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B. Sadowski & C. van Beers

Eindhoven Centre for Innovation Studies, The Netherlands

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Bert M. Sadowski*
Economics of Innovation and Technological Change
University of Technology Eindhoven
PO Box 513
5600 MB Eindhoven
The Netherlands
Tel.: 0031-(0)40-2472640
Fax.: 0031-(0)40-2474646
E-mail: b.m.sadowski@tm.tue.nl

Cees van Beers
Delft University of Technology,
Department Economics of Innovation,
Jaffalaan 5,
2628 BX Delft,
The Netherlands
E-mail : C.P.vanBeers@tbm.tudelft.nl

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* Corresponding author

Abstract

Although multinational companies (MNCs) have increasingly become active in diversifying their technological activities internationally, these activities have rarely been examined with respect to the innovation performance of their affiliates. As foreign affiliates seem to foster innovative activities in host countries, the kind of innovation produced in these firms has hardly been studied. In this context, the paper examines the innovation performance of foreign affiliates with respect to the introduction of 'real' innovations, i.e. products that are new to the market (in contrast to 'imitative' innovations, those products that are new to the firm). It employs firm-level panel data consisting of a data set of 10,664 firms from the Community Innovation Survey (CIS-2) data in the Netherlands for the years 1994 to 1996. The estimation results support the hypothesis that foreign affiliates positively effect innovative activities in host countries. Our results suggest furthermore that the innovative activities of foreign affiliates are oriented towards producing imitative innovations.

1.   Introduction

As the generation of new technologies has to a large extent been dominated by multinational corporations (MNCs),[1] foreign affiliates are considered as being of crucial importance in fostering indigenous technological activities in host countries. Within a growing tendency of MNCs to locate research and development (R&D) abroad, most facilities are concentrated in a few, mostly highly industrialized countries (UNCTAD, 2000, UNCTAD, 2001). In the Netherlands, for example, 64 percent of all foreign affiliates undertake own R&D activities. Based on these activities, they contribute a large amount of value added to the innovativeness of the national economy as a recent governmental report concluded (Ministry of Economic Affairs, 2001). It seems, however, that these companies rarely contribute to the development of product innovations in the host country (Beers, Braber, Hoen, Moor, & Poppelaars, 1999). The more general question is therefore to what extent has technology transfer within MNCs effected the innovation performance of its affiliates. As the Netherlands belongs to the top receiving countries of foreign direct investment (FDI) in the world (UNCTAD, 2001), the trends analyzed might have some application to other developed countries and are relevant for managers as well as policy-makers.

The organization of technology transfer along location decisions about the centralization or decentralization of R&D activity is a complex issue. The theoretical

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[1] As the focus of the paper is on foreign affiliates, we consider them as part of a multinational enterprises (MNCs). MNCs are defined as companies that control and manage production establishments - plants - in at least two countries Caves, R. 1996. *Multinational Enterprises and Economic Analysis*. Cambridge: CUP. For a further discussion on the different forms of MNCs see Ghoshal, S. & C. Bartlett. 1998. *Managing Across Borders*. London: Random House.
Rugman, A. & A. Verbeke. 1998. Multinational Enterprises and Public Policy. *Journal of International Business Studies*, 29(1): 115-36.

literature, drawing on earlier versions of the product life cycle, considers the centralized location of R&D as a necessity to achieve economies of scale in the R&D function and to diffuse technology through transfer to a firm or affiliate (in another location). R&D in foreign affiliates is performed to facilitate the effective implementation of less profitable stages of the product cycle (Cantwell & Janne, 1999). But as some recent evidence has shown the international flow of technology has not only been one-directional, i.e. running from creation (in one location), through transfer to a firm or affiliate (in another location), to diffusion to a wider variety of firms in the host country. In contrast, it has been proposed that MNC, embedded in ongoing firm-internal changes in the organization of their technological activity, locate a growing proportion of their technological capabilities outside the country of origin. These affiliates might even tap into the local field of expertise in their innovative activities in order to utilize this expertise internationally (Cantwell, 1995, Cantwell & Janne, 1999, Pearce & Papanastassiou, 1999). Decentralization decisions of R&D activity therefore directly effect the extent to which affiliates are able to pursue particular technological activities such as adapting technology to local conditions, imitating innovations developed elsewhere in the firm, or even develop product innovations that are entirely new to the firm.

The innovation performance of foreign affiliates has not been well explored in the theoretical literature and the empirical evidence remains to a large extent anecdotical. In focusing on this relationship, the paper employs firm-level panel data from the Community Innovation Survey (CIS-2) in the Netherlands consisting of a data set of 10,664 firms between 1994 to 1996. The innovation performance is measured based on a firm's assessment in a postal survey of new product introductions. In the survey,

managers are asked to subdivide their product range into products that, during the last three years,

- remained essentially unchanged,

- underwent incremental change or

- were subject to radical change or were entirely new introduced.

The responses allowed us to introduce distinctions between 'real' innovations that are 'new to the market' and imitative innovations that are "new to the firm" (Beers & Sadowski, 2002, Kleinknecht, van Montfort, & Brouwer, 2002). In contrast to previous studies in the area focusing on R&D expenditures (Florida, 1997, Fors, 1997, Kokko & Blomström, 1995, Pearce & Papanastassiou, 1999) or on patent data of foreign affiliates (Cantwell & Piscitello, 2000, Zander, 1999), our indicator allows us to directly measure the contribution of technology transfer to innovation (Beers & Sadowski, 2002, Kleinknecht, van Montfort, & Brouwer, 2002). As the focus of the paper is on innovative output of foreign affiliates, we have to defer a discussion of issues of international technology spillovers to domestic firms to further studies (For a recent discussion see (Blomström & Kokko, 2001, Blomström & Kokko, 1998, van Pottelsberghe & Lichtenberg, 2001)). In the following, the paper indents to, firstly, utilize important variables in the relationship between innovation and firm, industry and market characteristics before it, secondly, examines the effects of foreign affiliates on innovation performance.

The paper is organized as follows: In the first section, the theoretical literature on the issue of innovation performance of foreign affiliates is briefly reviewed. We link here to the discussion of multinational enterprises and technology. In section three, four and

five of the paper, the data, the empirical models and the estimation results are presented respectively. Summary and conclusions are presented in section VI.

2.   Literature and hypotheses

The innovation process consists of a complex sequence of decisions aimed at improving innovative output which is closely linked to the competitive advantage of a company (Tidd, Bessant, & Pavitt, 2001). There are differences in the management of the innovation process depending on the degree of novelty of the innovative output. 'True' innovations (i.e. products that have not previously been introduced in the market) represent a higher degree of novelty compared to imitations (i.e. products that are already known to the firms in the market) (Beers & Sadowski, 2002, Kleinknecht, van Montfort, & Brouwer, 2002, Tidd, Bessant, & Pavitt, 2001). The development of 'true' innovations imposes a high risk and greater chance of failure for management compared to imitations which have already been introduced and tested in the market.

The theoretical discussion on the innovation performance of companies has been at the heart of research in the Schumpeterian tradition. There has been an extensive literature on the relationship between innovation and different industry-, firm- and innovation specific variables dating back to the original work by Schumpeter (1912, 1942) (For a review see (Cohen & Levin, 1989). As we are focusing on a particular set of variables in this relationship, we briefly discuss the relevant literature in the area.

2.1. Innovation and firm size

The relationship between firm size and innovation has been a classical research topic in the Schumpeterian tradition. Schumpeter posed the question to the extent to which there are qualitative differences between the innovative activities of small, entrepreneurial enterprises and those of large modern corporations with own R&D laboratories (Schumpeter, 1942). Within the empirical literature, his claim for a large firm advantage in innovation was interpreted as proposition that innovative activity increases more than proportionally than firm size (Cohen, 1995). Although the empirical results have been mixed, they seem to suggest that there is a positive relationship between innovativeness of companies and firm size, however this relationship is not necessarily linear (Cohen & Levin, 1989, Kamien & Schwartz, 1982). In recent nation-wide surveys on innovation, there has been some evidence that size has been in important variable in explaining innovative behavior (Brouwer & Kleinknecht, 1999, Evangelista, Perani, Rapiti, & Archibugi, 1997, Veugelers & Cassiman, 1999).

2.2. Innovation and industry characteristics

It seems commonly accepted that industry/technology characteristics have been important variables in determining innovative behavior of companies. As there have been no clear cut theoretical relationships between particular industry characteristics and innovation, the empirical results have remained ambiguous (Bozeman & Link, 1983). Therefore most studies have included industry dummies to control for industrial sectors and particular technology characteristics such as appropriability conditions. A widely used taxonomy (Archibugi, 2001) has been introduced by Pavitt (1984) who characterizes industrial

sectors according to the main sources and directions of technological accumulation as well as main channels of imitation. Based on certain industry and technology characteristics, he distinguishes between supplier dominated, scale-intensive, information-intensive, science-based and specialized supplier industries (Pavitt, 1984). Several studies have demonstrated that this taxonomy explains rather well the innovative behavior of manufacturing firms (Arundel & Kabla, 1998, Brouwer & Kleinknecht, 1999, Evangelista, Perani, Rapiti, & Archibugi, 1997).

Other important industry dimensions have been related to the scope of the future demand, i.e. the classical hypothesis raised by Schmookler. Therefore not only the size and growth of the market matters, but also the willingness to pay for new or improve products (Schmookler, 1962).

2.3. Innovation and export performance

Modern trade theory has raised the hypothesis that innovation activities (mostly proxied by R&D expenditure or patent counts) are closely linked to export performance (Dosi, Pavitt, & Soete, 1990, Siebert, 1991). However, the empirical evidence in favor of this hypothesis has been far from clear-cut. This has been due to deficient innovation data as well as innovation performance indicators used (Brouwer & Kleinknecht, 1993). The majority of firm-level studies on innovation and export performance has utilized R&D intensity as a measure of innovation (e.g Lefebvre, Lefebvre, & Bourgault, 1998). In utilizing additional innovation variables such as number of produced innovations Wakelin (1998) found differences in the export performance of innovating and non-innovating firms since the former were, on average, more export oriented (Wakelin,

1998). Therefore it has been proposed that export-intensity has been a major factor in explaining the innovative performance of companies (Beers & Sadowski, 2002) because export-intensive firms have been more exposed to international competition, therefore are more inclined to innovate than firms that oriented towards domestic markets.

2.4 Innovation and internationalization of MNCs

MNC have an advantage in undertaking innovative activities in host countries because they can easily transfer technology to their affiliates at lower costs than domestically owned companies (Reis, 2001). Increasing internationalization of MNCs has not only influenced the transmission and diffusion of technology but also the generation of technology in their affiliates (Cantwell & Santangelo, 1999). There has been some agreement in the literature that multinational corporations have since the 1990s followed a trend towards technological diversification (Archibugi & Michie, 1995, Cantwell, 1995, Florida, 1997, Zander, 1997). However, opinions among researchers differ about the extent to which MNC have utilized these diversified capabilities to undertake innovative activities. Some studies, in particular in the 1970s, have concluded that most foreign affiliates were engaged in the adaptation of products to meet the particular needs of local markets (Mansfield, Teece, & Romero, 1979). Similar studies undertaken in the 1980s and 1990s have indicated that there have been some changes in foreign-owned enterprises, i.e. that these affiliates increasingly acquired more advanced technology capabilities (Cantwell & Santangelo, 1999, Florida, 1997). For this purpose, multinational companies transfer R&D personnel and build up R&D facilities in their

affiliates. This lead to a situation in which affiliates might even take responsibility for product development in selected fields of technology (Pearce & Papanastassiou, 1999, Zander, 1997).

3   The Data

The data used in the present study originate from the Community Innovation Survey (CIS) for the Netherlands in 1994-1996. This is a questionnaire that covers the period 1994-1996 (CIS-2) with the aim to analyze the determinants of firms' innovation behavior.

The survey was undertaken amongst companies in the Netherlands with 10 or more employees. It provides e.g. data on R&D activities of companies, their innovations in the past two years and their expenditure on product and service innovations (Brouwer & Kleinknecht, 1999). A total of 10664 companies responded to the survey. Out of these, 831 companies reported that they had foreign headquarters. As the Table 1 shows, these companies with a foreign headquarters seem to have been more innovative, in particular in the area of technological innovations compared to their domestic counterparts. From all foreign companies in industry, 65.7 percent produced imitative innovations (new to the firm) and 42.6 percent introduced product innovations (new to the market). For the all companies in the survey, these percentages were 42.6 and 10.7 respectively. In the service sector, similar trends can be observed.

INSERT TABLE 1 ABOUT HERE

The choice of the sample has been related to the fact that foreign direct investment in the Netherlands in the period 1994-1996 has been rather extensive due to institutional as well as market environment that fostered FDI (Hoesel & Narula, 1999). FDI in the Netherlands was growing by 34.9 per cent on an annual basis between 1995 and 2000 to a record high of $ 55011 million in 2000. As a result, the Netherlands was at the sixth place as a receiving country of FDI outpacing countries such as France and Sweden (UNCTAD, 2001).

4   The Empirical Model

In order to examine to what extent have foreign affiliates been undertaken a decision to produce innovation an empirical model has been formulated. The dependent variable is a measure of innovation activity. It is a yes/no answer to the question: Did your firm sell products and/or use processes that were technologically new or improved during 1994-1996? Therefore the dependent variable has a binary character, which allows formulating of the following probit model:[2]

(1) $\text{Probit (INN)} = \beta_0 + \beta_1 SIZ + \beta_2 MG + \beta_3 EXP + \beta_4 NEW + \beta_5 FOR + \beta_6 IND + \beta_7 SUPD + \beta_8 SCB + \beta_9 SPSUP$

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[2] For the econometric background of probit estimation procedures: see Maddala (2001).

The application of a probit model allows us to estimate the probability that a company innovates conditional on a number of independent variables. This kind of models has frequently been used in empirical studies of innovation behavior (Kleinknecht & Brouwer, 1999, Veugelers & Cassiman, 1999).

The main interest of the present study is how the independent variable for foreign affiliates (FOR) effect the dependent variable (INN) controlling for other variables in the model. The dependent variable (INN) distinguishes between products and/or processes that are *new to the firm* as a proxy for all innovations including imitations, and those that are *new to the market* which is a proxy for innovations excluding imitations (so-called 'real' innovations). The independent variables include size (SIZ), market growth (MG), export intensity (EXP), domestic (independent) company (IND), newly established firm (NEW) and different dummy variables of industry specific characteristics (SUPD, SCB, SPSUB).[3]

The first independent variable (SIZ) is a proxy for the size of the firm. It is expected that a larger firm has more funds available to implement research and development, which will increase, in turn, the probability to generate innovations. The independent variable EXP characterizes the export-intensity of the company. Export-intensive firms are more exposed to international competition than firms than are oriented towards domestic markets. Hence it is expected that export-intensive firms are more involved in processes of innovation than those that do not export. However, less export intensive firms tend to interpret *new to the market* more generously, than larger and internationally operating firms do. As a result we expect for EXP a positive sign if the

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[3] For a more detailed description of the variables see Appendix 1.

dependent variable is *new for the firm* and a negative or insignificant sign if it is *new for the market.*

For the independent variable MG (market growth) we expect similar signs for the independent variables. Variables SUPD, SCB, and SPSUP measure the relationship between industry characteristics and innovation performance. As described by Pavitt (1984), in supplier dominated sectors (SUPD) such as textiles the innovation process is closely following a linear logic from invention (in the basic research stage mostly at R&D laboratories) to market innovation. Science-based sectors (SCB) are heavily dependent on knowledge, skills and techniques from academic research. Examples of typical science-based core sectors are chemicals and electronics. We postulate a positive effect of SCB on the dependent variable. The variable SPSUP consists of firms in the specialized supplier sectors. These are generally small and provide high performance inputs into complex production systems. Examples of typical specialized supplier core sectors are machinery, instruments and software. Technological advances take place incrementally. It is expected that the sign to be positive (Pavitt, 1984).[4]

The central variables of the analysis are the variables FOR and IND. For variable FOR a positive sign is expected. Similarly a positive sign is expected for the variable IND. The variables and their expected signs are summarized in Table 2.

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[4] Pavitt (1984) also defines a supplier-dominated category (SUPD). These firms' technical change come from suppliers of their inputs. Textiles, lumber, wood and paper products are examples. For econometric reasons this category has been left out. Its effect is captured by the constant term.

INSERT TABLE 2 ABOUT HERE

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5   The Estimation Results

Due to some missing observations in some of the independent variables specified in the empirical model, 4947 observations remained valid for the use. Based on the responses in dataset which have been by innovating as well as non-innovating firms, we were able to discriminate between innovators and non-innovators. Therefore we could use a Probit model where the dependent variable is one when the firm claims to innovate (based on a specified positive innovation budget). We added some (standard) explanatory variables such as firm size (SIZ), market growth (MG) and export performance (EXP) as well as industry dummies capturing the scope for innovation opportunities in the particular industrial sector. As can be seen in Table 3, the two observed models have a high joint explanatory power of the independent variables as indicated by the high Chi-squared in the model.   If all possible industrial sectors are included (science based –SCB, specialized suppliers - SPC and scale intensive - SCA), the model fit actually improved.

The coefficient in Table 3 are the estimated partial derivatives of probabilities with respect to the vector of characteristics. They are computed at the means of the independent variables. The coefficient reflects how much the probability that the firm innovates increases with an increase in the particular independent variable, holding the other independent variables constant. The signs of most of the coefficients are as

expected. The variables for company size (SIZ), export intensity (EXP) and market growth (MG) have been positive and significant. Similar positive and significant results can be reported for the industry dummies for science based (SCB), specialized supplier (SPC) and scale intensive (SCA) industries. We found a negative sign for new established firms (NEW) in model 1 and for the specialized supplier industries (SUP) in both models.

However and more interestingly, we could verify our hypotheses that foreign affiliates have a high probability to innovate. In model 2, the variable FOR is as expected positive and highly significant. Surprisingly we did not find a positive relationship between domestically owned companies (denoted by IND) and innovation. Our estimates indicate a strong and significant negative relationship.

In Table 4, we present two models that show the estimates for the probability that particular firm characteristics effect the likelihood for introducing 'real' innovations (new to the market). From the 4947 observations in the original sample, 1845 observations could be used. Both models are significant, and some variables show (the expected) similar signs (SIZ, EXP, SUP) as in model 1 and 2, despite only the variables for size (SIZ) and specialized supplier industries (SUP) has been highly significant. The variables for domestically-owned firm (IND) and newly established company (NEW) are positive but insignificant. Interestingly the variables for foreign affiliate (FOR), as it is still positive, becomes insignificant.

The results indicate that foreign affiliates in the Netherlands seem to innovate more than domestic firms but this innovative performance is primarily based on imitations, in particular, the application of innovations developed elsewhere to local conditions.

6.   Summary and Conclusions

As our analysis has demonstrated foreign affiliates have been very active in innovative activities in the Netherlands. This is in line with the current literature on multinationality and technology. However, as the data have shown this innovative activities seems to be targeted primarily at the production of 'imitative' innovations in host countries. This trend would support arguments in the literature that have related the international technological expansion of multinational companies to more 'simple' tasks in the innovation process such as local adaptation of technologies. Therefore the more value added activities in innovation such as basic research activities are still undertaken at headquarters in the home country. More worrying for domestically owned companies is, however, that they seem hardly involved in innovation process.

In the case of the Netherlands, a high developed country, this might have serious repercussions for the development and specialization of the national economy. A national industrial policy based on the 'foreign-direct-investment-as-market-discipline' might be not appropriate to foster the inflow of technology and to promote innovative activities in the national economy. As competitive pressure surely is an important element in these policies that can force multinational companies to transfer advanced technologies to host countries, it should be accompanied by measures to facilitate the innovative capabilities of domestically owned companies. Otherwise, the 'crowding out' effects could even force domestically owned companies out of the national markets in the medium to long term.

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Appendix 1. Variables used in the model

Variable	Description	Measurement
INN	Propensity to innovate	Binary Variable = 1 if firm innovates in 1994-1996 = 0 if firm does not innovate in 1994-1996;
SIZ	Firm size	Log (employment in numbers of employees) in 1994
MG	Market growth	Sales growth between 1994 - 1996
EXP	Export	Share of export in turnover in 1994
FOR	Foreign affiliate	Binary variable
NEW	Newly established firm	Binary variable newly established firms between 1994 and 1996
IND	Domestically-owned company	Binary variable
SCB	Science-based sector	Binary variable firm belongs to the science-based sector according to Pavitt's taxonomy (1984)
SCA	Scale-intensive sector	Binary variable firm belongs to the scale intensive sector according to Pavitt's taxonomy (1984)
SPSUP	Specialized supplier sector	Binary variable firm belongs to the specialized supplier sector according to Pavitt's taxonomy (1984)
SUPD	Supplier dominated sector	Binary variable firm belongs to the supplier dominated sector according to Pavitt's taxonomy (1984)

Table 1 Foreign owned companies and innovative activities

	Total number of companies	Companies introducing innovations New to the firm (in %)	Companies introducing innovations New to the market (in %)
Foreign companies in the Netherlands			
Industrial sectors	425	344 (80.9)	181 (42.6)
Service sectors	393	49 (12.5)	N.A.
Others	13	8 (61.5)	2 (15.4)
Total	831	546 (65.7)	183 (22.0)
All companies	3299	2096 (63.5)	993 (30.1)
Industrial sectors	5648	1997 (35.4)	N.A.
Service sectors	1717	449	145
Total	10664	4542 (42.6)	1138 (10.7)

Table 2. The independent variables of the model and their theoretical signs

Variables	P(innovation)	P(innovation)	
	General	New to the firm	New to the market
SIZ	+	+	+
EXP	+	+	0/–
MG	+	+	+
SCB	+	+	+
SUPD	+	+	+
SCA	+	+	+
SPSUP	-	-	-
NEW	-	-	-
IND	+	+	0
FOR	+	+	+

Table 3: **'Imitative innovations' (new to the firm) and foreign affiliates: Probit estimations 1994 – 1996.**

Regression	1	2
Variables		
Constant	- 0.5795***	-0.6174***
	(0.0908)	(0.0802)
SIZ	0.2633***	0.2507***
	(0.0193)	(0.0195)
EXP	0.4620***	0.4241***
	(0.0688)	(0.0695)
MG	0.0078*	0.0076*
	(0.0135)	(0.0133)
SUP	-0.7797***	-0.7790***
	(0.0403)	(0.0404)
NEW	-0.3239**	-0.3220**
	(0.1641)	(0.1633)
IND	- 0.0774**	
	(0.0454)	
FOR		0.2431**
		(0.1633)
Observations	4947	4947
Chi Square	729.97***	729.37***

Note: *** = significant at 1 %; ** = significant at 5 %; * = significant at 10%. Standard errors are in parentheses. The estimates are robust maximum-likelihood probit estimates.

Table 4:   **'Real innovations' (new to the market) and foreign affiliates:**
            Probit estimations 1994 – 1996.

Regression	3	4
Variables		
Constant		
SIZ	0.1835***	0.1798***
	(0.0291)	(0.0293)
EXP	0.0672	0.0396
	(0.1076)	(0.1096)
MG	-0.0003	0.0006
	(0.0563)	(0.0562)
SUP	-0.4056***	-0.4050***
	(0.0662)	(0.0662)
NEW	0.1114	0.1161
	(0.2962)	(0.2967)
IND	0.0608	
	(0.0715)	
		0.0192
FOR		(0.0830)
Observations	1845	1845
Chi Square	99.70***	99.51***

Note: *** = significant at 1 %; ** = significant at 5 %; * = significant at 10%. Standard errors are in parentheses. The estimates are robust maximum-likelihood probit estimates.

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