INTERNATIONALISATION OF INNOVATIVE ACTIVITIES IN FINNISH MULTINATIONAL ENTERPRISES

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Abstract

Current discourse suggests that Multinational Enterprises (MNEs) are evolving into global creators of technology, sourcing skills and knowledge from disparate locations. Against this framework, US patent data covering the period 1976- 1995is employed to examine the internationalisation of innovative activity in 30 large Finnish multinational companies. Two aspects are explored: 1-.innovation in foreign subsidiaries, and 2- cross-border communications in innovation ("cross-fertilisation"). Both aspects of internationalisation are shown to have increased in absolute and relative between 1976 and 1995. The growth that was observable coincided with the major international expansion period of Finnish firms. It also appears that domestic and foreign innovation activities have not increased at a similar pace. Few Finnish firms rely on purely domestic innovation, and many of them have a number of active foreign R&D units, which communicate with the home base.

1. Introduction

As an economy Finland is making rapid strides in gaining world class technological capabilities. A recent United Nations study attests to the rapid pace of technological advancement in Finland. Thus the 2001 *Human Development Report* (UNIDO, 2001) ranks Finland first in terms of *Technology Achievement Index.* a composite measure of economy wide technological development *(* the USA is ranked 2nd and Sweden third). Finnish firms, like their counterparts elsewhere have responded to pressures from the global techno-economic environment by internationalising their operations in general, and becoming more innovative in particular. Internationalisation of firm activities is both a further testimony to growing organisational and technological capabilities (Porter 2000) and also may be vehicle for further development of these capabilities .This paper aims to investigate the internalisation of innovative activities in Finish multinational companies- to our knowledge no previous study has tackled this issue. More specifically we are interested in answering the following questions:

1. How significant is innovation activity in the foreign subsidiaries of Finnish MNEs?
2. To what extent have foreign units contributed to innovation in the home base research units of those MNEs?

This research is the first of its kind to cover the manifestations of Finnish corporate innovation activity abroad utilising long time series of patent data. The remainder of the paper is structured as follows. Section II reviews the existing theoretical and empirical literature relevant to the topic and formulates hypotheses on that basis. SectionIII explains the methodology, focusing on the utilisation of patent data. Section IV discusses the findings in relation to the test hypotheses Section V concludes the paper.

2. Literature Survey

2.1 Theoretical Approaches: From Transfer to Creation

Theoretical developments concerning innovation activity in firms have, in very general terms, focused either on the importance of the home base environments for firms' capacity to innovate (e.g. Porter 1991, 1998, 2000; Vernon 1966, 1979), or on the specific role of the MNE as a creator and transmitter of knowledge and innovation across borders (e.g. Buckley and Casson 1976; Kogut and Zander 1993). Together they imply that innovation takes, or can take place both in MNE home bases and their foreign subsidiaries, and neither operates in isolation: there are also intra-firm flows of knowledge between them.

Vernon (1966) was among the first to try to explain why certain functions of the firm are moved abroad. His seminal paper discusses innovation and its determinants in the context of corporate internationalisation, albeit only with regard to "certain kinds of products, namely to those associated with high income and those which substitute capital for labour" (193). Limitations of communication inherent in long geographical distances imply in his reasoning that an entrepreneur is best endowed to innovate in the home market. In case of the above-mentioned products, markets with higher average incomes would provide the impetus for innovation, as there is demand for both labour-saving processes as well as products "responsive to wants at high levels of income" (192). This Product Life Cycle model suggests that production outside the home market would be feasible for mature, standardised products. Innovation in Vernon's paper, however, takes place only in the United States, since it had in the 1960s the highest per capita income in the world. Thus the MNE essentially transfers knowledge to subsidiaries, having already created it in the home base.

However, already in the 1970s it began to appear that Vernon's (1966) view of innovation in MNEs was too narrow. Terpstra (1977), for instance, recognises the importance of "tapping personnel who have sophisticated research talent and specialised product skills" (27), the possibility of "a greater and more varied flow of new ideas and products" (28), as well as the need for greater sensitivity to local markets. This has later become known as the dual nature of international innovation activity: firms not only need to be more effective but also be able to satisfy diverse tastes and needs (Räsänen 1999, 49).

In a later paper, Vernon (1979) indeed acknowledges that many developed market economies, such as France and Germany, have converged with the US in terms of per capita income and technological sophistication, and can indeed stimulate innovation. Vernon mentions the "global scanner" MNE, which seeks to gather innovation inputs and stimuli outside its home base as well. However, in Vernon's (1979, 262) view "the hypothetical global scanner, of course, is not to be found in the real world. The acquisition of information is seldom altogether costless; and the digestion and interpretation of information always entails costs." He indeed finishes his 1979 paper by defending his original notion that innovation depends on home country income, market size and factor cost patterns. In practice, he still sees very little chance of MNEs innovating outside their respective home bases.

Empirical evidence aside, Vernon (1979) overestimates the costs of knowledge transfer, and fails to see the various mechanisms as to how it could be facilitated. This is probably because Vernon's focus is on particular industries, and not on the MNE as an organisation. Indeed, since then many of the centralising forces on R&D assumed in the Vernonian discourse, such as economies of scale, communication and coordination problems and concerns of knowledge security have declined (Pearce 1999b).

Porter (1991, 1998, and 2000) largely agrees with Vernon (1966, 1979) on the importance of a firm's home base for innovation. He defines the key to a firm's success as "competitive advantage", which is virtually analogous to its capacity to innovate, and is embedded in the firm's environment. Firms gain advantage over rivals "because they perceive a new basis for competing, or find new and better means to compete in old ways" (Porter 1998, 578). Through innovation, firms thus "have considerable latitude in both influencing their environment and responding to it" (Porter 1991, 111). While in his original "diamond" model of competitive advantage the environment was essentially a national one, Porter has later come to admit that selective tapping of competitive advantages of foreign nations is increasingly important. Nevertheless, firms should not abandon their home base (Porter 2000, 238).

However, the above-mentioned views tend to ignore the essential nature of the late 20th century techno-economic environment. That is, "high technology is, first and foremost, a child of R&D and an expression of the 'natural' tendency of all things to

become even more complex" (Braun and Polt 1988, 213). Thus, with the increasing technological content of many products, the association between the globalisation of production and R&D activities has grown stronger, and at the same time cross-border mergers and alliances have brought more R&D capacity within the domain of MNEs. When required technologies are not found at home, the location of R&D activities is increasingly guided by supply criteria, or where to find the necessary expertise and personnel (Howells 1997, 20).

Consequently, later theories have increasingly emphasised the importance of knowledge creation within MNEs. That is: subsidiaries as well can have a prominent role in innovation activities, beyond the adoption and adaptation of new technologies. The MNE is seen to constitute a network of "creative subsidiaries" (e.g. Pearce 1999) located in diverse "centres of excellence" (Cantwell 1995a). In their most advanced form, these approaches can be considered as evolutionary theories, for according to them "the technology of firms and locations is in a process of constant and cumulative change" (Cantwell 1989, 186). This theme is perhaps taken furthest by Kogut and Zander (1993), who see the MNE as a social community crossing national borders, which creates knowledge in its dispersed units and transfers it to other units for diffusion and recombination with other knowledge. Such knowledge is never produced by one individual but a community that interacts and debates. Therefore, the border between knowledge creation and transfer becomes porous.

The process of intra-firm communication in innovation that crosses national borders is often referred to as "international cross-fertilisation of innovation." In other words, several R&D units located in different countries contribute to the creation of one innovation. Such activity was first hypothesised by Vernon (1979), and the term "cross-fertilisation" has now been established to describe it (e.g. Sölvell and Zander 1995; Zander 1998). Today, there is a general agreement that "technological knowledge is inherently embodied in human capital" (Davenport and Bibby 1999, 442). As Sölvell and Zander (1995, 23) point out, much of advanced and specialised knowledge tends to be tacit and is not necessarily communicable via centralised computer databases and the like. Tapping such knowledge from different environments is thus very difficult without cross-border personal interaction.

International cross-fertilisation of innovation could take place in three forms. First, engineers and scientists can travel between geographically dispersed research units. The more tacit knowledge is, the greater need there is for face-to-face contact, and the role of such key personnel becomes even more important (Subramaniam and Venkatraman 2001, 363; Teece 1996, 196). Second, R&D personnel can exchange information and discuss problems without leaving their local units with the help of modern communication technology. This is equivalent to what Paoli and Guercini (1997, 6) call "internationalisation without movement", or that "many research institutions are deeply involved in the phenomenon of internationalisation, even though they may be located in only one country." Third, MNEs could also engage transfer non-commercialised projects between units, ship around of research projects in order to find the unit best fit to develop and commercialise it, and share technological knowledge amongst such units (Zander 1998). This could be also labelled "internationalisation without movement" in Paoli and Guercini's (1997, 6) terms.

2.2 Empirical Evidence

2.2.1 Innovation in Foreign R&D Units

The establishment of R&D units in foreign subsidiaries started at least several decades ago, and this aspect of the internationalisation of innovation activities has received the greatest attention from scholars (e.g. Belderbos 2001; Cantwell 1995a, b; Cantwell and Kotecha 1997; Patel 1995; Patel and Pavitt 1991; Pearce and Papanastassiou 1999a, b). The results of these studies suggest that innovation activity in overseas subsidiaries only began to grow rapidly in the late 1980s and early 1990s. As for qualitative change, it also appears that many R&D units now have a strategic role, which suggests that MNEs are giving more importance to internationally dispersed innovation activity, including the development of new products overseas.

It is also evident that MNEs originating in smaller countries have the greatest tendency to source technologies globally. Much of this strain of literature is based on empirical research on Swedish MNEs (Håkanson and Zander 1988; Håkanson and Nobel

1993; Zander 1999). Similar tendencies are also observable in case of MNEs from the Netherlands (e.g. Cantwell and Janne 2000). This is generally because firstly, in small economies increasing economic openness forces domestic companies to specialise and be more innovative. Firms can compete either with innovative products, or they must keep costs down by improving their process technology, or by creating process innovations (Johnson 1988, 291-292). Second, small countries usually have a smaller resource base. There is usually less money and weaker incentives to invest in R&D, and the number of qualified personnel available within the country is usually lower (Cantwell and Janne 1999, 125).

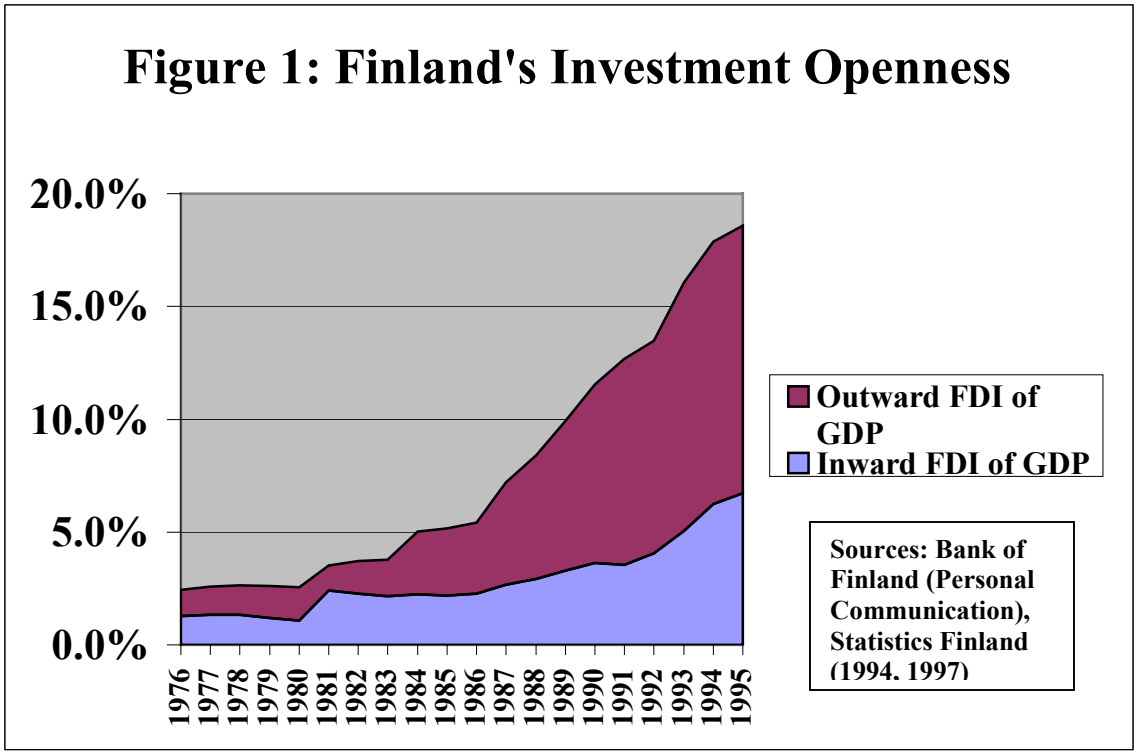
Nevertheless, the Vernonian notion of innovations emanating from the most advanced countries still appears to have validity, not only in terms of domestic but also of foreign innovation activity as well. For instance, Cantwell (1995b) and Meyer-Krahmer and Reger (1999) claim that innovation in overseas subsidiaries is heavily "Triadised", or concentrated in worldwide centres of excellence in Europe, Japan, and the US. The US appears to be the primary host to international innovation activities. This is evident from US patent data (Patel and Vega 1999), R&D expenditure (Dunning and Narula 1995; Serapio and Dalton 1999), and the number of foreign-owned laboratories (Serapio and Dalton 1999; Walsh 1997).

In case of Finnish companies, the main internationalisation push of their operations started in the mid-1980s. Figure 1 shows how the value of Finnish FDI in relation to the country's Gross Domestic Product (GDP) has increased rapidly during the past two decades. The increasing innovativeness of Finnish firms, particularly those in the information and communications technology sector, has been given considerable attention in the popular and trade press in recent years (Asian Review of Business and Technology 1998; Colvin 16.8.1999; Economist 23.1.1999, 9.10.1999; Financial Times 7.9.2000; Klee and Bensko 24.5.1999; Lyytinen and Goodman 1999; Morais 27.12.1999; Wagner 1999). However, not much academic research on the subject has yet appeared. Broad, cross-sectoral empirical studies of the innovativeness of Finnish firms are scarce: the information available has usually appeared as part of broader studies of innovation.

For instance, Archibugi and Michie (1995, 123) show that the growth of patents granted to Finnish inventors abroad increased from 5.7% between 1970 and 1980 to

13.2% between 1980 and 1990. Patel (1995) provides data on the US patenting activities of seven large (though unnamed) Finnish firms 1985-1990. It is shown that 18% of the innovative activity of those companies was undertaken abroad.

Within the country, the state body Statistics Finland has been collecting data on the innovation activities of Finnish companies in frequent surveys, and they have been used as empirical evidence in a number of works. Åkerblom (1994) discovered that 24% of R&D expenditure was accounted for by overseas subsidiaries in 1992. Koskinen (1999) examines the results of a follow-up study to the one described by Åkerblom (1994), concentrating on the changes in the landscape of Finnish companies' international R&D 1993-1998. During that time the share foreign units out of the total R&D expenditures of Finnish companies rose slightly to 26%. Koskinen (1999) notes that the period 1987-1992 witnessed the rapid internationalisation of the innovation activity of major Finnish companies, as the share of overseas R&D expenditure rose from 15% to 29%.



2.2.2 Intra-Firm Communication in International Innovation

Literature reviewed earlier suggests that in many cases, R&D units wherever located do not innovate in isolation. Yet intra-firm cooperation in innovation has attracted less research effort (it is recalled that Vernon [1979] dismissed it as purely hypothetical). One of the first efforts to empirically establish the occurrence of international intra-firm communication as a part of innovation process is found in Ghoshal and Bartlett (1988), although in a very limited fashion only. There, intra-firm communication was found to be of importance only in the later stages of adoption and diffusion of innovations (Ghoshal and Bartlett 1988, 385).

Most of the later evidence is found in the literature concerned with the configuration of innovation activity. Themes discussed include the roles of R&D units, beneficiaries of the output of their work, and their communication with the rest of the

organisation: here, the focus is on whether these units create new products and to what extent such innovation activity is enhanced by intra-firm cooperation. Bartlett and Ghoshal (1990), Ghoshal and Bartlett (1988), Medcof (1997), Dunning and Narula (1995), and Pearce and Papanastassiou (1999a,b) all mention cases where local R&D units create innovations for local and global use and participate in joint projects at the MNE level.

Knowledge of intra-firm cooperation in innovation in Finnish companies is scarce, as any empirical evidence on that subject. Survey-based evidence in Åkerblom (1994) and Koskinen (1999) shows that up to 40% of Finnish corporate R&D units communicate cooperate with other parts of the firm but it is not mentioned how much of this actually crosses international borders.

2.3 Hypotheses

It has been shown in the existing literature that sourcing knowledge globally and recombining it across borders is getting increasingly common in MNEs. From this, two hypotheses are formulated. The first one relates to the geographic dispersal of innovation activity:

1. The importance of R&D units abroad ("creative subsidiaries") in the innovative activity of Finnish MNEs is expected to have increased, relative to R&D units in Finland, during 1976-1995.

The great need to combine dispersed knowledge in the contemporary environment firms face means that R&D units isolated from each other may not be effective enough. Thus, intra-firm communication in innovation activity has become increasingly important as well:

2. The relative importance of international cross-fertilisation of innovation in Finnish MNEs is expected to have increased during 1976-1995.

The examination of these hypotheses should bring more light into the issue of the internationalisation of corporate innovation activity in Finnish MNEs in general. In particular, more information of the patterns and dynamics of cross-fertilisation should emerge, the study of which has been especially urged by Zander and Sölvell (2000, 55).

3. Research Methodology

This study uses US patents as a proxy for innovation activity. Patel and Pavitt (1991) specify three dimensions associated with this type of methodology. First, they point out that patents specifically measure technology creation, or innovation in its "purest" form. Second, there are great variations in the propensity to patent amongst countries, reflecting differing costs and benefits of such protection. Therefore, it is best to use data from one single patent authority for greater comparability. Using US patent data also creates a high degree of generalisability, as the United States Patent and Trademark Office (USPTO) has tended to receive the largest number of foreign applications out of all national patent offices, at least as far as the period 1976-1995 is concerned. Third, the interpretation of time trends also creates a potential problem, meaning that the ownership of subsidiaries can change over time. Here, this problem was eliminated by combining patent data with specific information on selected 30 Finnish companies' foreign holdings at the beginning of four five-year periods (1976-1980, 1981-1985, 1986-1990, 1991-1995), as published in annual reports and other company literature. Following the OECD definition, a company located outside Finland was considered a Finnish subsidiary if a Finnish company owned at least 51% of it.

With the names of subsidiaries of Finnish MNEs known (both in Finland and abroad), their patent data was gathered from the USPTO online database (http://www.uspto.gov/patft/index.html). At this stage, only the location of the assignee (the company to whom the patent was granted) mattered: no attention was paid to the domicile of inventors. Then, the share of foreign patenting out of their total innovation activity during the four five-year periods was calculated. In order to test the first

hypothesis, independent sample t-tests were run on three pairs of data (shares of foreign patenting in the 30 MNEs 1976-1980 and 1981-1985; 1981-1985 and 1986-1990; and 1986-1990 and 1991-1995) in order to establish the significance of differences between time periods. In addition, the same test was run on the pair 1976-1980 and 1991-1995 in order to establish the statistical significance of change during the entire period under study.

Apart from the location of the innovating firm or subsidiary, US patent database also displays the places of residence of inventors associated with a particular invention. Thus, the patents issued to parent firms or subsidiaries in Finland were scrutinised for inventors residing outside Finland. If any of the inventors resided abroad, it was taken as evidence of international cross-fertilisation of innovation as described earlier. This method thus covers cross-fertilisation regardless of whether the project "travelled", whether the inventors travelled, or merely communicated from their local R&D units. This appears to be a novel method indeed, as no other study in our knowledge has utilised patent data in this fashion.

The shares of cross-fertilised patents out of all patents issued to the 30 MNEs in Finland were calculated. In order to test the second hypothesis, independent sample t-tests were run on three pairs of data (shares of foreign patenting in the 30 MNEs 1976-1980 and 1981-1985; 1981-1985 and 1986-1990; and 1986-1990 and 1991-1995) in order to establish the significance of differences between time periods. In addition, the same test was run on the pairs 1976-1980 and 1991-1995 in order to establish the statistical significance of change during the entire period under study, as was done with foreign R&D unit data.

4. Results

A summary of results appears in Table 1. They are discussed in greater detail below.

Table 1: US Patents Granted to the 30 Finnish MNEs Home and Abroad, 1976-1995

Years	Number of all patents granted to the 30 MNEs in Finland	Number of all patents granted to the 30 MNEs abroad	Share of all patents granted to the 30 MNEs abroad	All patents granted to the 30 MNEs	Number of patents granted to the 30 MNEs in Finland involving cross-fertilisation of innovation	Share of patents granted to the 30 MNEs in Finland involving international cross-fertilisation of innovation
1991-1995	1467	417	22.1%	1884	245	16.7%
1986-1990	926	169	15.4%	1095	115	12.4%
1981-1985	543	23	4.1%	566	34	6.3%
1976-1980	345	20	5.5%	365	13	3.8%
Total	***3281***	***629***	***19.2%***	***3910***	***407***	***12.4%***

Source: USPTO Online Database (http://www.uspto.gov/patft/index.html)

4.1 Innovation in Foreign R&D Units

Recalling the first hypothesis, it was expected that shares of patents granted to locations abroad show an increase 1976-1995 for the sample of 30 Finnish MNEs. Thus, the null hypothesis is:

$$H_0 : \mu \leq 0$$

It is reminded that μ constitutes here the assumed difference in the shares of foreign innovations between 1976-1980 and 1981-1985, 1981-1985 and 1986-1990, 1986-1990 and 1991-1995; and 1976-1980 and 1991-1995. As the share of foreign innovations is expected to rise, one-tail tests are run. Thus, the alternative hypothesis is:

$$H_1 : \mu > 0$$

The t-tests were run on the shares of foreign patenting weighted according to each firm's share of the total number of patents granted to Finland and abroad. The results of the t-tests appear in Table 2. In all cases except between 1976-1980 and 1981-1985 the share of foreign patenting has increased, but that growth was statistically significant only between 1981-1985 and 1986-1990, as well as during the entire period (between 1976-1980 and 1991-1995). Between 1976-1980 the share of foreign innovation in fact decreased (as is evident from the negative t-value). However, Table 1 reveals that the absolute number of patents granted to foreign location increased from 20 to 23 during those years. What made their share to decrease was the more rapid growth of innovation activity in Finland. Thus, the alternative hypothesis can be only partially supported.

Table 2: T-Test Results for Creative Subsidiaries

1976-1980 and 1981-1985	*1981-1985 and 1986-1990*	*1986-1990 and 1991-1995*	*1976-1980 and 1991-1995*
-0.56510940	1.90975043**	0.75840903	2.38225516**

**Significant at 5% level

In percentage, the shares of patents granted to foreign subsidiaries rose from mere 5.5% in 1976-1980 to 22.1% in 1991-1995 (Table 1). Overall, this trend corresponds fairly closely to what is known of other late internationalisers such as French firms (Cantwell and Kotecha 1997) and to survey-based figures of overseas innovation activity by Finnish MNEs (Åkerblom 1994). As for small country firms such as Swedish MNEs, their foreign innovation activity appears to have grown about as fast, but owing to their higher initial levels of overseas R&D, they were considerably more internationalised than Finnish MNEs in this respect as well (Zander 1999). As for previous studies utilising US patents (Archibugi and Michie 1995; Patel 1995), the results obtained in this research show slightly lower levels of innovation in foreign subsidiaries but it must be remembered that the "Finnish-ness" of patents is defined differently here (others have used the place of residence of the innovator in order to define the "nationality" of an innovation).

4.2 International Cross-Fertilisation of Innovation

The number of US patents granted to Finland and involving international cross-fertilisation in innovation (Table 1) was very low until the mid-1980: 13 in 1976-1980 and 34 in 1981-1985. Thereafter, a dramatic increase is witnessed: 1986-1990 there were 115 US patents granted to Finland involving international cross-fertilisation of innovation, and 245 in 1991-1995.

Recalling the second hypothesis, it was expected that shares of patents granted to Finland and involving international cross-fertilisation of innovation show an increase as during 1976-1995 for the sample of the 30 Finnish MNEs. Thus, the null hypothesis is:

$$H_0 : \mu \leq 0$$

Again, μ constitutes the assumed difference in the shares of cross-fertilised innovations between 1976-1980 and 1981-1985, 1981-1985 and 1986-1990, 1986-1990 and 1991-1995; and 1976-1980 and 1991-1995. As the share of cross-fertilisation is expected to rise, one-tail tests are run. Thus, the alternative hypothesis is:

$$H_1 : \mu > 0$$

The t-tests were run on the shares of foreign patenting weighted according to each firm's share of the total number of patents granted to. The results of the t-tests appear in Table 3. The increase in the shares of cross-fertilised patents observed is not statistically significant, except for the whole period under study (cross-fertilisation between 1976-1980). Thus, only partial support can be given to the alternative hypothesis.

Table 3: T-Test Results for International Cross-Fertilisation of Innovation

1976-1980 and 1981-1985	*1981-1985 and 1986-1990*	*1986-1990 and 1991-1995*	*1976-1980 and 1991-1995*
0.85332194	1.18993213	0.52919516	1.88190080**

**Significant at 5% level

In percentage, the share of international cross-fertilisation of innovation has grown from 3.8% in 1976-1980 to 16.7% in 1991-1995 (Table 1). Thus, while cross-fertilisation does not appear as common as the overseas innovation described in the

previous section (apart from the period 1981-1985 when it was in fact more prominent), it has nevertheless grown more steadily than the latter.

5. Conclusions

5.1 Innovation in Foreign R&D Units

International innovation activity in Finnish MNEs, as defined in this paper, increased 1976-1996. The number of US patents granted the foreign subsidiaries of Finnish MNEs grew between those years, although not always very fast. During the first ten years of the period of study innovation in foreign subsidiaries increased slower than that in Finland, and thus the former's share in fact fell, although not to a statistically significant degree. The most prominent period of growth for this type of innovation activity, both in absolute and relative terms, was between 1981-1985 and 1986-1990, which coincides with a major expansion of the overseas operations of Finnish MNEs in general (measured in the growth of outward FDI stocks). Towards the end of the period of study, innovation in foreign subsidiaries continued to increase, but not to a statistically significant degree. In 1991-1995 Finnish MNEs undertook 22.1% of their innovation activity in their foreign subsidiaries, as opposed to 5.5% in 1976-1980.

Thus, hypothesis 1 is partially supported.

Nevertheless, this growth trend is not dissimilar to that of other small countries and late internationalisers. From a theoretical point of view, it appears that the development of innovation activity in overseas subsidiaries has not followed a gradual, evolutionary process as described by Hewitt (1980) and Dunning and Narula (1995). This suggests that late internationalisers must engage in various types of overseas activities concurrently in order to catch up with the rest. With limited resources of usually smaller-than-average MNEs, it may not be possible to increase foreign R&D in line with other operations or domestic innovation activity, even if it were desirable. However, to establish this more convincingly, one would have to look at FDI at the individual firm

level, which was beyond the scope of this study. On the other hand, the concurrent increase of US patents granted to locations outside Finland and the growth of FDI can also be seen as supporting the views that many MNEs end up with the possession of foreign R&D units when they acquire a firm abroad for other reasons (Gassmann and von Zedtwitz 1999, 233; de Meyer and Mizushima 1989, 135; Räsänen 1999).

5.2 International Cross-Fertilisation of Innovation

International cross-fertilisation of innovation grew as well, both with regard to the number and share of innovations involving it, but only in the overall period 1975-1995 was the increase statistically significant. While in 1976-1980 3.8% of US patents granted to the Finnish MNEs in Finland involved cross-fertilisation, the figure had risen to 16.7% in 1991-1995. It appears that the growth of cross-fertilisation has been somewhat more linear that that of innovation in creative subsidiaries abroad.

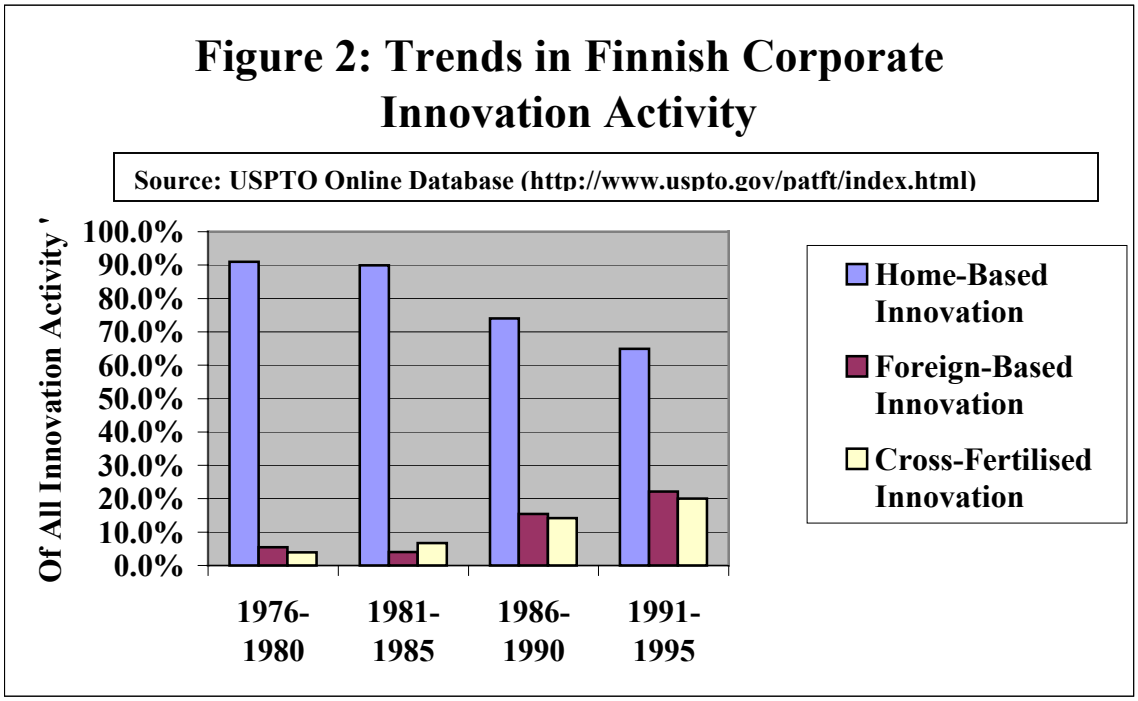
Thus, hypothesis 2 is partially supported.

This was also true for those MNEs who had creative subsidiaries abroad: only the increase between 1976-1980 and 1991-1995 was statistically significant. Thus, while international cross-fertilisation of innovation appears to be a reality also among those MNEs, which have an extensive network of R&D units, this has been a long-term process. Despite weak statistical support, one can nevertheless postulate that Finnish MNEs have sought a certain degree of integration in their corporate innovation activity from an early stage. As the numbers of innovations abroad rose simultaneously, it appears that Finnish MNEs have been quite successful in tackling the management challenge of integrating new R&D units into the corporate innovation system. This appears to give some support to the views of Buckley and Casson (1976) and Kogut and Zander (1993): increased cross-fertilisation can be taken as evidence of the increased significance of the MNE's role as a vehicle for the international creation and transfer of knowledge. The slower growth of cross-fertilisation in the 1990s, then, could be taken as

evidence of firms reaching the optimal configuration of an integrated cross-border R&D network. However, firm conclusions of this matter are still too early to bring forward.

This dissertation has also demonstrated a hitherto undiscovered way of utilising patent data. On the basis of reasoning, the study of international cross-fertilisation of innovation appears not only possible but also effective with US patents, as this methodology is able to capture those instances of intra-firm communication and cooperation, which specifically contribute to innovation.

Figure 2: Trends in Finnish Corporate Innovation Activity



5.3 Issues for Further Research

The methodology utilised here for the study of international cross-fertilisation of innovation must be put into further use. In other words, more patent data from MNEs from different countries need to be examined for this in order to establish whether such distinctive temporal patterns as this dissertation argues exist elsewhere as well. More precise sectoral patent data (by patent classes) can be combined in this type of research as well to establish any industry-specific patterns in cross-fertilisation.

Second, many of Finland's prominent innovators were acquired by foreign firms in the 1990s. As of late 2000, no more than one third of the value of the Helsinki Stock Exchange was under Finnish control (Alkio and Möttölä 8.1.2001). Nokia, for instance, is now mostly owned by international institutional investors (Steinbock 2001, 89). The question to ask would be: what kind of impact does the acquisition of an R&D unit by foreigners have on its performance? Such units are usually one part of the firm, and as has happened before, that firm can have been acquired for other reasons. Thus, what exactly happens after the acquisition could be studied using US patent data as well, with due consideration of the appropriate time lags.

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