentiated products and processes (Dunning, 1988, 1993). This argument holds especially true for MNEs operating in industries characterized with rapidly changing technologies because the main competitive weapon in these industries is technology which results from large investment in R&D. Analysing from a different angel, Fosfuri & Motta (1999) consider the possibility of capturing technological spillovers both at home and abroad, and demonstrate that spillovers may induce a technologically less advanced firm of both host and home countries to undertake more R&D. In a simultaneous vein, Fors (1997) suggests that the technology generated by the MNE can be used in its home plant and/or its subsidiaries abroad to earn rent. In this respect, MNEs may take advantage of economies of scale from 'know-how' in multiple plants both home and abroad. In line with these arguments, mainstream theoretical perspectives, such as

[1] One example is that the Taiwanese government still has tight control in place to restrict investment in China by high-technology Taiwanese electronics firms to prevent technology transfer to China.

the OLI paradigm (Dunning, 1981; 1993) suggests that MNEs operate predominantly in technology-intensive industries or industries with more technological opportunities.

The extant literature on R&D suggests that differences in R&D intensities and their contributions to value added between firms in different industries reflect to some extent inter-industry differences in technological opportunities and in appropriability conditions (e.g., Klevorick et al., 1995; Nelson & Wolff, 1997; Cohen et al., 2002). Technological opportunities are defined as the set of possibilities for technological advance (Klevorick et al., 1995). Recent studies distinguish between industries of 'high' or 'low' technological opportunities (e.g., Bhattacharya & Bloch, 2004) and the differential effect of technological opportunities on R&D intensities (Cohen & Levinthal, 1989, 1990; Klevorick et al., 1995). The strength of R&D activities varies considerably between the two types of industries as high technological opportunity industries usually belong to R&D-intensive sectors and low technological opportunity industries fall into less R&D-intensive sectors. Indeed, prior studies suggest that the level of technological opportunities in a given industry is associated with its research intensity (e.g., Clark & Griliches, 1984; Klevorick et al., 1995; Kumar & Aggarwal, 2005), For example, Kumar & Saqib (1996) reported that firms in the Indian engineering industries undertook higher levels of product adaptation and incremental innovation than firms in other industries. They also found firms in the Indian chemical and related industry undertake relatively high levels of process adaptation.

The literature on FDI spillovers suggests that technological conditions moderate the strength of technological spillovers of FDI to host country local firms. Buckley et al. (2002; 2007) argue and empirically confirm that host country local firms in technology-intensive industries (which often face more technological opportunities) receive more spillovers than in labour intensive industries. There are strong reasons to extend this argument to the case of home country R&D effects of OFDI. OFDI may induce more technological spillovers in the high technological opportunity industries than in low technological opportunity industries at home through a range of channels such as backward and forward linkages between foreign affiliates and parent firms and other firms, demonstration effects, and labour turnover which are identified in the literature on FDI spillovers to host country firms. The reasoning is that MNEs in high technological opportunity industries such as telecommunication sector have more opportunities to learn new technological knowledge from technological 'centres of excellence' in the host country and to expose to fierce competition within global scope, which in turn may benefit more their parents and other firms at home and enhance their R&D (Kokko, 1996). Additionally, appropriability regime in high technology opportunity industries such as pharmaceutical industry may be stronger which enable the firm to earn handsome profits overseas. This should eventually enhance the R&D activity of the parent at home. In contrast, in industries with fewer technological opportunities OFDI is not expected to strengthen home R&D significantly because MNEs in these industries may learn only limited new knowledge and technology.

FDI in developed markets by MNEs from emerging or newly industrialized economies is characterised to be knowledge-seeking. For example, there is evidence that Taiwanese investment in computer and electronic industry of the United States which takes a lion's share of Taiwanese FDI in 'other countries' is driven by knowledge-seeking (Poon & MacPherson, 2005; Wang et al., 2007). Because computer and electronics industries are classified into the high technological opportunity category, one may expect the Taiwanese OFDI in 'other countries' to produce significant impact on the R&D activities at home. However, it should be pointed out that geographical distance between MNEs and their home counterparts may make spillovers less probable to home parents and other firms in the home country than to local firms in the host country. However, the strategy of minimization of the probability of leakage of knowledge to local competitors (Ethier, 1986; Kugler, 2006) may also mean the opposite: fewer spillovers to host country local firms than to parent firms in the home country. In contrast, Taiwanese OFDI in China which falls into low technological opportunity industries is expected to produce limited positive impact on the R&D activities back in Taiwan.

The empirical literature

The empirical literature on the relationship between the presence of MNEs in host countries and the R&D conducted by firms in the home country is scant. Existing empirical work overwhelmingly concentrates on the influence of MNEs on the technical efficiency (labour productivity) of host country's industries (Caves, 1974; Globerman, 1979; Liu et al., 2000; Buckley et al., 2002). Although there is an emerging body of work focusing on technology- or knowledge-sourcing FDI (Almeida, 1995; Dunning & Narula, 1995; Kuemmerle, 1997; Co and List, 2004), especially such types of FDI by firms from less developed countries (Lecraw, 1993; Makino, et al., 2002), these studies have not examined the extent to which the technology gained through technology-sourcing FDI (if any) impacts the R&D base at home.

Additionally, Kuemmerle (1997) and Dunning and Narula (1995) investigated the effect of OFDI on R&D activities for American manufacturing firms. Dunning and Narrula (1995) found that if the level of skilled labour is used as an indicator of R&D activities, then the firms tend to upgrade their R&D activities at home when they move their low technological production to low-cost countries. Fors' (1997) study of 121 Swedish manufacturing MNEs shows that Swedish firms tend to supply R&D-generated knowledge at home to their overseas production, which implies that overseas production is positively associated with R&D activities at home.

To summarize, previous studies have largely focused on technology-sourcing FDI and the link between overseas and home R&D. Few of them have examined the direct relationship between OFDI and home R&D. To fill this gap, this study investigates the effect of Taiwanese FDI on the R&D base of Taiwanese industries at home and how this effect (if any) varies with the location of investment and industry-specific characteristics.

DATA AND METHODOLOGY

The study uses a panel dataset for fifteen distinct Taiwanese manufacturing industries (two-digit ISIC) during the period between 1991 and 2007, i.e., the period during which Taiwanese FDI entered a more active phrase and was gaining credibility[2]. The data were obtained from two different databases, both of which were published by the Ministry of Economic Affairs (MOEA) of Taiwan. FDI-related data were collected from several issues of *Monthly Report*, published by the Investment Commission (ICM), MOEA. Data on the other variables can be found at the website of the MOEA Economic Statistics Database (ESD) and National Statistics (NS, http://www1.stat.gov.tw). Official data from MOEA are the most detailed and reliable to date for studying the outward FDI made by Taiwanese firms.

The datasets contain a wide range of data for each industry, including sales, employment, capital, export, R&D, and, most importantly, the amount of direct capital investment in both foreign countries and Mainland China as two separate measures. Together with a range of other sectoral attributes, the datasets provide a rich statistical source that is directly amenable to economic analysis. Disaggregated data that can be used to study the source-country effects of OFDI made by firms from newly industrialized economies (NIEs), such as Taiwan, for a heterogeneous set of industries is rarely found in a comprehensive and comparable form. To the best of our knowledge, this is the first study to use such detailed industry-level data from a NIE country.

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[2] The fifteen industries include: (1) food, beverage, tobacco, (2) textiles, mills, (3) wearing apparel and clothing accessories, (4) wood and bamboo products, furniture, (5) pulp, paper and paper products, printing and reproduction of recorded media, (6) plastic products, and (7) non-metallic mineral products. Schumpeter Industries include: (8) leather, fur and related products, (9) chemical materials and products, petroleum and coal products, medical products, (10) rubber products, (11) basic metal products, fabricated metal products, (12) machinery and equipment, manufacturing not elsewhere classified, (13) electronic parts and components, computers, electronic products and equipment, (14) motor vehicles and parts, other transport equipment, and (15) precision, optical products, medical equipment, watches and clocks.

Employing industry-level data presents several unique advantages. First, industry-level study considers the impact of both the investing firms and the non-internationalized domestic firms. Firm-level data disregards the general equilibrium effects of FDI on the investments of other firms (Arndt, et al., 2007). If some firms engage in offshoring, other firms at home might be affected, as well. However, firm-level data looks only at the impact of offshoring on the home operations of the investing firm (e.g., Lipsey, 2002). In fact, MNEs may also impact non-internationalized home firms (Castellani & Zanfei, 2006). Indeed, it is possible that a substitution at the firm level may be accompanied with complementarities at the industry level when spillover effects between the firms are taken into account (Seo & Suh, 2006). Second, many of the determinants of exports, employment, investment, productivity, and R&D are industry-wide, implying that a substantial part of the OFDI effect may occur at the industry level at which the firm operates and carries out most of its external relations. For instance, the degree of competition and the technology policy are regarded as important factors that influence productivity, but they cannot be adequately captured in firm-level research. Third, a firm's industry is an important part of the milieu within which government policies are framed and executed. While government agencies in NIE countries have adopted a generally favourable attitude towards OFDI, policy-making is often implemented at the industry level. In fact, the Taiwanese government determines sector-specific restrictions on OFDI to China on an industry-by-industry basis. Hence, there is more variation in the OFDI variables in industry-level data as a result of the discriminating industry-by-industry policy towards OFDI. The industry-level data thus presents an opportunity to evaluate the effects of a variety of policy initiatives on the FDI outflow.

This research sets up the following models to examine the effect of OFDI on the R&D base of the home country industries:

$$RD_{it} = \alpha_0 + \alpha_1 TOFDI_{it-1} + \alpha_2 IFDI_{it} + \alpha_3 KL_{it} + \alpha_4 EXPORT_{it} + \alpha_{65} SKILL_{it} + \alpha_6 SIZE_{it} + \alpha_7 D + \varepsilon \quad (1)$$

$$RD_{it} = \alpha_0 + \alpha_1 OFDIC_{it-1} + \alpha_2 OFDIO_{it-1} + \alpha_3 IFDI_{it} + \alpha_4 KL_{it} + \alpha_5 EXPORT_{it} + \alpha_6 SKILL_{it} + \alpha_7 SIZE_{it} + \alpha_8 D + \varepsilon$$

(2

Where, the subscript t denotes time, while subscript i refers to industry. Where, RD is R&D expenditure of each industry in Taiwan[3]. We are particularly interested in the three variables for outward FDI – TOFDI, OFDIC and OFDIO (as defined in previous chapters). As predicted in the theoretical discussion in the literature review section, the sign of these variables could be either positive or negative. A positive sign indicates a complementary relationship between OFDI and home R&D, whilst a negative sign implies that OFDI depresses or squeezes R&D of the home industries.

This empirical study controlled for possible confounding effects by including various relevant control variables. IFDI is the level of inward FDI. The literature suggests technology transfer within MNEs (Young & Lan, 1997; Siler et al., 2003) can potentially contribute to the home base of R&D. KL is capital intensity. The inclusion of this variable is based on the argument that firms with higher capital intensity will have higher R&D intensity because technology is often embodied in capital (Wand & Yu, 2007). EXPORT is the value of exports. Theory of international trade argues that exports facilitate technology creation and diffusion (Coe & Helpman, 1995; Coe et al., 1997) because participation in export markets enables firms to explore new technologies and enhance organizational learning by analyzing the innovations of their foreign competitors (MacGarvie, 2006). SKILL is the level of human capital, capturing tacit knowledge of entrepreneurial managers and talented technicians. SKILL should be positively related to R&D because of its complementary role in the development of R&D (Siler et al., 2003). SIZE is average firm size. The inclusion of this control variable follows the considerable literature on the relationship between firm size and R&D expenditure. Prior research has shown that larger firms spend more on R&D relative to their size than smaller firms (Schumpeter 1942; Lichtenberg & Siegel; 1991), while others argue for no relationship (Scherer, 1984; Cohen et al, 1987; Acs & Audretsch, 1990; Wang & Tsai, 2003). Table 1 displays descriptive statistics of all the dependent and independent variables.

"Table 1 goes about here"

[3] Using the form of stock in measuring R&D would in principle be better than that of R&D flow. However, Jefferson et al. (2004) investigate the sensitivity of using a single year's R&D expenditure rather than measure of R&D stock, and they find 'the relevant elasticity is stable over flow and stock measures of R&D input'. So the use of R&D expenditure should not bias our results significantly.

Some of the explanatory variables in the equations could create problems of two-way causality. For instance, OFDI is likely to influence a company's R&D efforts at home but the intensity of OFDI may itself depend on R&D efforts of the company at home. Similarly, a firm's investment in R&D activities could be high because of outward orientation or vice versa. In other words, it may be the case that firms which conduct OFDI are more likely to have above average R&D intensity at home. A large number of studies that have examined the determinants of firm R&D spending overlook the problem of simultaneity. Therefore, econometric estimates of the impact of various explanatory variables on the R&D of the home industries are both biased and inconsistent. This makes it difficult to put much reliance on the performance of individual variables.

This study addresses the potential causality issue by regressing the R&D intensity on lagged OFDI variables in equations (1) and (2) above. This also helps to capture the longer time taken for R&D intensity to respond fully to OFDI in foreign countries. Theoretically, the best solution is to employ instrumental variable techniques, but in practice it is extremely hard to find appropriate instruments: exogenous variables that have a direct effect on OFDI but do not belong in the R&D equation. It is difficult to find such an instrumental variable in our database owing to data limitation. For similar reasons, we have also adopted a lag structure for all other explanatory variables. Table 2 shows the correlation matrix for the independent variables. Among the correlations we concern, there is only two higher than 0.70, indicating that there are no serious problems of multi-collinearity. This has enhanced confidence that the results are not distorted by spurious correlations between variables.

"Table 2 goes about here"

RESULTS

The results of estimation of equations (1) and (2) are displayed in Table 3. A Hausman test (Hausman, 1978) rejects random effects at 1 per cent level of significance, indicating a correlation between specific industry effects and the explanatory variables. A fixed-effects model is thus considered. Column (1) shows that the effect of overall OFDI on R&D of the home industries is not statistically significant. This suggests that outward FDI has produced a neutral effect on the R&D of home industries. In other words, outward FDI does not upgrade, harm or substitute home R&D. Breaking OFDI data according to investment location, column (3) shows that the results remain unchanged – OFDI in both China and other countries also produces an insignificant impact on home R&D. This latter finding suggests that the effect of OFDI on home R&D does not vary with the location of investment. Taken together, these results suggest that the home R&D effects of OFDI are not just positively significant or negatively significant as previous studies showed (Dunning & Narula, 1995; Almeida, 1995; Fors, 1997; Kuemmerle, 1997). Rather, the effect is virtually neutral.

"Table 3 goes about here"

There are various reasons why relocation of part of the production process abroad produces negligible effects on R&D at home. First, the structure of overseas investment should explain partly the weak link between overseas and home R&D. Investment in China accounts for a lion's share of the total OFDI by Taiwanese firms. However, these investments take place mainly in labour-intensive industries where R&D is often not a major input of the production process. Although Taiwanese firms have increased investment in recent years in electronics industries in China, much of such investment falls into the labour-intensive stage of high-technology industries (Wang et al., 2007), taking the location advantage of low labour cost in China. This means that overseas investment will not squeeze domestic R&D at home significantly. Second, a large part of the Taiwanese OFDI in other countries (notably the USA and the EU) is concentrated in computer and other electronics industries, falling into the type of strategic asset-seeking FDI (Poon & MacPherson, 2005; Wang et al., 2007). If this is indeed the case, we would expect significant positive effects of OFDI in other countries on domestic R&D through international technological spillovers. However, such effects are not observed in our data. One reason may be that technology sourcing may have indeed improved productivity at home but this is through development of new products or direct application in the production process rather than enhanced R&D at home. In such circumstances, successful technology sourcing does not necessarily foster the R&D of the home industries. Another possibility is that some of the technologies they have acquired are used as inputs either in local subsidiaries and/or subsidiaries in other foreign countries. Third, in addition, part of the Taiwanese FDI was in South-Eastern Asia which is relatively more labour-intensive compared with that in the USA and Europe, and can not be expected to have a positive impact on home R&D through technology transfer or spillover effects. Fourth, although some argue that OFDI is a substitute for domestic investment in R&D (Singh, 1977; Thirlwall & Hussain, 1982), this does not necessarily mean a perfect substitution. Taiwanese firms may invest in R&D abroad in order to diversify or expand in foreign markets, without reducing at the same time the investment in R&D at home. In this case, OFDI by Taiwanese multinationals may not necessarily reduce home R&D. In summary, one way of interpreting the weak relationship between OFDI and home R&D is that there are circumstances in which foreign production tends to stimulate home R&D and circumstances in which it tends to squeeze home R&D. These effects run in different directions but may cancel each other out.

Turning to the results for control variables, it is interesting to see that inward FDI (IFDI) is positively associated with R&D (RDI). This result may be interpreted as relating to the small amount of the investment. The significant effect on R&D here suggests that the limited amount of inward FDI is actually concentrated in technology-intensive industries, thereby contributing to local R&D through technology spillover effects. The variable for export (EXPORT) is positive and significant, indicating that exports act as stimuli for investment in R&D (Coe & Helpman, 1995; Coe et al., 1997). The level of skill (SKILL) which includes the effect of tacit knowledge gained through learning and less formal means is positively related to R&D. This finding is consistent with the argument for the complementary relationship between human capital and R&D (Siler et al., 2003). SIZE is positively correlated with R&D, indicating that the larger the size of the firm, the stronger its impact on R&D is. This result lends support to the argument that innovative activity increases more than proportionately with firm size (Cohen et al., 1987; Tsai & Wang, 2005). Lastly, repeating the same result as in the last chapter, capital intensity is unexpectedly negative and significant. This is somewhat surprising and further research on this is needed.

The finding of the insignificant effect of OFDI on home R&D, however, may mask significant heterogeneity across industries with different levels of technology opportunities. The discussion in the literature review section suggests that technological opportunities may moderate the relationship between OFDI and home-country R&D. To test this hypothesis, we split the sample into two groups: 'high technology opportunity industries' and 'low technology opportunity industries' on the basis of the level of R&D intensity (R&D expenditure per employee). We label the group with low R&D intensity as 'low technology opportunities industries' and the group with high R&D intensity as 'high technology opportunity industries'. The results of estimations of equations (1) and (2) for both groups of industries are shown in Table 4.

"Table 4 goes about here"

Columns (1) and (3) show that the variable of TOFDI is not statistically significant, suggesting that the effects of OFDI do not differ between industries with different levels of technological opportunities. Put differently, the relationship between outward FDI and home R&D is not moderated by the differences in the level of technological opportunities in different industries. There are a number of reasons for this observation. It is possible that Taiwanese firms in the high technology opportunity industries do not have high absorptive capacities which are a function of prior investment in knowledge and R&D of the firm (Cohen & Levinthal, 1990, p. 128). Home country firms with low absorptive capacities are not able to fully benefit from technology-sourcing OFDI abroad. It is also possible that R&D intensity may be not an ideal measure of technological opportunities. Further research is needed to investigate how technological opportunities moderate the relationship between OFDI and home R&D.

Columns (2) and (4) show the results for different locations of the investment. The variable for outward FDI in China (OFDIC) is not significant in both groups. This indicates that the effect of OFDI in China on R&D in Taiwan is not moderated by the level of technological opportunities. This finding is consistent with our discussion in the literature review. Indeed, the result is expected because a lion's share of such investment in China is concentrated in labour-intensive industries and labour-intensive stages of high technology industries such as electronics industries (as previously noted) where technological opportunities are limited.

Perhaps the most telling result of Table 4 is that the significant positive effect of OFDI in other countries shows up in the high technology opportunity industries. This finding is consistent with our discussion in the literature review and supports the view of Kim and Kang (1996) who argue that outward FDI to countries with advanced technology may enhance technology transfer to the home country. Empirically, the finding confirms that of Egger and Pfaffermayr (2003) which finds that firms investing abroad raise their investments in R&D and in intangible assets at home. It is in line with Desai et al. (2005) who find that OFDI is associated with greater domestic R&D spending, because FDI has allowed the home MNEs to grow larger and to spend more resources on R&D than would otherwise have been possible. One explanation for this finding is that the Taiwanese investment in other countries is driven by strategic asset-seeking which transfers knowledge or technology back to Taiwan. This explanation is consistent with fact that some Taiwanese electronics and computer firms in recent years have acquired small US firms in order to get access to the advanced technology of these firms. Indeed, our finding is in line with a few existing studies analyse the interactions between external sources of knowledge and in-house R&D activities. For example, several scholars argue that the external acquisition of knowledge may stimulate rather than substitute for firms' own R&D (Arora & Gambardella, 1990; Veugelers, 1997). Cohen and Levinthal (1989, 1990) explain this relationship of complementarity in some depth, using the concept of absorptive capacity. Cohen and Levinthal concluded that in-house R&D activities not only contribute to the generation of new knowledge, but also enhance the firm's ability to assimilate and exploit knowledge generated outside the firm.

CONCLUSIONS

This paper has examined the effects of OFDI on R&D in the source country. The results show that the impact of outward FDI by Taiwanese MNEs on R&D in Taiwan is in general neutral. This study concludes that Taiwanese FDI does not significantly upgrade, harm or substitute domestic R&D in Taiwan. This research has considered the effects of OFDI in China and other countries and finds that the insignificant effect does not vary with the location of investment.

Furthermore, this study have analysed the OFDI effect in high and low technology opportunity industries separately. The results show that while OFDI in China exerts a negligible impact on R&D in Taiwan in both groups of industries, OFDI in other countries produces a significant impact on R&D in Taiwan in high technology opportunity sectors. The contrasting pattern of findings corroborates the argument that the nature of the investment by multinationals varies between different host countries, leading to different patterns of relationship between OFDI and R&D in the source country. It also illustrates that industry-specific effects have to be considered for a full understanding of the relationship between OFDI and home R&D. Although theories do not provide any clear-cut answers, the empirical analysis in this chapter pinpoints situations under which OFDI can and can not stimulate R&D in the source country.

In anchoring the findings of this study in the larger literature, some of its limitations must be acknowledged**.** First, the study can not distinguish the effect of OFDI on multinationals and non-multinationals at home. In fact, OFDI may have a positive impact on the R&D of non-multinational companies, if the setting up of a foreign affiliate boosts demand for intermediate products from suppliers located in the home country. This effect would be particularly strong when the foreign affiliate uses 'conditional buying' which forces those home companies to improve technology. Second, the use of industry level data is a limitation because it does not allow the separation of the determinants of R&D that result from a firm's specific capabilities, from those improvements that are general to the industry. The employment of firm-level data would enable us to better examine the impact of micro-level characteristics, such as ownership and size of enterprises, on R&D.

The results nevertheless carry important policy implications. The findings suggest that the Taiwanese government should distinguish the level of liberalization towards OFDI for different locations and different types of industries. In particular, the government should channel more investment towards high technology opportunity sectors Western countries. This will enhance R&D of the Taiwanese industries at home and hence the long-run competitiveness of the Taiwanese economy.

ENDNOTES

[1] One example is that the Taiwanese government still has tight control in place to restrict investment in China by high-technology Taiwanese electronics firms to prevent technology transfer to China.

[2] The fifteen industries include: (1) food, beverage, tobacco, (2) textiles, mills, (3) wearing apparel and clothing accessories, (4) wood and bamboo products, furniture, (5) pulp, paper and paper products, printing and reproduction of recorded media, (6) plastic products, and (7) non-metallic mineral products. Schumpeter Industries include: (8) leather, fur and related products, (9) chemical materials and products, petroleum and coal products, medical products, (10) rubber products, (11) basic metal products, fabricated metal products, (12) machinery and equipment, manufacturing not elsewhere classified, (13) electronic parts and components, computers, electronic products and equipment, (14) motor vehicles and parts, other transport equipment, and (15) precision, optical products, medical equipment, watches and clocks.

[3] Using the form of stock in measuring R&D would in principle be better than that of R&D flow. However, Jefferson et al. (2004) investigate the sensitivity of using a single year's R&D expenditure rather than measure of R&D stock, and they find 'the relevant elasticity is stable over flow and stock measures of R&D input'. So the use of R&D expenditure should not bias our results significantly.

TABLES

Table 1: Description of variables

Variable	Measurement	Mean	S. D.
RD	R&D expenditure	7373934	21318407
TOFDI	Total annual OFDI outflows from Taiwan to foreign countries	321494.10	612716.80
OFDIC	Annual FDI outflows from Taiwan to China	245355.30	480177.20
OFDIO	Annual FDI outflows from Taiwan to other countries	76138.83	173628.10
IFDI	Annual FDI inflows to Taiwan	141789.00	490825.60
KL	Fixed capital employed/employees	0.13	0.11
EXPORT	Value of direct exports from Taiwan	2.08E+08	4.34E+08
SKILL	Wages/employees	35423.06	7375.72
SIZE	Fixed capital employed/number of firms	4.14	5.18

Table 2: Correlation matrix of variables

	2	3	4	5	6	7	8
1.TOFDI	0.91	0.66	0.60	0.46	0.45	0.44	0.39
2.OFDIC		0.46	0.58	0.47	0.42	0.49	0.38
3.OFDIO			0.49	0.31	0.35	0.31	0.27
4.IFDI				0.45	0.44	0.47	0.41
5.KL					0.32	0.86	0.85
6.EXPORT						0.31	0.37
7.SKILL							0.70
8.SIZE							

Table 3: The impact of OFDI on R&D expenditure

Dep.Var.: RD	FE	RE	FE	RE
	(1)	(2)	(3)	(4)
C	-44.220 (-7.63)***	-26.981 (-4.84)***	-47.380 (-7.70)***	-27.792 (-4.99)**
TOFDI	0.045 (0.96)	-0.048 (-1.20)		
OFDIC			0.071 (1.34)	-0.077 (-2.03)**
OFDIO			0.002 (0.09)	-0.001 (-0.04)
IFDI	0.078 (3.25)***	0.097 (4.29)***	0.074 (3.03)***	0.104 (4.51)***
KL	-0.691 (-3.61)***	-0.312 (-1.71)*	-0.711 (-3.70)***	-0.297 (-1.64)*
EXPORT	0.670 (13.63)***	0.728 (15.10)***	0.658 (12.99)***	0.753 (16.09)***
SKILL	4.435 (7.89)***	2.549 (5.06)***	4.442 (7.93)***	2.642 (5.24)***
SIZE	0.281 (2.54)***	0.156 (1.43)	0.295 (2.64)***	0.140 (1.29)
Adjusted R^2	0.756	0.699	0.756	0.701
F value	35.727***	87.726***	34.057***	75.998***
N	225	225	225	225
Hausman test	$\chi2(6)$=62.046***		$\chi2(7)$=60.174***	

Figures in parentheses are t statistics (two-tailed tests); *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table 4: The impact of OFDI on R&D expenditure (FE model)

Dep.Var.: RD	Low technology opportunities		High technology opportunities	
	(1)	(2)	(3)	(4)
C	-17.199 (-1.818)*	-19.336 (-1.95)**	-46.681 (-4.52)***	-42.794 (-4.05)***
TOFDI	0.086 (1.30)		0.080 (1.06)	
OFDIC		0.004 (0.05)		0.043 (0.58)
OFDIO		0.021 (1.03)		0.054 (1.66)*
IFDI	0.009 (0.31)	0.009 (0.31)	0.040 (1.06)	0.023 (0.59)
KL	0.499 (1.71)*	0.481 (1.62)	-0.901 (-3.11)***	-0.854 (-2.92)***
EXPORT	0.598 (7.28)***	0.620 (7.02)***	0.725 (9.72)***	0.726 (9.50)***
SKILL	1.958 (2.41)**	2.192 (2.55)***	4.253 (4.68)***	3.906 (4.18)***
SIZE	0.118 (0.70)	0.144 (0.83)	0.261 (1.83)*	0.248 (1.71)*
Adjusted R^2	0.673	0.667	0.712	0.716
F value	11.708***	10.914	15.739	15.251
N	105	105	120	120

Figures in parentheses are t statistics (two-tailed tests); *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

References

Acs, Z.J. & Audretsch, D.B. 1990. *Innovation and small firms*, Cambridge, Mass: MIT Press.

Almeida, P. 1996. Knowledge sourcing by foreign multinationals: Patent citation analysis in the U.S. semiconductor industry, *Strategic Management Journal*, 17 (Summer Special Issue): 155-165.

Almeida, P., Song, J.Y. & Grant, R.M. 2002. Are firms superior to alliances and markets? An empirical test of cross-order knowledge building, *Organization Science*, 13(2): 147-161.

Almeida, P. & Phene, A. 2004. Subsidiaries and knowledge creation: the influence of the MNC and host country on innovation, *Strategic Management Journal*, 25(8/9): 847-864.

Almor T., Hashai N. & Hirsh S. 2006. The Product Cycle Revisited: Knowledge Intensity and Firm Internationalization, Management International Review, 46(5): 507-528.

Arndt, C., Buch, C.M. & Schnitzer, M. 2007. FDI and domestic investment: an industry-level view, Discussion Paper No. 212, Governance and the Efficiency of Economic Systems (GESY).

Arora, A., Gambardella, A. 1990. Complementarily and external linkages: the strategies of the large firms in biotechnology, *Journal of Industrial Economics*, 38, 361–37.

Bhattacharya, M. & Bloch, H. 2004. Determinants of innovation, *Small Business Economics*, 22(2): 155-162.

Bjorkamn, I., Barner – Rasmussen, W. & Li, L. 2004. Managing knowledge transfer in MNCs: the impact of headquarters control mechanisms, *Journal of International Business Studies*, 35(5): 433-455.

Buckley, P.J. & Casson, M. C. 1988. Models of the Multinational Enterprise, *Journal of International Business Studies*, 29(1): 21-44.

Borensztein, E., De Gregorio, J. & Lee, J.W. 1998. How does foreign direct investment affect economic growth? *Journal of International Economics*, 45(1): 115-135.

Brewer, T. & Young, S. 1998. *The multinational investment system and multinational enterprises*. Oxford: Oxford University Press.

Buckley, P.J. & Casson, M. C. 1976. *The future of multinational enterprise*. London: Macmillan.

Buckley, P.J., Clegg, J. & Wang, C. 2002. The impact of inward FDI on the performance of Chinese manufacturing firms, *Journal of International Business Studies*, 33(4): 637-655.

Buckley, P.J., Clegg, J. & Wang, C. 2007. Is the relationship between Inward FDI and spillover effects linear? An empirical examination of the case of China, *Journal of International Business Studies*, 38(3): 447-459.

Buckley, P.J., Wang, C. & Clegg, J. 2007. The Impact of Foreign ownership, Local Ownership and Industry Characteristics on Spillover Benefits from Foreign Direct Investment in China, *International Business Review, 16(2), 142-158.*

Cantwell, J. 1994. The relationship between international trade and international production, in Greenway, D. and Winters, L. A. (Ed), *Surveys in International Trade*: 303-328, Oxford: Blackwell

Cantwell, J. 1995. The Globalisation of Technology: What Remains of the Product Cycle Model?, Cambridge Journal of Economics, 19(1): 155-174.

Castellani, D. and Zanfei, A. 2006. *Multinational firms, innovation and productivity*, Edward Elgar.

Caves, R.E. 1974. Multinational firms, competition and productivity in host country markets, *Economica*, 41(162): 176-193.

Caves, R.E. 1982. *Multinational enterprise and economic analysis*, Cambridge: University Press.

Caves, R. 1996. *Multinational enterprises and economic analysis*, Cambridge, MA: Cambridge University.

Child, J. & Rodrigues, S.B. 2005. The Internationalization of Chinese firms: A case for theoretical extension, *Management and Organization Review*, 1(3): 381-410.

Clark, K.J. & Griliches, Z. 1984. Productivity growth and R&D at the business level: results from the PIMS data base, in Griliches, Z. (Ed.), R and D, Patents and productivity, NBER, Chicago: University of Chicago Press.

Co, C. Y. & List J.A. 2004) Is foreign direct investment attracted to knowledge creators, Applied Economics, 36(11): 1143-1149.

Coe, D.T. & Helpman, E. 1995. International R&D spillovers. *European Economic Review*, 39(5): 859-887.

Coe, D.T., Helpman, E. & Hoffmaister, A.W. 1997. North-South R&D spillovers, *Economic Journal*, 107(440): 134-149.

Cohen, W.M., Levin R.C. & Mowery, D.C. 1987. Firm size and R&D intensity: A re-examination, *Journal of Industrial Economics*, 35(4): 543-565.

Cohen, M.W. & Levinthal, D. 1989. Innovation and learning: the two faces of

R&D, *Economic Journal,* 99: 569-596.

Cohen, W.M., Levinthal, D.A. 1990. Absorptive capacity: a new perspective on learning and innovation, *Administrative Science Quarterly*, 35: 128–152.

Cohen, W.M., Goto, A., Nagata, A., Nelson, R.R. and Walsh, J.P. 2002. R&D spillovers, patents, and the incentives to innovate in Japan and the United States, *Research Policy*, 31: 1349-1367.

Das, S. 1987. Externalities and technology transfer through multinational corporations, *Journal of International Economics*, 22(1-2): 171-182.

Desai, M.A., Foley, F. & Hines Jr, R.J. 2005. Foreign direct investment and domestic economic activity. NBER Working Paper, No 11717, Cambridge: National Bureau of Economic Research.

Driffield, N. & Love, J.H. 2003 Foreign direct investment, technology sourcing and reverse spillovers, *The Manchester School*, 71(6): 659-672.

Dunning, J.H. 1977. Trade, location of economic activity and the NINE: a search for an eclectic approach , in Ohlin, B. , Hesselborn, P. O. and Wijkman, P. M. (eds), *The international allocation of economic activity*: 395-431, London: Macmillan.

Dunning, J. H. 1981. *International Production and the Multinational Enterprise*, London: Gorge Allen and Unwin.

Dunning, J.H. 1988. The eclectic paradigm of international production: a restatement and some possible extensions, *Journal of International Business Studies*, 19(1): 1-31.

Dunning, J.H. 1988. *Explaining international production*, London: Happer Collins Academic.

Dunning, J.H. 1998. *Globalization, trade, and foreign direct investment*, New York: Elsevier.

Dunning, J.H. 1993. *Multinational enterprises and the global economy*, UK: Addison-Wesley Publishing Co.

Dunning, J.H. & Narula, R. 1995. The R&D activities of foreign firms in the United States, *International Studies of Management and Organisation*, 25(1/2): 39-73.

Egger, P. and Pfaffermayr, M. 2003. The counterfactual to investing abroad: an endogenous treatment approach of foreign affiliate activity, University of Innsbruck Working Paper, No. 02.

Ethier, W. 1986. The multinational firm, *Quarterly Journal of Economics*, 101(4): 805-834.

Fors, G. 1997. Utilisation of R&D results in the home and foreign plants of multinationals, *Journal of Industrial Economics*, 45(3): 341-358.

Fosfuri, A. & Motta, M. 1999. Multinational without advantages, *Scandinavian Journal of Economics*, 101(4): 617-630.

Frost, T.S. 2001. The geographic sources of foreign subsidiaries innovations, *Strategic Management Journal*, 22(2): 101-123.

Frost, T., Birkinshaw, J.M., & Ensign, S. 2002. Centres of excellence in multinational corporations, *Strategic Management Journal*, 23(11): 997-1018.

Globerman, S. 1979 Foreign direct investment and ‘spillover’ efficiency benefits in Canadian manufacturing industries, *Canadian Journal of Economics*, 12(1): 42-56.

Görg, H. & Greenaway, D. 2002. Do domestic firms really benefit from foreign Direct investment? CEPR Discussion Paper No. 3485, London: Centre for Economic Policy Research.

Griffiths,W. & Webster, E. 2004. The Determinants of Research and Development and Intellectual Property Usage among Australian Companies, 1989 to 2002, Melbourne Institute Working Paper No. 27/04, Melbourne Institute of Applied Economic and Social Research, Melbourne: The University of Melbourne.

Gupta, A. & Govidarajan, V. 2000. Knowledge flows within multinational corporations, *Strategic Management Journal*. 21(4): 473-496.

Hausman, J. 1978. Specification tests in econometrics, *Econometrica*, 46(6): 1251-1271.

Hobday, M., 1995. *Innovation in East Asia: The Challenge to Japa*n, Vermont:

Edward Elgar.

Hu, A.G.Z., Gary, H.J. & Jinchang, Q. 2005. R&D and technology transfer: firm-level evidence from Chinese Industry, *The review of economics and statistics*, 87(4): 780-786.

Hymer, S. 1976, originally written in 1960. The International Operations of National

Firms: a Study of Foreign Direct Investment, Ph.D. dissertation, Massachusetts Institute of Technology: MIT Press.

Kim, J.D. & Kang, I.S. 1996. Outward FDI and exports: the case of South Korea and Japan, *Journal of Asian Economics*, 8(1): 39-50.

Klevorick, A.K., Levin, R.C., Nelson, R.R. & Winter, S.G. 1995. On the sources and significance of interindustry differences in technological opportunities, *Research Policy*, 24 (2): 185-205.

Kokko, A. 1996. Productivity spillovers from competition between local firms and foreign affiliates, *Journal of International Development*, 8(4): 517-530.

Konings, J. & Murphy, P.A. 2006. Do multinational enterprises relocate employment to low-wage regions? Evidence from European multinationals, *Review of World Economics*, 142(2): 267-286.

Kuemmerle, W. 1997. Building effective R&D capabilities abroad, *Harvard Business School*, 75(2): 61-70.

Kuemmerle, W. 1999. The drivers of foreign direct investment into research and development: an empirical investigation, *Journal of International Business Studies*, 30(1): 1-24.

Kugler, M. 2006. Spillovers from foreign direct investment: within or between industries?, *Journal of Development Economics*, 88(2): 444-477.

Kumar, N. & Aggarwal, A. 2005. Liberalization, outward orientation and in house R&D activity of multinational and local firms: a quantitative exploration for Indian manufacturing, *Research Policy*, 34(4): 441-460.

Kumar, N., Saqib, M. 1996. Firm size, opportunities for adaptation, and in-house R&D activity in developing countries: the case of Indian manufacturing, *Research Policy*, 25 (5): 712–722.

Lecraw, D.J. 1993. Outward direct investment by Indonesian firms: motivation and effects, Journal of International Business studies, 24(3): 589-600.

Lichtenberg, F. & Siegel, D. 1991. The impact of R&D investment on Productivity-New evidence using linked R&D-LRD data, *Economic Inquiry*, 29(2): 203.

Lipsey, R.E. 2002. Home and host country effects of FDI, NBER Working Paper No. 9293, National Bureau of Economic Research, Cambridge, Mass.

Liu, X., Siler, P., Wang, C. & Wei, Y. 2000. Productivity spillovers from foreign direct investment: evidence from UK industry level panel data, *Journal of International Business Studies*, 31(3): 407-425.

Luo, Y. 2000. Dynamic capabilities in international expansion, *Journal of World Business*, 35(4): 355-378.

MacGarvie, M. 2006. Do firms learn from international trade? Review of *Economics and Statistics*, 88(1): 46-60.

Makino, S., Lau, C.M. & Yeh, R.S. 2002. Asset-exploitation versus asset-seeking: implications for location choice of foreign direct investment from newly industrialized economies, *Journal of International Business Studies*, 33(3): 403-421.

Markusen, J.R. 1995. The boundaries of multinational enterprises and the theory of international trade, *Journal of Economic Perspectives*, 9(2): 169-189.

Mathews, J.A. 2006. Dragon multinationals: New players in 21st century globalisation, *Asia Pacific Journal of Management*, 23(1): 5-27.

Nelson, R., Wolff, E. 1997. Factors behind cross-industry differences in technical progress, *Structural Change and Economic Dynamics*, 8(2): 115-123.

Pain, N. 2000. The impact of inward investment on the UK economy, Paper presented at HM Treasury seminar on economic growth and government policy, London.

Pearce, R.& Papanastassiou, M. 1999. Overseas R&D and the strategic evolution of MNEs: Evidence from laboratories in the UK, Research Policy, Vol. 28, pp. 23-41.

Patel, P. & Vega, M, 1999. Patterns of Internationalisation of Corporate Technology: Location vs. Home Country Advantages, Research Policy, 28(2/3), 145-155.

Poon, J.P.H. & MacPherson, A. 2005. Technology acquisition among Korean and Taiawnese firms in the United States, *International Business Review*, 14(5): 559-575.

Porter, M.E. 1990. *The competitive advantage of nations*. Detroit: Free Press.

Rugman, A.M. 1986. New Theories of the Multinational Enterprise: An Assessment of Internalization Theory, Bulletin of Economic Research, 38(2), 101-119.

Scherer, F.M. 1984. *Innovation and Growth. Schumpeterian Perspectives. Cambridge*, Mass: MIT Press.

Schumpeter, J. 1942. *Capitalism, Socialism, and Democracy*, New York: Harper and Row.

Seo, S.J. & Suh, S.C. 2006. An analysis of home country trade effects of outward foreign direct investment, *ASEAN Economics Bulletin*, 23(2): 160-70.

Shan, W. & Song, J. 1997. Foreign direct investment and the sourcing of technological advantage: evidence from the biotechnology industry, *Journal of International Business Studies*, 28(2): 267-284.

Siler, P., Wang, C. & Liu, X. 2003. Technology transfer within multinational enterprises: panel data evidence from US subsidiaries in Scotland, *Regional Studies*, 37(1): 15-25.

Singh, A. 1977. UK industry and the world economy: a case of deindustrialization? *Cambridge Journal of Economics*, 1(2): 113-136.

Singh, J. 2004, Multinational firms and knowledge diffusion: evidence using patent citation data, INSEAD Working Paper 2004-75.

Song, J.& Shin, J. 2008. The paradox of technological capabilities: a study of knowledge sourcing from host countries of overseas R&D operations, *Journal of International Business Studies*, 39(2): 291-303.

Teece, D. 1977. Technology Transfer by Multinational Corporations: The Resource Cost of Transferring Technological Know-how, Economic Journal, 87(346), 242-261.

Teece, D.J. 1992. Competition, corporation, and innovation: organizational arrangements of regimes of rapid technological progress, *Journal of Economic Behaviour and Organization*, 18(1):1-25.

Thirlwall, A.P. & Hussain, M.N. 1982. The balance of payments constraint, capital flows and growth rate differences between developing countries, *Oxford Economic Papers*, 34(3): 498-509.

Tsai, K.H. & Wang, J.C. 2005. Does R&D performance decline with firm size?—A re-examination in terms of elasticity, *Research Policy*, 34(6): 966-976.

Van Pottelsberghe de la Potterie, B. & Lichtenberg, F. 2001. Does foreign direct investment transfer technology across borders? *Review of Economics and Statistics*, 83(3): 490–497.

Vernon, R. 1966. International investment and international trade in the product cycle, *The Quarterly Journal of Economics*, 80(2): 190-207.

Veugelers, R. 1997 Internal R&D expenditures and external technology sourcing, *Research Policy*, 26(3): 303-315.

Wang, C & Yu, L. 2007. Do Spillover benefits grow with rising foreign direct investment? An empirical examination of the case of China, *Applied Economics*, 39(3): 397-405.

Wang, C., Buckley, J. P., Clegg, J. & Kafouros, M. 2007. The impact of foreign direct investment on Chinese export performance, *Transnational Corporations*, 16(2): 119-136.

Wang, J. & Tsai, K. 2003. Productivity growth and R&D expenditure in Taiwan's manufacturing firms, NBER Working Paper 9724.

Young, S. & Lan, P. 1997 Technology transfer to China through foreign direct investment, *Regional Studies* 31(7): 669-679.

Zhao, H. & Luo, Y. 2005. Antecedents of knowledge sharing with peer subsidiaries in other countries: a perspective from subsidiary managers in a foreign merging market, *Management International Review*, 45(1): 71-97.