Workpackage 6

Role of Multinational Enterprises for Information on R&D

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Preface

This report is the third and final deliverable of the workpackage 6 (WP 6, Role of multinationals for information on R&D) of the KEI-project (Knowledge Economy Indicators: Development of Innovative and Reliable Indicator Systems). KEI is part of the Policy Orientated Research section of the specific programme Integrating and Strengthening the European Research Area in the context of the Sixth Framework Programme of the European Commission.

In this report, the work done and all experiences achieved during the course of the workpackage are pulled together. Besides a state-of-the-art review on the existing literature on studies in globalisation of R&D and results of testing various approaches in practice, different ways of producing indicators and foundation for further work in efforts of measuring the scale and scope of cross-border R&D are presented in this report.

Chapters 1–3.1, 4 and 6 were written by Mikael Åkerblom, chapters 3.2 and 5 by Tero Luhtala.

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Chapter 1

Introduction

Globalisation is a key word characterising many processes in modern economy. It is of course not a new phenomenon, but the development of the knowledge economy has given it a more significant role as one if its key elements. Globalisation is currently not very well covered by official statistics mainly related to activities carried out by national actors within national boundaries. The development of quantitative indicators to increase our understanding of globalisation has started, however. Work package 6 within the KEI project looks at globalisation from the point of view of improving the measurement of the R&D of multinational enterprises (MNEs).

National indicators on R&D efforts such as the common benchmark indicator R&D expenditures/GDP are partly distorted by the worldwide R&D activities of multinational companies. Some MNEs have difficulties in properly splitting up their R&D resources between various countries, which affects the reliability of existing statistics and indicators. R&D flows within a company are difficult to trace. Strategic choices of multinationals where to locate their R&D activities is not directly dependent on any policy choices on the national level. MNEs try to locate their R&D where the conditions are the best. In some countries R&D activities in the business enterprise sector are more or less dominated by MNEs (either as parent companies or subsidiaries). This may largely influence the possibilities of countries to reach the 3 per cent Barcelona target. The current available information on the role of multinationals in R&D activities is rather fragmented.

The aim of work package 6 of KEI has been to develop and test new indicators on the role of multinational companies for R&D in order to estimate their effects on national R&D statistics. Both R&D performed abroad by companies from reporting countries and R&D performed in reporting countries by subsidiaries of foreign companies are relevant. There are several issues to be tackled. The work package has addressed the problems in splitting global R&D resources of MNEs between various countries. A proper identification of multinationals, their parents and affiliates is very important. The main research topic, however, has been to develop and improve indicators on outward R&D (R&D in foreign affiliates of domestic companies) and inward R&D (R&D in affiliates of foreign companies), which could be produced on a regular level.

This work package has as far as possible followed the recommendations in the OECD Globalisation Manual (OECD, 2005b), which presents the conceptual and methodological

framework for gathering quantitative information and constructing globalisation indicators, including the internationalisation of R&D activities of multinational enterprises. The indicators were expected to be mainly derived from analyses of existing R&D survey data on the enterprise level, but other sources like special surveys or companies own reporting were also used as far as possible.

This is the final report of the work package. It is based on two previous reports, of which the former was completed in autumn 2005 and the latter in spring 2006.

The first report D6.1 was a review of what is known on the topic. Two main issues were reviewed in it. The first one covered country experiences so far on measuring internationalisation of R&D based on a selective review of the literature and interviews. The second issue was a presentation of some sources for further work, such as the OECD Globalisation Manual and a new EU database with company level information on R&D (the EU R&D Investment Scoreboard).

The aim of the second report D6.2 was to go deeper into various methodological issues. Available methodological options were introduced and pros and cons with various approaches were discussed. The results of testing various approaches were presented and finally some preliminary conclusions were drawn on how to proceed in the future.

The work has been performed in close co-operation with four countries: Germany, the Netherlands, Poland and Sweden from which experience and opinions have been collected in particular for use in the formulation of recommendations. Sweden, Poland and the Netherlands have also participated in the testing activities. The results of the KEI workshop arranged by Statistics Finland in March 2006 in Helsinki have also been utilised in this report.

Chapter 2

Policy issues and measurement needs

The most recent policy debate has clearly demonstrated the need for improved indicators on R&D in multinationals. The information is needed both by those responsible for designing public policy actions, those making research about the economic effects on globalisation and the multinationals themselves trying to benchmark their companies against competitors. The aim of the short discussion below is to put the discussion on the development of indicators later into a certain policy context and not to give any comprehensive policy review. The discussion of these policy issues is therefore of course far from being exhaustive.

According to a note prepared by Prof. Reinhilde Veugelers for commissioner Potocnik's expert group on knowledge for growth, "the rising internationalisation of R&D has caused concern among policy makers of both net recipient and net source countries. Governments of *net recipient countries* on the one hand actively compete to attract foreign firms, but at the same time fear that foreign-owned firms may act as 'Trojan horses' since they may milk the national technology and production base while keeping the core of their innovative activities in their home countries. Countries that are *net sources* of foreign R&D investment are worried that the internationalisation of R&D may relocate ('hollow out') the domestic knowledge base to abroad."(Veugelers, 2005).

The policy measures with respect to R&D globalisation can be divided into three groups:

- policies towards attracting R&D units from abroad
- government measures to link domestic firms to knowledge from abroad
- policies towards the mobility of human resources

Policies of attracting R&D units from abroad relate to measures aimed at strengthening the scientific and technological capabilities of a country and non-discrimination of foreign firms compared with domestic enterprises. Technology programs in a country may serve as platforms for attracting international experts and foreign firms.

Measures to link domestic firms to knowledge from abroad may include financial support for R&D abroad. This has up to now been rather seldom used. Various measures of

promoting international and national networking are more common as well as giving services for establishing international contacts.

There are a lot of policies aimed at stimulating import of foreign talent. These relate to releasing barriers to immigration, income taxation, accreditation of foreign qualification, improving legislation on S&T and lessening cultural and structural barriers.

Several indicators, both traditional as well as new ones focused specifically on globalisation issues are needed to monitor progress in these policy fields. Indicators of relevance for monitoring these policy fields are among other general statistics on foreign direct investments, indicators on the qualification structure of the population and the mobility of qualified personnel. The basic questions on which countries are net recipients of foreign R&D and which countries are net sources of foreign R&D are not enough illuminated by statistics and most of this report is devoted to a discussion of the possibilities on improving indicators on these issues.

Chapter 3

Current Knowledge about R&D internationalisation

This chapter first reviews what kind of internationally comparable information of a more statistical nature is available on the internationalisation of R&D. Then experiences from special studies and other sources for some selected countries are presented as a state-of-arts glance.

3.1 Statistical information about the internationalisation of R&D

Inward R&D (R&D by affiliates of foreign companies) is nowadays fairly well covered by OECD statistics. Data on R&D expenditures of foreign affiliates is collected as part of the OECD effort to measure globalisation through the role of multinationals. To fill up the information needs, which were put forward in the Globalisation Manual, the main proposed indicators were then presented in the OECD Economic Globalisation Indicators (OECD, 2005a) for the purpose of measuring the scope and magnitude of the globalisation process through its main vectors like the internationalisation of technology. Data on the activity of foreign affiliates are based on the concept of controlling interest (over 50% of shares with voting rights on a company's board of management).

The OECD surveys, which cover the activities of foreign affiliates in OECD countries and of national firms abroad (AFA[1] database) show that in 2002 R&D performed abroad and by foreign affiliates represented on average well over 16 per cent of total expenditure on industrial R&D in the OECD area. Foreign affiliates account for a growing share of R&D in the manufacturing sector, ranging from less than 5 per cent in Japan to over 70 per cent in Hungary and Ireland. At over 40 per cent, the share of R&D conducted by

[1]AFA: The Activities of Foreign Affiliates database presents detailed data on the performance of foreign affiliates in the manufacturing industry of OECD countries (inward and outward investment). The data indicate the importance of foreign affiliates in the economies of host countries, particularly e.g. in R&D. AFA contains 18 variables broken down by country of origin and by industrial sector (based on ISIC Rev. 3) for 18 OECD countries.

foreign affiliates is also high in the Czech Republic, Spain, Portugal and Sweden. R&D investments by foreign affiliates are highly sector-specific, with the ICT, chemicals (incl. pharmaceuticals) and transport sectors accounting for the vast majority (OECD, 2004, OECD, 2005c).

A considerable portion of the R&D performed by foreign affiliates remains in the OECD area. R&D internationalisation remains mainly an intra-Triad phenomenon with mostly USA and EU the major locations for foreign R&D while EU and US firms have the largest shares of foreign R&D. During the last decade MNEs especially from small European countries have increased their foreign R&D activities and more recently the trend toward internationalisation has become more truly global when the emerging markets are currently attracting also an increasing share of overseas R&D outlays by MNEs.

In almost all countries, foreign affiliates have a lower R&D intensity than domestic firms do. However, in Hungary and Ireland, foreign affiliates carry out relatively more R&D than national firms. In many OECD countries, the share of foreign affiliates in R&D is smaller then their share in manufacturing production, like in the US, France and the UK. Hence R&D activities are still less internationalised than production, which suggests that most research still remains at corporate headquarters.

Only a few countries regularly produce survey based data on outward R&D. The possibilities for international comparisons are very scarce, as only a few countries are included in the statistics. There are, however, examples of various approaches to collect information, which are described more in detail in the next section.

A kind of proxy measure for outward R&D is the use of patents. As firms relocate research facilities abroad, an increasing share of technology is owned by firms of another country than the inventor‘s country of residence. In both the mid- and late 1990s, an average of 14 per cent of all inventions in any OECD country were owned or co-owned by a foreign resident. Foreign ownership of domestic inventions is high in many small economies, as well as in Canada and the United Kingdom, where US companies own a large share of inventions. Japan and Korea are much less internationalised in this respect. Some of the studies using patents as indicators are described in more detail below.

3.2 Other information from various special studies

In this section we present information on the globalisation of R&D from studies in various countries. Overall this gives a rather fragmented picture and possibilities for comparisons are quite limited.

3.2.1 General remarks on character of R&D units in subsidiaries abroad

Multinational companies are creating R&D networks in their key markets around the world to leverage their global reach. The establishment of MNEs' R&D activities abroad (in both inward and outward investments) follows the setting up of production units.

R&D laboratories may either be created out of nothing, like greenfield investments, or obtained through a merger/acquisition, or laboratories transferred abroad (relocation) as part of the restructuring of the R&D activities of a group of companies (Hatzichronoglou (2005)).

Recent studies (Florida, 1997; Kuemmerle, 1999; Pajarinen and Ylä-Anttila (eds.), 1999; Pearce and Singh, 1992)[2] confirm that both demand (close to local markets) and supply (access to human capital and technological expertise) related motives are important, but that the latter have been on the rise. Although technology sourcing motives are becoming a major force for setting-up R&D abroad, both demand and supply related motives remain heavily intertwined. The innovating performance of the R&D laboratories shows that these sites are not mere 'listening posts' but are dedicated to the creation of new scientific and technological knowledge. Although acquisition of a foreign laboratory could be a shortcut for getting access to localised knowledge, Kuemmerle found that greenfield investment is the dominant form of entry both for the case of HBA ('home-base augmenting'; technology-oriented activities) and HBE ('home-base exploiting'; market oriented-activities) sites.

Empirical literature has also started using patent citation information to trace technology transfers from local sources to foreign subsidiaries. A higher than expected level of citations in patents by foreign subsidiaries to sources in the host market is suggestive of technology sourcing motives for foreign R&D.

Internationalisation of R&D is nowadays not only due to the expansion of MNEs' production operations abroad, but also to the dynamics and constraints of innovation based competition. Sachwald (2005) provided a typology of R&D centres abroad and discussed the specific factors of attraction of the three types, which are local development centre /HBE, global R&D laboratory /HBA(HBE) and global rationalisation unit. Large local market (size, purchasing power) accompanied by quality of education is determinant in local development centre. Centres of excellence, quality of research-industry relations and to some extent also leading market are decisive in setting up global laboratories. For global rationalisation units it is important to obtain good cost/efficiency for R&D activities.

Empirical evidence on the role of subsidiaries in MNE innovative strategies relies on survey-based analyses. Although 44 per cent of the 296 sample subsidiaries in a study by Pearce and Singh (1992) report that they predominantly function as internationally interdependent labs, on average 60 per cent regularly worked to adapt to local markets, 70 per cent developed new products for local markets, while 45 per cent developed new products also used in other markets. The study on Finnish MNEs (Koskinen, 1999) reported foreign-based units having become more integrated into the R&D strategy of the group, rather than being separate units without many contacts to other R&D units of the group. In 1997, 46 per cent of the major companies' R&D units located abroad were support units focused on giving support to local production and marketing. 41 per cent were development units for technology localisation and selective development with R&D focused on the whole business division or its line of business and 13 per cent were global R&D centres serving the whole group.

[2]Studies cited in Background Report. OECD and Belgian Science Policy (2005).

3.2.2 A review of the literature on R&D internationalisation

R&D expenditures (and patent data) have been used in documenting the growing internationalisation of R&D activities by MNEs. Other empirical studies, based on surveys and case studies, have investigated into more detail companies' motivations in carrying out R&D abroad. Often a combination of sources has been used. Studies focusing on the topical issue of globalisation of business enterprise R&D activities have been many in recent years.

This section presents a brief survey of the relevant empirical literature for our study of R&D activities by MNEs. Publicly available data from various international sources are brought together for the basis of our upcoming analysis. This review is selective, with an effort to capture trends in this complex and topical issue. Besides actual literary references, presentations given in the third workshop organised by Statistics Finland in March 2006 within the KEI project are being utilised in this section. The purpose of the workshop was to discuss the measurement needs and possibilities arising from the increasing attention paid to issues related to globalisation of R&D in the context of the challenges facing globally integrated knowledge economies.

This discussion below also takes a closer look at some of the changes that have taken place during the late 1990s and 2000s in the internationalisation of business enterprises' R&D operations. The aim of this section is to present various measurement approaches but also to give some examples of results in various countries.

Some Finnish studies

Different studies on the globalisation of R&D done in Finland will be presented below.

Cross-border R&D in a small country

Statistics Finland in co-operation with ETLA (The Research Institute of the Finnish Economy) and VTT Technical Research Centre of Finland – Group for Technology Studies performed as a joint project a study (Pajarinen and Ylä-Anttila (eds.), 1999) on the internationalisation of R&D from 1993 to 1998. It studied both the extent and effect of Finnish enterprises' R&D activities abroad (Koskinen, 1999) and the R&D operations of foreign firms' subsidiaries in Finland (Pajarinen, 1999). Besides these, detailed changes in Finnish multinationals' R&D strategies were analysed. The primary purpose of the study was to shed some light on the changes in globalisation of corporate R&D in the 1990s, its motives, consequences and impacts.

The objectives of this study were to find out the extent, forms and development of *Finnish companies' R&D abroad* between 1993–1998; to evaluate the effects of internationalisation on domestic R&D; to evaluate the motives for the internationalisation of R&D and to evaluate R&D co-operation of the foreign R&D units. The survey was an updated and expanded version of a similar Statistics Finland study published earlier in the 1990s (Åkerblom, 1994). A Finnish-owned company was defined according to the OECD guidelines.

Surveys concerning Finnish firms' R&D abroad were directed to two different groups of firms: the first to 19 largest Finnish industrial multinational companies (ranked according to their personnel abroad) and the second to 540 other large and medium-sized companies,

mainly in the manufacturing industry, with more than FIM 0.5 million (approx. EUR 84.000) investment in R&D and/or more than 100 employees. The basic idea in this study was to uncover changes in general patterns of foreign-located R&D of Finnish firms since the early 1990s, when the previous survey was made. The coverage of these two surveys was about 86 per cent of total industrial R&D made by Finnish companies in Finland in 1998, measured in terms of R&D expenditure. Data on the R&D activity performed in Finland was received from regular R&D inquiries, which have been collected every other year and annually since 1997.

The first survey to multinationals was carried out mainly at the division (business unit) level except a couple of companies, which were included at the corporation level. The second survey was sent to other large and medium-sized companies, of which about 90 per cent responded.

Internationalisation of R&D is quite heavily concentrated in major companies, which accounted for over 90 per cent of Finnish' firms R&D expenditure abroad in 1998. The total R&D expenditure of the enterprises included in the study was EUR 2.2 billion, of which nearly EUR 0.6 billion or 26 per cent was spent through R&D units abroad. In major Finnish companies the proportion of foreign-based R&D was 31 per cent, in other large and medium-sized firms nine per cent. Metals, engineering and electronics industry accounted for up to 80 per cent of all foreign-based R&D.

The three main objectives of the study on *foreign firms' R&D activities in Finland* were to analyse the scale and scope of foreign companies and their R&D activity in Finland; to study whether there were any significant differences between their R&D activities and other firms in Finland; and to evaluate the effects of foreign take-overs on R&D activity. Data sources in this study comprised research conducted at ETLA, which include a considerable amount of information about foreign firms' activities in Finland. A part of this data was then updated and combined with the data sources provided by Statistics Finland. This included the Business Register, the Industrial Statistics publications, the FATS[3] Database and the R&D surveys (for 1997 and to some extent estimates concerning 1998). Companies' annual reviews and other information were also utilised. Therefore, using, merging and relying on various existing data banks means that own large-scale inquiries about foreign firms' R&D activities in Finland were not carried out.

Study results suggested that foreign firms were inclined to invest in industries at a relatively high level of technology, which points at their willingness to make good use of existing technological knowledge and know-how. Subsidiaries of foreign multinational corporations had been growing very rapidly following acquisitions especially in high technology industries.

In 1997, some 140 or eight per cent of all 1,800 foreign affiliates performed R&D in Finland. R&D activity was concentrated in (large) manufacturing firms, where more than one in three foreign affiliates had R&D. Foreign-owned firms had increased their share of total business sector R&D expenditure in Finland in the 1990s; the figure stood at 14 per cent

[3]FATS: A database with detailed data on Foreign Affiliates Trade in Services. The data indicate the importance of foreign affiliates in the economies of host countries and of affiliates of national firms implanted abroad. FATS contains five variables (production, employment, value added, imports and exports) broken down by country of origin (inward investments) or implantation (outward investments) and by industrial sector (based on ISIC Rev. 3) for 19 OECD countries.

in 1998 compared to less than ten per cent in 1990. In 1998 total expenditure amounted to EUR 320 million.

Multinational Enterprises in the Finnish Innovation System

It is known that a growing share of corporate R&D is carried out in foreign subsidiaries, but an accurate, up-to-date information on the extent and nature of companies' foreign R&D has been scarce. There has been no perfectly reliable statistical source on the topic. To fill the need, studies on internationalisation of Finnish R&D has been carried out as one part of the MEFIS (Multinational Enterprises in Finnish Innovation System) program, which was a joint research project of ETLA, VTT – Technical Research Centre of Finland, Helsinki School of Economics (Department of Organisation and Management), and Finpro in 2001–2003.

The data gathered in the context of MEFIS studies show that over 40 per cent of all industrial R&D of the Finnish corporations is done abroad. At the same time as Finnish multinationals are expanding their R&D abroad, inward foreign direct R&D investment is also increasing.

In his article (Lovio, 2005a) R.Lovio aims to introduce dimensions into the definition of the globalisation profile in Finnish companies by using a new, experimental globalisation index, which consists of several indicators for globalisation. Among them 'share located abroad' has been used as the indicator for R&D operations with boundary values 'less than 25%', '25–50%' and 'more than 50%'. Corporations included in the study pertaining 2002 data consist of all the 23 Finnish-owned companies with foreign turnover of over EUR 500 million in November 2003. Companies' annual reports have been useful information sources from the perspective of the globalisation index. However, since they don't include information on the geographical distribution of their R&D, the relevant information has been collected in this particular project.

Results show that internationalisation has occurred clearly less in firms' R&D activities and ownership than in markets and personnel. The least internationalised dimension is management and governance. In R&D the average foreign share is 47 per cent and only five out of 23 companies is above half of the maximum value.

Lovio's in-depth analysis (Lovio, 2005b) in the context of the same project puts more light on Finnish corporations' foreign R&D activities. A review of the most recent available data is based on personal interviews, publicly available documents, previous studies, national statistics and investment surveys by the Confederation of Finnish Industry. 11 large corporations were selected on the basis of the size of their R&D investments and the extent of their international operations. This overview was then followed by an examination of the internationalisation of R&D operations. The final section studied Finland's situation through the international literature.

The compilation of the available data describes the development since 1993. It shows that the foreign share of R&D by (large) Finnish industrial companies has grown from 28 per cent in 1993 to 46 per cent in 2001 and remained at that level past few years. Respectively the actual amount of foreign R&D expenditures has multiplied from EUR 157 to 2,278 million. It should, however, be noted the figures obtained from various sources differ remarkably.

The studies presented above suggest that Finnish multinational enterprises perform more R&D abroad than foreign companies carry out in Finland. Finnish companies are not, however, transferring their R&D activities abroad. Overseas R&D outlets are often by-products of foreign acquisitions, rather than explicit strategy going beyond the usual product development and market monitoring. As the R&D activities of Finnish companies become international, it is important that this is counterbalanced by increased research in Finland by foreign MNEs. The acquisition of foreign units by Finnish MNEs has not reduced their R&D investment in Finland, which appears to have maintained its advantage as a location in terms of cost and quality. Large companies' R&D activities abroad are integrally linked to the companies' other R&D activities.

The general investment survey

The general investment survey could also be a relevant source for gathering information. For example EK, the Confederation of Finnish Industries, carries biannually an investment survey, which aims to find out the actual development and current year estimates for fixed investments in Finnish manufacturing industries and energy sector. The development of Finnish companies' R&D investments both home and abroad is monitored every spring. The investment survey in April–May 2006 (EK, Confederation of Finnish Industries, 2006) mainly among businesses included in the EK business tendency survey sample was responded by 312 manufacturing companies in different branches.

Following the results published in June 2006 nearly 35 per cent of the R&D expenditure by the manufacturing industry was spent abroad in 2004[4] and over 36 per cent in 2005. The greater part of Finnish firms' R&D investments abroad is located in the European Union and North America. In accordance with the two-year earlier survey (EK, Confederation of Finnish Industries, 2004) the share of the EU-15 was estimated to be 48 per cent and the figure for North America nearly 38 per cent. However, R&D expenditure in North America has shrunk in recent years while the significance of Asia has been on the increase. Almost 13 per cent of all R&D expenditure go to Asian countries.

Foreign R&D operations of Finnish companies are highly concentrated in technology industries (electronics industry, mechanical engineering and metals). Its share of total foreign-based R&D expenditure has stayed around 93 per cent since 2000.

A current study by LTT Research Ltd

In Finland, also LTT Research Ltd has recently been conducting a study (LTT Research Ltd, 2005) on outward research and development activities. It attempts to provide answers to questions pertaining the impact of European firms' R&D off-shoring behaviour to the innovation capability of the European economy. Off-shoring activities in this study can be either in-house or outsourced (external to the company in question).

The assessment of the study is comprised of a survey with 200 telephone interviews of executives in companies that have recently offshored R&D as well as 20 case studies. Firms are primarily from Europe, but also examples from other regions like the US are included. Besides trends in the volume, location and character of R&D activities in EU and beyond, reasons and problems connected with R&D off-shoring are being asked. The

[4]Over 39 per cent according to the one-year earlier survey (EK 2005)

focal question in the study is in which extent domestic R&D is replaced by off-shoring. Results are expected to be published in autumn 2006.

Swedish Experience of Collecting Data on Inward and Outward Research and Development

In Sweden, both SCB (Statistics Sweden) and ITPS, the Swedish Institute for Growth Policy Studies are active in compiling statistics on R&D activities in Sweden and beyond. ITPS is responsible for conducting regular (biennial) surveys concerning R&D internationalisation in business enterprises. The surveys are realised by Statistics Sweden. 'Research and Development at International Enterprises 2003' (ITPS, 2005) published in July 2005 consisted of three separate studies. *Foreign owned enterprise* refers to enterprises where more than half of the voting rights are foreign controlled. *Swedish international company* refers to a Swedish-owned company with at least one subsidiary and at least one employee abroad. *A (Swedish) national company* has no affiliates abroad.

The first study is based on a survey aimed at the 20 largest Swedish-owned industrial groups (60 enterprises) in terms of the number of employees abroad. It concerns the groups' R&D both in Sweden and abroad. The sample is drawn from an annual survey of all groups in Sweden which have at least one subsidiary abroad. Large manufacturing groups dominate both in terms of the number of employees in the business sector outside Sweden and R&D investments in Sweden. This sample should provide a good picture of outward R&D activities. The statistical unit is the group, i.e. the group of enterprises, which are consolidated, in the annual report of the group. In a few cases for technical reasons, a member of a group is studied instead of the group as a whole. Correspondingly, the second study is based on a questionnaire to 10 large foreign controlled groups (30 enterprises), which all formerly had been Swedish-owned. This survey concerns their R&D activities in Sweden only. R&D in Sweden as a percentage of the group's global R&D is among the variables in this inward R&D study.

In addition to these questionnaires, the ITPS register of foreign-owned enterprises is combined with SCB's regular study of R&D in Sweden, which includes around 1,700 enterprises with at least 50 employees. The statistical unit is the enterprise. The data only refers to their activities in Sweden. An enterprise is defined as foreign-owned if an owner outside Sweden has more than 50 per cent of the voting rights in the company.

According to the combination of the ITPS register and the SCB study, foreign owned companies' share of the total business enterprise R&D expenditure in Sweden was 45 per cent in 2003, an increase of as much as 26 percentage points since 1997. The total BERD in Sweden was SEK[5] 72 billion, with just over SEK 39 billion of which by Swedish national and international companies and almost SEK 33 billion by foreign owned enterprises. 73 per cent of the latter was either by British or American enterprises.

The new study with large foreign-owned groups shows that their share of the R&D in manufacturing rose from 20 to 35 per cent between 1993 and 2003. During the same period, their R&D expenditures increased from SEK 7 billion to SEK 20 billion.

The 20 largest Swedish-owned industrial groups invested SEK 47 billion in R&D in 2003, of which SEK 27 billion in Sweden. Thus a total of 43 per cent of their R&D was

[5]1 EUR = approx. 9.30 SEK (September 2006)

performed abroad. Swedish-owned companies' R&D overseas was highly concentrated in EU-15 (share 53%) and in the United States (26%). In contrast to the rapid development of foreign owned firms' R&D in Sweden, that of the 20 largest Swedish ones decreased approximately as much (about 22 % from 2001 to 2003) home as abroad.

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ITPS conducted quite recently an extensive project (Karlsson (ed.), 2006) on internationalisation of corporate R&D with 10 studies covering different countries including China, India, Japan, United States and Sweden. Together these studies published in May 2006 provided a multi-faceted account of the extent of international flows of corporate R&D, its driving forces and its potential implications. The studies built upon existing literature and aimed to contribute more up-to-date empirical evidence based on interviews, surveys and additional data analysis.

R&D and innovation are still rooted at 'home', but internationalisation is proceeding. Most R&D is located within the Triad of the USA, Europe and Japan, but the share of developing countries is increasing driven by China and India. Foreign R&D is steered by acquisitions and political requirements, as well as company strategies to be close to production, markets and knowledge, and is facilitated by technology, people and new actors. International R&D is becoming more advanced (innovative instead of adaptive) and is beginning to involve also smaller companies.

Measuring Cross-Border R&D in Germany[6]

In Germany the research statistics unit of the *Stifterverband für die Deutsche Wissenschaft*, an association of research-funding charities, regularly compiles comprehensive statistical data on industrial R&D spending. This is based on questionnaires, on which companies provide detailed information on their current and future research budgets. In 2003 German industry spent EUR 37.7 billion[7] on research and development in-house. Extramural R&D spending, i.e. expenditure for R&D carried out abroad or contracted out to companies or public sector research institutes, was EUR 8.3 billion (Stifterverband, 2006). In context with globalisation Stifterverband has since 1995 also produced data on R&D in German companies' foreign affiliates and respectively on foreign-owned firms' R&D activities in Germany.

Question concerning outward R&D of German companies was included in the R&D survey until 1999. Then it was abandoned due to difficulties of enterprises in providing the information. A data bank on 50 major corporations was created for the statistical year 2001 by using company reports, various scoreboards and the Internet as sources. Estimates on R&D performed in foreign affiliates of German firms has been done by combining data from this data bank and the information obtained in the regular German R&D survey. A control question if the enterprise has performed R&D in foreign affiliates or not, was introduced in the 2003 R&D survey. The 2003 data revealed the R&D expenditures carried out by German affiliates abroad to be EUR 10.9 billion, which is 29 per cent of the total intramural R&D expenditure by German companies. In 1995 the corresponding figure was just good EUR 5 billion.

[6]Partly an adaptation of a presentation *"Measuring the globalisation of R&D – the German experience"* by Grenzmann (2006) (Stifterverband) in the KEI Workshop, Helsinki, 3 March 2006.

[7]Including EUR 1.9 bn without identified country of owner (ultimate beneficial owner).

Information on the R&D activities by foreign companies in Germany is available since the statistical year 1993. Companies have been asked in odd years whether they belong to a corporation and if so, also in which country its possible foreign headquarters is located. The ownership of a firm has been defined by the 'ultimate beneficial owner' concept. However, because this is not inquired in the survey, the actual ownership is determined with the help of secondary sources like annual reports. The proportion of foreign-owned R&D in Germany has risen from around 16 per cent to over 25 per cent between 1993 and 2003. This clearly shows that the internationalisation of business enterprise R&D has proceeded notably. The share of European countries of the total EUR 9.6 billion foreign-owned intramural R&D expenditure was 60 per cent and that of the North America 37 per cent.

Globalisation in R&D has increased in Germany and this concerns both inward and outward investments, which are 'nearly' in balance. Globalisation of R&D is (mainly) caused by acquisition, but acquisitions may cause instability from year to year. Current approaches to compile data on both inward and outward R&D are intended to use for the 2005 statistics –despite the evident limitations in harmonising external sources on global R&D of MNE with national R&D survey in order to obtain outward R&D figures. External sources are very inhomogeneous: every MNE has to be treated individually, which is very labour-intensive, and the fact that information is reliable, but on a small scale.

R&D internationalisation studies in the Netherlands

CBS, Statistics Netherlands, has made efforts in order to get information about Dutch companies' R&D expenditure abroad. Annual national surveys and company reports have been utilised together with complementary straight contacts. Also plans to include a small block of internationalisation questions in the R&D survey have been considered. CBS has in its registers no information about the owner country of a company. Therefore private databases and innovation surveys are used to define the foreign ownership on which the data on foreign firms' R&D activities in the Netherlands is based. Some new data sources like tax registers and business registers became available in late 2005. These are to help avoiding overlaps.

In recent years in the Netherlands, efforts have been made in order to get to measure whether business enterprise R&D activities in the Netherlands are declining or increasing. A study by Cornet and Rensman (2001) analysed e.g. the R&D location behaviour of Dutch and foreign firms present in the Netherlands, and the factors that determine the R&D location decision. This study discussed broadly the topic of the choice of location and potential relocation for R&D. Data sources used in this study included for example:

- The CPB company R&D database which information on R&D activities of a large number of enterprises operating in the Netherlands. Quantitative R&D data were available for 130 small and large Dutch- and foreign-owned companies.

- Interviews from August to December 2000 with eight R&D managers of Dutch multinationals and foreign R&D-intensive companies operating in the Netherlands and six experts from academia, government, employers' organisations, and location consultancy firms.

The following conclusion could be drawn from the research on the seven largest Dutch R&D companies, the so-called 'Big Seven'. Along with increasing internationalisation of R&D, they have continued their R&D activities in the Netherlands, while at the same time they have developed complementary R&D activities elsewhere, which means that R&D has not being moved abroad. Hereby there has not recently been relocation of R&D abroad, but instead an expansion of R&D in foreign countries. The increase in foreign R&D expenditure of the 'Big Seven' over the past years has not been at the expense of these companies' existing R&D activities undertaken in the Netherlands. Furthermore, the R&D activities that have been hived off in the Netherlands have been continued. There is therefore no relocation of R&D, but only a change of owner.

According to the same study, foreign R&D investments in the Netherlands have typically been of the non-greenfield type. Once established, they have generally been to stay and the size of foreign affiliate R&D efforts in the Netherlands has grown over the years.

Also the Dutch Ministry of Economic Affairs has been quite active in the field of internationalisation of R&D, and has performed a lot of research in this field. Among them, a study by Erken and Gilsing (2005) on the internationalisation of R&D in the Netherlands was conducted by the authors on behalf of the ministry in 2002–2003. The aim of the study was to find out what exactly is going on in the internationalisation of R&D, based on the experiences of the 'Big Seven' (which undertake roughly 50 per cent of total BERD in the Netherlands) and their R&D strategies. The most significant trends and developments in R&D, both from a macro and micro perspective, were set out. Strategic questions confronting businesses when organising their R&D function were considered as well. Their conclusions corresponded with the results by Cornet and Rensman (2001) on the choice of R&D (re)location.

Another recent ministry-conducted paper by Erken *et al.* (2005b) focused on the question which location factors are decisive for the attractiveness of a country in terms of foreign R&D investments. Results were based on a literature review, a field study and econometric analysis. To test the validity of the identified location factors from the literature, field research was conducted among 62 foreign companies with international R&D establishments. Among the surveyed R&D subsidiaries, 30 were located in the Netherlands and the rest in other Western European countries. Five in-depth interviews with foreign firms in the Netherlands completed the survey. Although the sample in the field research was hardly representative for Europe as a whole, it does provide a good picture of the foreign R&D activities in the Netherlands. In brief, the results proved the availability of qualified personnel, international accessibility and the quality of knowledge institutions to be the three most important location factors for R&D. Therefore this field research shows that businesses locate their R&D in the proximity of highly-qualified people, who are easy to access and who have access to state-of-the-art knowledge. In addition, while financial factors such as R&D stimulation incentives, the labour costs and tax regulations are important, they are not decisive for attracting foreign R&D.

Studies by Erken *et al.* (2005a) continued further in presenting both a quantitative and a qualitative approach to the globalisation of R&D with a focus on the Netherlands and other small economies. It combined both the outward and inward perspective insights. This research included also the benchmarking the R&D investment climate between the Netherlands and the EU-15, and the Netherlands and other small, open economies. Lin-

kages between foreign R&D investments and the underlying location determinants were in focus.

Belgian experiences

In Belgium a good 70 per cent of total R&D in 2001 was realised by foreign controlled subsidiaries. Therefore it is of high importance to understand the driving forces and motives for multinational enterprises to perform R&D in a certain location. Special surveys are in great demand, because little is known about the subject due to a lack of statistics. In this study (Teirlinck, 2005) the internationalisation of R&D was presented from the ownership perspective.

The results presented here made use of firm based R&D budgets for all Belgian firms performing R&D on a regular basis. The 2000–2001 expenditure and location data used were collected on the basis of the biannual OECD R&D surveys provided by the Belgian authorities. There was information on 2,163 firms, which contribute 91 per cent of the total EUR 4,062 million BERD in Belgium. According to the guidelines of the OECD Globalisation Manual (OECD, 2005b), the criteria used for ownership was that of ultimate control, which defined the head office and hence the home country of a firm. The target population was divided into three groups: foreign subsidiaries (number: 540), domestic subsidiaries (614) and independent (domestic) firms (1,009). Foreign affiliates' R&D was then refined by size, sector and country of origin and their R&D performance was also compared to the domestic ones.

Belgian private enterprise sector is no exception to the high degree concentration in a small number of R&D champions noted in most OECD countries. Only two domestic controlled firms remain among the top 10 R&D spenders in Belgium. A descriptive overview of the unexplored results shows a very high dominance of foreign subsidiaries (more than 80%) in the three largest R&D sectors: pharmaceuticals, ICT-hardware and instruments, and refineries and chemical products. Together these three sectors represented more than 60 per cent of total BERD in 2001. The corresponding share for transport sector was equally high. As for the size aspect, it is noted that the share in R&D of foreign subsidiaries increases with the size of the company. Only in small firms the R&D is not dominated by foreign subsidiaries. In 38 per cent of all cases the United States was the country of origin of the ultimate controller of R&D performed in foreign subsidiaries in Belgium. Main trade partners (United States, France, Netherlands, Germany, United Kingdom) accounted together for nearly 95 per cent of all foreign controlled R&D.

Globalisation of R&D in France

In France a study (Madeuf, 2001) was commissioned by the French Ministry of Education on the R&D in affiliates of French firms. This study made by the FORUM team of Universite Paris-X included 27 groups representing over half of Business Enterprise R&D in France. The study collected information on 352 research centres of these groups worldwide of which 214 abroad. According to this study some 35 per cent of the R&D of the groups included were performed abroad. The shares were biggest in the electrotechnical and chemical industries.

Another French study (Francoz (2003)) on the R&D activities of foreign-controlled activities was based on the results of the R&D annual business enterprise survey conducted by the French Office of Statistics. In the questionnaire, firms were asked to specify whether

they are part of a group and, if so, to identify that group. Replies were then checked by searching commercial databases on financial links (DAFSA, KOMPASS), mainly to identify the ultimate owner.

The study suggested that until the early 1990s, the research activity was largely performed by French firms regardless whether they were affiliates of French groups or independent firms. Then closer relationships started to develop at the global level between major industrial groups through mergers and acquisitions. R&D functions were also part of this relocation process.

In 1999, the R&D expenditure of foreign-controlled affiliates amounted to nearly EUR 3.5 billion, i.e. 18.7 per cent of total BERD in France. This was a continuation of the upward trend observed in the middle of 1990s. In 1993 the corresponding share was 12 per cent followed by a strong growth until 1996. Affiliates of foreign groups were among the most dynamic firms during the period 1995–1999 according to various R&D indicators. Growth was the outcome of a stronger growth in R&D activity in existing affiliates under foreign control but also by new foreign participation in French ventures. A number of R&D centres were established under foreign control as well.

The major share (around 90%) of R&D by both foreign-controlled and French groups' affiliates was concentrated in units with more than 250 employees. The corresponding percentage for independent French firms was 57 per cent. Foreign firms with R&D activity in France were primarily from EU-15 (54% in 1999) of and North America (37%).

The Internationalisation of UK R&D

A rather recent paper by Bloom and Griffith (2001) considered trends in the United Kingdom R&D performance. It showed UK R&D to be more internationalised than that of other G5 countries and it was also becoming increasingly so at a faster rate. Foreign firms are carrying out a rising share of UK R&D and UK firms are undertaking more of their R&D abroad. A special focus was in pharmaceuticals, the largest R&D-performing sector.

The micro data that underlie the annual Business Expenditure on Research and Development (BERD) survey undertaken by the Office for National Statistics (ONS) was used to look at business *R&D undertaken by foreign firms* in the UK. It provides details of R&D expenditure in the UK at the firm level and it enables breaking down the expenditure by e.g. the nationality of the firm that conducts the R&D. The proportion of BERD in the UK that is conducted by foreign-owned firms has increased from 29 per cent in 1994 to almost 35 per cent in 1999. During this same period, the share of UK-based R&D in the pharmaceuticals industry being conducted by foreign firms rose from 18 to 29 per cent. 68.5 per cent of BERD is conducted by British-owned firms. North-American-owned conduct around 17 per cent, EU-owned 7.5 per cent, other European 2 per cent, Japanese 3.6 per cent and other foreign-owned around 2.3 per cent. R&D undertaken by foreign firms in the UK is usually associated with their production processes and plants, rather than as a stand-alone R&D laboratory.

The study on *UK firms' R&D abroad* was limited only to the pharmaceutical industry. Parallel to the increasing share of UK-based R&D by foreign firms, there is an increasing share of R&D conducted abroad by 15 largest UK-based pharmaceutical firms. Total spending has grown over 1.5-fold from 1994 to 1999. However, spending on R&D in the

UK by the same firms has increased less than 20 per cent, which suggests that these firms are increasing R&D spending in their overseas research labs at a faster pace than in the UK. In 1994, 66 per cent of R&D by UK pharmaceutical firms was done abroad, in 1999 the share had risen to nearly 72 per cent.

International flows of R&D expenditure in the Italian business R&D survey[8]

In recent years among the variables collected by the ISTAT business R&D survey, those about R&D globalisation have raised a general attention. In this perspective, the annual survey has been providing information on inward R&D by questions about firms belonging to industrial groups, the position of these firms within their groups (parent company, intermediate firm, subsidiary) and the geographical location (since 1998 edition) of the parent company. These information enable estimating the rate of R&D carried out in Italy by foreign affiliates of multinational enterprises.

Inward R&D represents a large percentage of total R&D expenditure carried out in Italy. Its share has risen from 27.3 to 38.2 per cent between 1998 and 2002. Correspondingly, the proportion of R&D personnel has gone up from 23.6 to 29.4 per cent with reference to the same period. Additionally, almost the whole inward R&D activity is carried out by affiliates of groups with parent companies based in only nine countries.

The question about whether, and to what extent, Italian parent companies are controlling subsidiaries or firms carrying out any R&D activity abroad has been included in the R&D questionnaire since 1998 in order to get information on outward R&D. This information is used to identify the multinational group (either Italian or foreign based) the enterprise belongs to after first checking against the position of the company in its group. The respondents are then asked to indicate the amount of R&D expenditures and number of R&D employees by country distribution.

Compared to inward, outward R&D shows three main differences: (1) the total amounts of R&D expenditure and personnel are significantly smaller, (2) the countries of destination are slightly different from the ones of origin and (3) the impact of top countries on the total is smaller.

Additional information about international R&D flows can also be drawn from the survey: the flow of extramural R&D expenditure carried by foreign affiliates in their same group, and the amount of intramural R&D expenditure funded by foreign affiliates of the same group. On the basis of these information further development of a proposed classification of R&D performing businesses is possible.

Future plans of ISTAT in efforts to obtain more data on R&D flows include further integration between different statistical and administrative sources at national level, analysis of intra-group R&D flows (checking data from the IPTS Scoreboard), comparison of the results of the business R&D survey with business R&D data from other countries and development of a common framework for R&D and FATS statistics at national level.

Information on R&D internationalisation in the USA

In the USA, comprehensive data pertaining to MNEs is collected by the Bureau of Economic Analysis (BEA), U.S. Department of Commerce by means of mandatory surveys

[8]An adaptation of a paper by Cozza and Perani (2006) and a presentation of G.Perani in the KEI Workshop, Helsinki, 3 March 2006.

that it designs and conducts. BEA international investment data from the Survey of *US Direct Investment Abroad* (USDIA) and Survey of *Foreign Direct Investment in the United States* (FDIUS) are obtained from a combination of censustype surveys in benchmark years and sample-based surveys in nonbenchmark years. Financial and operations data covering technology-related items like R&D expenditures of US parent companies, their foreign affiliates, and US affiliates of foreign companies are collected regularly in context of the FDI surveys[9].

BEA's comprehensive benchmark surveys providing a variety of indicators of the overall domestic and foreign operations of US MNEs are conducted every 5 years, latest for 2004. They cover virtually the entire population of US MNEs consisting of all foreign business enterprises owned 10 percent or more, directly or indirectly, by a US person. In addition to them, BEA conducts annual sample surveys concerning financial and operating estimates. In the sample surveys, reports are not required for small affiliates, in order to reduce the reporting burden. Instead, BEA estimates the data for these affiliates by extrapolating forward their data from the most recent benchmark survey on the basis of the movement of the sample data. Thus, coverage of the US-MNE universe is complete also in nonbenchmark years. Financial and operating data are separately tabulated for two foreign-affiliate groups: all foreign affiliates and majority-owned foreign affiliates (MOFA's; foreign affiliates with the combined ownership of all US parents exceeding 50%). Each foreign affiliate is classified by its country of location: the country in which the affiliate's physical assets are located or in which its primary activity is carried out.

Entire operations of the US affiliates of foreign companies, irrespective of the percentage of foreign ownership, are covered in data collected by BEA. The primary focus of the data is on the overall operations of the US affiliate, not just on the affiliate's transactions or positions with the foreign parent group. The estimates are based on sample data from BEA's Annual Survey of Foreign Direct Investment in the United States or on universe data from BEA's Benchmark Survey of Foreign Direct Investment in the United States. The benchmark survey, or census, is BEA's most comprehensive survey and is normally conducted every 5 years, latest for 2002. Data on the activity of the affiliate as a whole are used, regardless of the foreign ownership share and they are generally presented by country of UBO. (Zeile, 2004)

Foreign-owned firms conducting R&D in the United States accounted for USD 29.5 billion of the total USD 204.0 billion industrial R&D expenditure in the USA in 2003. The share of foreign-owned R&D fluctuated between 11 and 13 per cent during the period 1994–2000 and rose to over 14 per cent in 2002. European-owned subsidiaries accounted for USD 20.7 billion (75%) of foreign-owned R&D in 2002. In the same year, chemicals was the largest industry with a share of 29 per cent. Parent companies of US multinational corporations accounted for almost 70 per cent of the R&D spending by all industrial R&D performers in the United States in 2003. These parent companies had R&D expenditures of USD 140.1 billion, whereas their majority-owned foreign affiliates had R&D expenditures of USD 22.3 billion, for a total of USD 162.4 billion in global R&D expenditures. The percentage of R&D spending abroad increased from 11.5 to 13.7 percent between 1994 and 2003. Europe accounted for a little less than 60 per cent (USD 12.3 billion) of all US-owned outward R&D investments in 2002. However, certain emerging markets such

[9]The focus is primarily on activities of the majority-owned nonbank affiliates.

as China, Israel and Singapore are playing an increasing role in US-owned overseas R&D. Transportation industry as the biggest branch accounted for 28 per cent of all the R&D by US-owned companies abroad. (Jankowski, 2006; National Science Board, 2006)

As a new feature in efforts of measuring R&D globalisation, a question of percent foreign ownership has been added in the regular National Science Foundation/Census Bureau BERD survey. For the time being, the results are not yet of the highest quality.

US Data Linking Project

The Bureau of the Census, which conducts the National Science Foundation (NSF) Survey of Industrial Research and Development, and BEA, which conducts the international investment surveys, were recently engaged in a statistical data-linking project, to cover the needs for better data on the domestic and international dimensions of US R&D activities. The US Internationalisation of R&D Data Linking Project (Jankowski, 2005) was a study to determine the feasibility of linking NSF's BERD data with BEA direct investment surveys: US affiliates of foreign companies (FDIUS data); and US parents with foreign affiliates (USDIA data). Most recent (last published) BEA benchmark years were covered: 1997 for foreign direct investment in the USA and 1999 for US direct investment abroad (BEA, U.S. Direct Investment Abroad, 2004). Data match to be linked included core items like the number and R&D expenditure of R&D performing companies.

Anticipated statistical benefits included (1) improving NSF/Census Bureau and BEA sample frames; (2) improving the quality of NSF/Census Bureau (BERD) and BEA R&D data pertaining erroneous or missing data and industry classification; and (3) better understanding of issues affecting reporting: definitions, consolidation, timing and sampling. Anticipated analytical benefits contained (1) better understanding of the international dimensions of R&D performance in the US and abroad; (2) integrated data set on R&D performance and funding, with domestic and foreign ownership detail; and (3) enhanced information on the R&D activities of US and foreign MNEs.

Expected link outcomes presented in the final report (Census Bureau *et al.*, 2005) summarised the research covering: comparability of data files; quality of the matches; types of tables that can be supported by the linked data set; feasibility of moving link forward in time; methodology for moving link forward; and various analytical tabulations. In terms of link coverage, results were encouraging, since 80–92% of the R&D data from the different sources in the three different phases matched. The study demonstrated that it is feasible to link micro-data from the BERD Survey to BEA's micro-data on US affiliates of foreign MNEs and on US parent MNEs. Extensive analytical findings were not anticipated since the linked data were somewhat dated. Nonetheless, the study proved the possibilities of exploring issues related to US and foreign affiliates' R&D activities that previously were not possible. Tangible benefits to both the Census Bureau and BEA through improvements in sample frames and in the quality of reported data were also provided. Three agencies, NSF, Census and BEA agreed in February 2006 on further matches with an intention to choose one single year (2003 or 2004) for inward and outward investments to allow analyses of integrated global R&D investments.

A brief glance (Jankowski, 2006) on the key analytical findings tells the following. Majority-owned US affiliates that linked accounted for 8 percent of the US industrial R&D expenditures reported by companies covered by the BERD sample in 1997. The matched US

parent companies accounted for 75 percent of the US industrial R&D expenditure reported by companies included in the BERD sample in 1999. Respectively in 1999, about two-thirds of overseas R&D by majority-owned affiliates of matched US parent companies was performed in 5 countries: United Kingdom, Germany, Canada, France and Japan.

The Maturation of Global Corporate R&D: Theory and Evidence

Hicks and Hedge (2005) seeked to investigate factors that determine the initiation and growth of innovative activity by foreign subsidiaries of US owned large firms in the period 1991–2002. The impact of foreign country factors like market size, technological strength, and science and engineering (S&E) capability on the conduct of US overseas R&D were examined. The influence of a host country's scientific and technological capability on the conduct of US multinational R&D in that country was specifically looked for. Inter-industry differences in the explanatory power of these factors were also investigated. Panel data comprised annual industry-level patenting and R&D expenditure records (the outcome variables of the study) of the majority-owned affiliates of US multinational corporations in 45 foreign nations where they have a significant presence. Publicly available data from the United States Patents and Trademarks Office (USPTO), the Bureau of Economic Analysis (BEA) and the National Science Foundation (NSF) were brought together for the empirical analysis.

In their literature review they offered an account of the changing role of foreign subsidiaries in the innovation activities of multinational corporations during the last five decades. To cut a long story short, the nature of foreign R&D can be seen as a continuum from customisation and modification (supporting local markets) through listening posts to sources of innovation what it currently is.

R&D overseas develops around its foreign markets. While overseas markets primarily predict the entry of US R&D, the S&E knowledge base of nations critically determines the level and sophistication of US foreign subsidiaries' innovative activity. Some important inter-industry differences were also found as result of the study. US electrical, electronics, computers, and communication industries are strongly drawn towards overseas S&E capability; industries including machinery, automobiles, and transport equipment are primarily attracted by the technological strength of foreign nations; US R&D in chemicals mostly follows overseas markets.

World Investment Report 2005

UNCTAD undertook a survey (UNCTAD, 2005b) of the world's largest R&D investors between November 2004 and March 2005 in order to gain a better understanding of the extent to which R&D is expanding abroad. The population basis for the survey was the first 300 firms in the DTI R&D Scoreboard (DTI, 2004) completed by 16 companies from developing, South-East European and CIS countries. Besides studies by ITPS (Karlsson (ed.), 2006), this survey is one of the most comprehensive ones conducted recently.

Results published in December 2005 suggested that the pace of R&D internationalisation might be accelerating. As many as 67 per cent of the 69 firms that responded to the survey stated that the share of foreign R&D is set to increase; only 2 per cent indicated the opposite. While the average firm spent 28 per cent of its R&D budget abroad in 2003, European transnational corporations had above average levels of R&D internationalisation (41%), United States companies were below the overall average (24%) and Japanese TNCs

displayed the lowest share of foreign R&D (15%). United Kingdom (66%) and Switzerland (61%) had the most internationalised R&D activities. The share of R&D employees abroad was similar to that of R&D funding. Chemicals was the most internationalised industry with 48 per cent foreign share of R&D funds.

57 per cent of surveyed TNCs already have an R&D presence in China, India or Singapore. The survey predicts that developing countries as R&D locations are set to grow in importance in the next 5 years, also as TNCs involve them in their collaboration on R&D. Developing Asia is the most often mentioned location for further R&D expansion. However, to date, the majority of developing countries remain excluded from this phenomenon. Whether R&D activities will spread to a more developing countries will to a great extent depend on the ability of these locations to strengthen their innovation systems. Broader analysis together with some findings from this survey were presented in the World Investment Report 2005 (UNCTAD, 2005a).

Patents as indicators on globalisation

Trends of R&D internationalisation can also be analysed using data on patenting by firms. As firms relocate their production and research facilities abroad, an increasing share of patents is owned by firms of a country that is not the inventor's country of residence.

Viewing the internationalisation of R&D through patent data has obvious possibilities and advantages. Patents cover long time periods and provide insights into the extent, nature and developments over time of the innovative activities of firms. Patents can be characterised as indirect output measures of innovation. They capture the advancement of knowledge and the realisation of inventive activities within firms, even though some inventions might never reach commercialisation and the markets. This is in contrast with R&D data that captures the inputs into innovation in terms of the expenditures that firms assign to such activity. Patent data are therefore particularly interesting for investigating the more detailed trends and patterns of the internationalisation of R&D, and especially how the internationalisation of R&D is reflected in the structure and nature of foreign-based innovative activities of MNEs. Using patent data in this context has, however, some disadvantages too. It does not capture all innovative activity since not all innovations are patented and not all patents lead to innovations.

Two main indicators of internationalisation can be constructed with patent data information. The first one is the share for a given country of patents with a domestic inventor and a foreign (owned) applicant in the country's total domestic inventions. It reflects the extent to which foreign firms control domestic inventions (inward R&D-FDI). The second one is the share for a given country of patents with a foreign inventor and a domestic applicant in the country's total domestic applications. It reflects the extent to which domestic firms control foreign inventions (outward R&D-FDI) (OECD and Belgian Science Policy, 2005).

A study by Patel and Vega (1999) was based on a detailed examination of information on the US patenting activities of the world's largest firms. The aim of the paper was to empirically distinguish between different patterns of foreign technological activities at the firm level. The data set was compiled from information, supplied by the US Patent Office, on the name of the company, the technical class, and country of residence of the inventor, for each patent granted in the United States between 1969 and 1996. The distribution by

technical field and nationality of firm was analysed to examine the main technologies in which firms of different nationalities go abroad. Respectively, the distribution by technical field and inventor country was analysed to study the main foreign locations within each technology.

220 firms with the highest volume of patenting outside the home country in the period 1990 to 1996 were chosen for this particular study. Of these, 58 per cent were European, 32 per cent North American and 10 per cent Japanese. Within Europe the largest contributor was the United Kingdom with 39 firms. The main empirical findings of the paper based on this systematic analysis of the US patenting activities included the following statements, among others: (1) Quite a sizeable part of the firms' foreign activities, regardless of product group and nationality, are concerned with improvements in process technology and machinery; (2) The most prominent foreign locations of activity are the USA, Germany and the UK. Together these three countries accounted for more than two thirds of all 1,130 cases; and (3) In more than three-fourths of the cases, firms tend to locate technology abroad in their core areas where they are strong at home.

Research on the internationalisation of Finnish multinational firms has also mainly relied on the global dispersion of R&D expenditure. Therefore Palmberg and Pajarinen (2004) have in their recent study in context of the PROACT-research program provided new insights into how the internationalisation of R&D of the Finnish MNEs has been reflected in their innovative output as measured by patenting.

The sample of multinationals was representative and covered over 95 per cent of all Finnish R&D undertaken at foreign locations. The analysis was limited to the period 1980–1999 due to data availability constraints. Patents granted at the US patent office was used as data. Briefly, according to results the patenting of Finnish MNEs shows a steady increase over time. The results indicate that inventor teams have grown in size over time, especially through the entry of US, German, Swedish and UK inventors. The share of patents with foreign inventors is lower for Finnish multinationals when compared with MNEs from other industrialised countries. However, foreign patents of Finnish multinationals score higher in terms of originality and point to the domination of home-base-augmenting R&D strategies over home-base-exploiting ones.

Chapter 4

Methodological options

4.1 Indicators to be further analysed

The aim of this chapter is to go deeper into various methodological issues. We will first choose a set of priority indicators from the OECD Globalisation Manual (OECD, 2005b), discuss various ways of producing these indicators and evaluate pros and cons with various approaches. The indicators are expected to be mainly derived from analyses of existing R&D survey data on the enterprise level but other sources like special surveys or companies own reporting will also be used as far as possible.

We will start with a discussion on how the recommendations in the OECD Frascati Manual (OECD, 2002) deals with the globalisation of R&D. Primarily R&D statistics compiled on the basis of it relate to activities of units within national boundaries but there are variables shedding some light on R&D globalisation as well.

Suggestions for various kinds of indicators describing the internationalisation of technology have been presented in chapter 4 of the OECD Globalisation Manual. They have been divided according to data availability and priority into three groups: reference, supplementary and experimental indicators. The starting point for the choice of indicators is an evaluation of their feasibility for further data collection.

The indicators could be broadly divided into two main groups:

- inward R&D investment
- outward R&D investment

In this paper, inward R&D investments consist of R&D activities by affiliates of foreign companies in reporting countries (the ultimate beneficiary owner is foreign). These can be created from nothing as greenfield investments or obtained trough acquisition of an existing company or relocation of an existing R&D unit abroad. The most common indicator is perhaps R&D expenditures, but also R&D personnel or number of researchers could be used. A specific subcategory mentioned in the OECD Globalisation Manual is affiliates performing R&D as the main activity serving exclusively the global entity they are part

of. Such foreign owned R&D units could also be organised as parts (establishments) of enterprises. These units should be included in the same category also for consistency.

Respectively in this report, outward R&D investment means R&D activities by affiliates of national companies abroad (the ultimate beneficiary owner is from the reporting country). Also these can be created from nothing or obtained through acquisition of an existing company or relocation of an existing R&D unit in the country to a location abroad.

4.2 Review of sources

4.2.1 Existing R&D statistics and its development

It is possible to derive some information on the role of multinational companies from regular R&D statistics. The Frascati Manual §179 recommends the identification of enterprises belonging to a national group (with or without foreign affiliates) performing R&D and enterprises belonging to a foreign multinational group. However, this recommendation is not implemented in all countries. Such a classification implemented in all countries could be helpful to identify parent companies in reporting countries and foreign affiliates relevant for the calculation of inward R&D.

Two variables in R&D surveys are relevant for illuminating globalisation of R&D. These are R&D financed by foreign enterprises belonging to the same group and extramural expenditures for R&D performed by enterprises abroad belonging to the same group. To a certain extent also other international R&D transactions like other R&D financing from abroad and other funding of R&D undertaken abroad is relevant.

Even if a question on R&D financed by foreign enterprises belonging to the same group is included in many surveys and reported in statistics, the interpretation of this is not clear. The borderline between own funds and funds from elsewhere within the group needs clarification. In several globally operating MNEs R&D is funded either completely or partially on the group level or on the level of the parent company. Especially if the R&D unit is serving the whole group and the group or the parent is financing all R&D the funding is very close to the own funding concept. Sometimes in R&D surveys this kind of funding is in practise inconsistently reported. In some cases it is reported under own funds and in other cases in funds from other enterprises in the group. In fact this 'basic funding' of the unit is something different from selling R&D services to a foreign unit belonging to the same group, which of course also might occur.

Practical survey experience has shown that cost accounting for R&D is often on the group or group division level, which makes R&D transactions between enterprises of a multinational group difficult to record. Therefore it is probable that the R&D funded by foreign enterprises in the same group is underestimated.

In the last revision of the Frascati Manual more details were recommended for breakdowns of extramural R&D expenditure (expenditure going to R&D outside the unit). It was recommended in its §412 to ask for extramural R&D expenditures to foreign enterprises belonging to the same group. It is unknown how this question has been implemented in

national surveys. There are also, however, several reasons to believe this indicator does not tell very much even if implemented.

Few countries systematically include extramural R&D in their surveys for companies not having any intramural R&D. Many enterprises not performing R&D acquire R&D from outside as a service. Some very rough comparisons with data from surveys on trade in services show the data on extramural R&D being underestimated.

Despite the methodological difficulties reported above, the relationship between the development of intramural R&D expenditure and extramural R&D expenditure spent abroad could be regarded as an indicator on the globalisation of R&D, even if it does not measure globalisation of R&D on the company level. The growth rates of extramural R&D expenditure are generally higher than those for intramural R&D expenditure.

Due to the same difficulties reported above under sources of funds for multinationals to report internal R&D transactions is it likely that R&D funds going to foreign enterprises in the same group is underreported. The borderline between intramural and extramural R&D is also somewhat unclear. A lot of joint projects between various units are performed in multinationals, which makes the distinction between intramural and extramural even more difficult.

In conclusion it seems that the possibilities of ordinary R&D statistics to describe the process of R&D globalisation are limited. It is not possible to have information on either inward or outward R&D investments on the company level on the basis of existing R&D statistics. In the next chapter, we will go into more detail of additional measures needed for developing indicators on R&D globalisation.

4.2.2 Sources for inward R&D

As presented in deliverable 6.1, in several countries studies have been conducted to determine the share of R&D undertaken by foreign affiliates. The OECD has started to publish figures on the share of foreign affiliates in national R&D. Also the United Nations Conference on Trade and Development has collected this information as part of the 2005 edition of the World Investment Report (UNCTAD, 2005a). The share of foreign affiliates varies a lot between countries. In Hungary are Ireland more than two thirds of BERD is foreign controlled while the shares in the United States and Finland are relatively low under 20 per cent.

These indicators can be derived from general surveys of foreign affiliates like in the United States or matching of the enterprise level of data collected in the normal R&D survey with various registers on foreign affiliates. These registers could be of various kind:

- the usual official business register of the country (if the information on foreign ownership is included),
- special registers on foreign affiliates,
- R&D surveys or innovation surveys having the information on foreign ownership.

Table 4.1: R&D expenditure of foreign affiliates as a percentage of R&D expenditures of enterprises in 2004 (source: OECD, 2006b)

Country	R&D expenditure (%)
Belgium	55.6
Canada	34.9
Czech Republic (1)	46.6
Finland	16.4
France (1)	22.6
Germany (1)	26.7
Greece (3)	4.5
Hungary (4)	78.5
Ireland (1)	72.1
Italy (1)	32.1
Japan (1)	4.3
Netherlands (2)	31.3
Portugal	24.6
Poland (1)	9.3
Slovak Republic (1)	22.4
Spain (1)	26.2
Sweden (2)	34.4
United Kingdom	38.6
United States (1)	14.5

(1) 2003 (2) 2002 (3) 1999 (4) 1998

It is essential the information on ownership be based on the concept of ultimate beneficiary owner. This does not seem to be the case for all countries according to meta data collected by the OECD.

In countries using weighting factors to raise sample values or adjust for non response, also the information for the foreign affiliates have to be raised according to the general weighting factors used in order to avoid distortions in calculations of shares of foreign affiliates.

R&D is included as a variable in the FATS regulation by the EU intended to collect information on inward investments of foreign affiliates. This means that in the future these data will be produced regularly. Using the same source of information on which enterprises are foreign as the general statistics on foreign affiliates will secure the consistency and comparability of the information on inward R&D.

As the basic source of information in most cases is R&D statistics all the main variables from R&D surveys, such as R&D expenditures, total personnel and researchers could be included in the analysis.

4.2.3 Sources for outward R&D

In principle there are two different approaches for the measurement of outward R&D. It is possible to get the information from various kinds of surveys and it is also possible to make estimations on the basis of comparisons of global figures from company accounts and figures on the national level based on surveys.

Surveys

Basically there are four different kinds of survey approaches, the pros and cons of which are described below.

(i) One option is including one or two questions on R&D in regular R&D surveys. This has been done earlier in Germany but has nowadays been abandoned. This is the approach used in Italy. The advantage with this is a very direct link with R&D surveys. One could assume that the definitions are entirely based on the Frascati Manual. The disadvantage is that the respondent for an enterprise in the reporting country does not necessarily know the R&D activities in subsidiaries abroad. There is also a risk that R&D performing subsidiaries of enterprises not performing R&D or not even included in R&D surveys in the reporting country will fall out of the survey. It is also difficult to collect any detailed information of what type of R&D is performed in the affiliate.

(ii) Detailed special surveys inquire data on the level of the foreign subsidiary or at least by country. These surveys should preferably be connected rather closely to the information from the official R&D survey. The data contents of these surveys are of course broader compared with R&D statistics or other approaches. This gives possibilities to collect complementary qualitative data like motives for conducting R&D abroad for a more in-depth analysis. These are clearly more resource consuming even if they are limited to only the biggest companies. Sweden performs such surveys every other year and the approach has also been tested in Finland in two special surveys.

(iii) An alternative to the previous approach is a small survey directed to only big companies with just a few questions on R&D abroad by country. The survey can be addressed to the contact persons of the R&D survey to find out who could respond on the group level including foreign affiliates. This approach would give a good consistency with R&D data from the national R&D survey and give the possibility to ask some questions indicating the nature of R&D performed abroad. This approach has been tested in Finland within the KEI project and the experience is reported in chapter 5 of this deliverable.

(iv) R&D could be included as a variable in general surveys of foreign direct investments. There might be some difficulties to ensure that the R&D concept applied is consistent with the Frascati Manual. The quality of the information has to be checked as R&D is not the main focus of FDI surveys and therefore the R&D variables may not be checked as carefully as in more R&D related surveys. The US, where the FDI survey is the main source of information for outward R&D, has tried to analyse the relations with official R&D data with rather encouraging results. The level of details in the information on R&D can not be so high if R&D is a part of general FDI surveys.

If sufficient resources are available to investigate outward R&D, option (ii) seems to be the best one as it is widest in details. If a more limited amount of resources are available,

options (iii) and (iv) might be good alternatives taking into account the results of the testing described in the following chapter.

The EU Industrial R&D Investment Scoreboard

The EU R&D Industrial Investment Scoreboards (European Commission, 2004, 2005) were described in some detail in deliverable 6.1. They refer to the worldwide R&D investments of the top ultimate parent companies and provide comparisons between companies, sectors, and geographical areas, as well as a full picture of the competitive situation of EU firms in the global R&D environment. Major R&D-investing companies, regardless of where the R&D is performed, are focused. The 2004 edition includes data on the top 500 EU and top 500 non-EU companies, and correspondingly the 2005 edition of 700 firms in both groups.

The use for the purpose of measuring outward R&D is focused on the lists by country of the biggest R&D performing companies in EU with information on their global R&D investments taken from annual audited company reports and accounts. Information on total funding of R&D (intramural R&D+extramural R&D-external funding of R&D) from the R&D survey can be matched with the global amount of R&D expressed in the Scoreboard. The difference gives an indication of R&D financing of the company not directly attributable to the national part of the company reporting in the national R&D survey. This is not the same amount of money as is spent on R&D performed abroad as measured by in the survey based approaches described above. The amounts should theoretically be bigger as they also cover extramural R&D commissioned by the company to universities, research institutes and other companies. Nevertheless, it is assumed that this gives a sufficiently good indication of the order of magnitude for outward R&D.

This approach is already regularly used in Germany although on the basis of an own database of some 50 big companies. The feasibility of this approach has now been tested in Finland and Sweden with satisfactory results and it will be reported in chapter 5 below. The results using this approach are also compared with the results from survey based approaches.

Estimations from data on inward R&D

A third option to share data on the country distribution of inward R&D was tested within the OECD task force on R&D globalisation. For example, the R&D performed by Finnish companies abroad is estimated from what the most important destination countries reports as R&D performed by Finnish companies. Some preliminary results of this analysis (OECD, 2006a) show in a few cases a reasonably good fit but in most cases big discrepancies. These may be due to differences in the application of the ultimate beneficiary owner concept in different countries. For example the US information on affiliates of US companies in Finland is different from the Finnish information on US companies. These differences affect probably both the inward and outward information and may deserve further attention in coming work.

Other sources for indicators on R&D globalisation

Cross border ownership of inventions is a widely used indicator of the globalisation of technology, especially in various research projects. Some research was cited using this indicator in chapter 3. It is of less use in routine statistical production. This is one of the

OECD globalisation indicators and it is calculated as the share of patent applications to the EPO owned by foreign residents in total patents invented domestically and the share of patent applications to the EPO invented abroad in total patents owned by country residents.

Besides in-house activities, technological competence is increasingly being obtained, exploited and complemented by international strategic alliances between firms. Actually, cross-border strategic alliances is a form of R&D globalisation growing most rapidly at present. Also the involvement of Finnish firms in these alliances has increased fast especially since the late 1990s and particularly in the R&D activities of ICT firms (Palmberg and Pajarinen, 2006. Explorative alliances (incl. R&D) are important for small knowledge-intensive economies. There are several databases on strategic alliances, which have been used for research purposes. It may be possible to add some questions for example to existing surveys of R&D or innovation in order to construct a regular indicator on this.

Chapter 5

Results of surveys and use of the EU R&D Scoreboard

5.1 A pilot study on outward R&D in Finnish companies

5.1.1 Aims and implementation

Introduction

Statistics Finland undertook a survey on R&D globalisation in the major Finnish corporations in order to test its feasibility as a source of information and to obtain new figures on the extent of outward R&D (R&D in foreign affiliates of domestic firms). This was completed by further information on motives for conducting R&D overseas. Multinational companies included in the survey population of this ad hoc study were chosen by the volume of research and development. These were the biggest Finnish-owned companies according to their domestic R&D expenditure in the 2004 regular R&D survey.

The survey to multinationals was carried out mainly at the corporation level except a couple of companies, which were included at the division (business unit) level. The initial purpose was to get data from around 20 largest group of companies with the assumption that they were engaged in R&D activities not only in Finland, but also abroad. Therefore results would illustrate the R&D performance in the firms included in the study, not the total outward R&D for Finland. However, due to the great significance of these companies, further-reaching views and conclusions concerning business sector R&D activities throughout Finnish industries could be expected. Measured in terms of R&D expenditure, the coverage of this survey was about 69 per cent of total business enterprise R&D made by Finnish companies in Finland in 2004.

Definition of company's country of origin

The definition used in this study was in line with the OECD recommendations of the concept of a foreign-owned firm where the focus was on ultimate beneficiary owners of firms. The UBO criterion was used in defining the country of origin. A company was

considered domestic if at least 50 per cent of the shares with voting rights were in the control of a Finnish owner. Companies in which total foreign ownership was high but also so highly diversified that no single foreign shareholder ultimately had over 50 per cent of the voting rights, were not classified under the foreign firms' category. Thus, a company was considered Finnish when its ultimate parent also had its registered office in Finland.

Ownerships between corporations were determined by using the information provided by Statistics Finland's enterprise group register. Foreign ownership was determined by comparing the FATS list of foreign companies with the R&D survey data. Data on foreign-owned enterprises in Finland (inward FATS) is collected by the unit of Business Structures in Statistics Finland.

Questionnaire

The survey questionnaire was inspired with a high degree by the one used in Statistics Finland's previous R&D globalisation survey in 1998 and also by the surveys done in Sweden. Besides updates made by ourselves, ideas for modification of the form was requested also from the foreign counterparts involved in the project. The double-sided questionnaire consisted of issues dealing with the extent and motives for performing research and development activities overseas. To start with there was a question whether the company or corporation had foreign affiliates or subsidiaries which had conducted R&D in 2003 and/or 2004. If the answer was yes, then detailed information on R&D expenditure and personnel with country distribution were requested. Together with this there were some additional questions concerning problems, reliability, easiness and confidentiality related to the given information. Furthermore, firms were asked to estimate the importance of different motives for R&D activities in foreign host countries. The purpose of this was to shed some light on the reasons for globalisation in R&D.

Implementation of the survey

In the first stage the survey questionnaire was sent to 28 companies or groups. Later it was sent to two more corporations that had been split up from the parent company after statistical year 2004. As for one group of companies, the survey was addressed to a total of five separate business units, of which only one would have been among the survey population as such. All these five units reported not to have had R&D activities overseas, however. The questionnaire was not sent to two major domestic R&D conducting corporations, since it was already known earlier that they did not had any R&D operations abroad. One company was excluded because of the fact that it had become under foreign control in 2005.

The questionnaire was sent by e-mail in the end of November 2005. Companies were informed that Statistics Finland would contact them within a fortnight in order to agree with the ways of delivering data. The enquiry was primarily addressed to the contact persons in Statistics Finland's annual domestic R&D survey. The returning of the questionnaire was arranged on the phone. Overall, companies were well co-operative and the final reply was received by the end of January 2006. Responses were often given by another person instead the initial one whom the questionnaire had been sent to. Typically the respondent was for instance a director either in technology, R&D or finance.

Eventually the survey was responded by a total of 30 company groups. One corporation had forwarded the questionnaire to one of its separate affiliated groups, which gave a reply

even though it didn't exactly belong to the biggest R&D conducting companies in Finland. In two cases replies covered the whole corporation instead of the business unit which had been the original receiver. However, these particular units were responsible for most of the research and development work in their corporations anyway. 17 companies answered they conducted R&D operations also abroad and 10 that they had such activities only in Finland. Only three companies refused to answer.

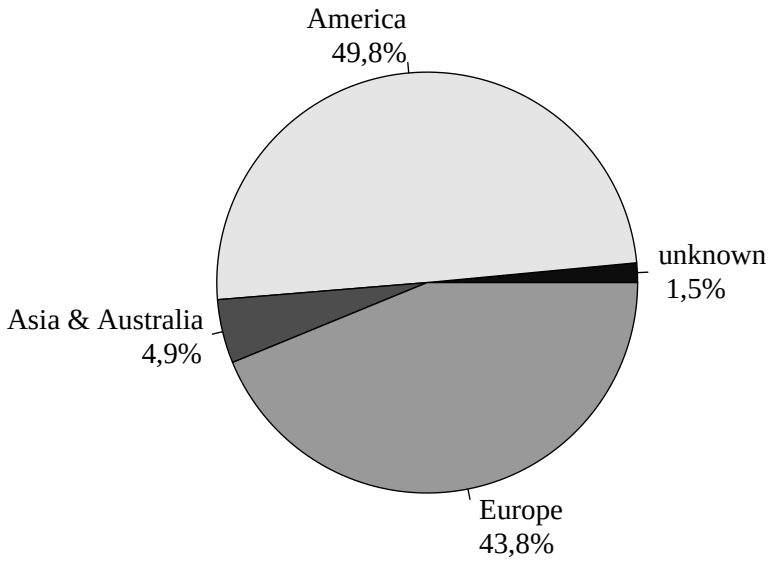
5.1.2 Results

Extent of outward R&D in 2004

The 2004 figures for the companies included in the survey show that almost 39 per cent of R&D expenditures and nearly 35 per cent of R&D personnel were in foreign affiliates. In nine out of the 27 companies which replied the share of outward R&D expenditure was under 25 per cent, in five between 25 and 50 per cent, and three of them more than half. The single highest proportion of foreign R&D was 75 per cent in expenditures and 80 per cent in the amount of employees. As already told, 10 companies reported not to been involved in R&D activities abroad, neither in 2003 nor in 2004.

As regards to the geographical distribution of R&D expenditure the share of America was almost 50 per cent and that of the United States alone 45 per cent. 44 per cent of the expenditure was spent in Europe, where the EU-15 area accounted for the most of it with a proportion of 41 per cent. The most significant countries in terms of Finnish companies' R&D expenditure in Europe were Germany, the United Kingdom and Sweden. Only 5 per cent of all outward R&D was located in Asia and Australia. The rest 1.5 per cent remained unknown.

Figure 5.1: R&D expenditures in foreign affiliates by region in 2004



Electronics industry appeared to be completely dominating the scene in a further examination of Finnish companies' R&D activities abroad with a rather rough industry break-

down. The share of electronics industry (subclasses 30–33 of NACE Rev.1.1) was 86 per cent of all R&D expenditure in 2004. Metals and engineering (subclasses 27–29, 34–35) accounted for slightly fewer than 6 per cent and wood processing industry (subclasses 20–21) close to 5 per cent. Thereby, the combined share of all the other branches was minor. A good 45 per cent of the R&D expenditure in wood processing was spent outside Finland. The corresponding shares for electronics industry was 40 per cent and for metals and engineering 35 per cent. Foreign subsidiaries' share of R&D expenditure was lowest in the chemical industry, only a few per cents.

Motives for R&D actives abroad

Besides R&D expenditure and personnel, motives for conducting research and development abroad was another essential thing, which was in focus in this pilot survey. Respondents were asked to estimate the importance of different reasons in conducting R&D activities in the host countries. Instead of a country by country outlook, a general view was aimed to be valued. Six various motives were given and the level of importance of each and every one of them was requested to be estimated on a four-figure scale from 'unimportant' to 'extremely important'. In addition to this it was possible to add other motives and to give further information concerning motives for overseas R&D and their relevance.

The most important motives for the internationalisation of R&D activities were demand-side factors. Giving support to local production and marketing was ranked the highest among all the motives for conducting R&D abroad. It scored a mean of 2.3 at the scale 0–3. 53 per cent of the respondents found this reason 'extremely important' and 29 per cent 'important'. Getting into closer contact with important markets was rated as an extremely important factor by 35 per cent and as an important by 41 per cent of the companies. Its mean value was 2.1. Other motives including supply-side factors were found clearly less important with means between 1.3 and 1.6. These four did not receive the figure 'extremely important' apart from a few exceptions. Good availability of skilled R&D personnel was estimated an important factor by 59 per cent, however. More than half of the respondents thought both acquiring technology and cost savings to be not more than just 'slightly important' as regards to outward R&D activities. Only 41 per cent of companies esteemed close connections with local universities and research institutes important. Overall, cost savings got the lowest mean (1.3).

A couple of respondents also gave comments on the motives presented in the questionnaire. Acquisitions were mentioned as a reason for conducting R&D abroad. Good availability of know-how i.e. qualified R&D personnel was found very important especially in greenfield investments. Despite that so far R&D costs have not been a disadvantage for Finland in comparison with other industrialised countries, acquiring cost-effective R&D was reckoned a factor with increasing importance already from the year 2005 on. This provides that skilful personnel will be available in lower-cost countries like China and India. On the other hand, in certain industries skilled employees already begin to be available almost everywhere. One respondent found acquiring technology an unclear variable. It remains to be seen if that has been mistaken more commonly too, because it was not considered as a very important motive, unlike in Statistic Finland's previous survey in the late 1990s.

Table 5.1: Motives for conducting R&D abroad

Motive	**Level of importance**, % of total					
	0	1	2	3	total	mean
Giving support to local production and marketing	6	12	29	53	100	2.3
Getting into closer contact with important markets (lead market)	0	24	41	35	100	2.1
Acquiring technology	13	44	38	6	100	1.4
Good availability of skilled R&D personnel	0	41	59	0	100	1.6
Close connections with local universities and research institutes	0	59	35	6	100	1.5
Cost savings in R&D	24	29	41	6	100	1.3

Note: Level of importance: 0 unimportant, 1 slightly important, 2 important, 3 extremely important.

Questions related to provided data and some general remarks

Responses given by the companies were adequate enough to be further analysed in order to calculate shares of outward R&D in 2004[1]. Overall, the survey can be considered rather straightforward from companies' point of view, since only a couple of them specified problems in providing the R&D data. Confidentiality of the data and response burden may sometimes set a limit in replying. Difficulties in breaking down R&D resources between various countries can be difficult, because companies' monitoring is often based on business units instead of geographical regions. A key to locate R&D expenditure between these sub-units around the world is sometimes simply missing.

Problems involved in reporting came up in three answers. One corporation gave only numbers for R&D personnel divided by country of location and another company only the distribution of R&D expenditures, respectively. Missing data values for these companies were estimated/imputed by using information obtained from a comparison (UBS, 2003) between engineers' average annual incomes in capitals of various countries in 2003. Furthermore, one company gave its R&D data only with the division between Finland and other countries and one other did not mention separately countries that were minor in terms of R&D activities. The problematic nature in the concept of funding vs. performing emerged again when R&D is performed between technology centres of a group, but reported to be conducted only by the unit, which is responsible for the costs.

Around 47 per cent of the respondents answered there was no difference between the two variables, when it was asked whether R&D expenditure or personnel gave a more reliable picture of R&D activities' country distribution in foreign subsidiaries of a corporation. R&D personnel was considered a more reliable variable by 29 per cent of the companies. When the mutual easiness of these two variables as for providing data was asked, 41 per cent of the responses were of the opinion that there was no difference. A good one third, 35 per cent, of the firms found R&D expenditure easier to give than R&D personnel, however.

[1]Figures for 2003 were not complete enough to be extensively analysed except for some comparisons with 2004 data.

It was also asked how confidential the data concerning country division of R&D activities were from the company view. According to 41 per cent of the companies 'data can be released for research purposes and they are possible to publish at such industry level, which does not allow obvious identification'. Another 35 per cent of companies replied 'data are not disclosed'. However, many companies that answered this way, gave out data concerning country division of R&D activities anyway. This seems to show that question was not always understood right. Therefore responses in this category can be combined with the answers in 'data are released for research purposes and possible to publish only at total industry level'. Then a total of 59 per cent of all responses fell on these two categories. Not a single firm answered their data to be 'entirely public, to be released as such'.

5.1.3 Comparison with other surveys

Results of a similar study in Poland[2]

A commonly known fact is that in the former transition economies, foreign affiliates have become important R&D players since the mid-1990s. This concerns also Poland, the biggest of the new EU member countries, as R&D centres are being set up by multinational companies. The share of inward R&D of the total business enterprise R&D expenditure in Poland was 16.3 per cent in 2004.

Continuous improvement of measuring inward R&D and methodological work on how to capture outward R&D by Polish companies are very important tasks for Polish R&D statistics in the forthcoming future. In order to fill these needs GUS, the Central Statistical Office of Poland conducted also within the KEI project a short ad hoc survey on outward R&D (Niedbalska, 2006). This effort to measure globalisation was based to a great extent on Statistics Finland's methodology. It revealed the current plans of some Polish companies to embark on conducting R&D abroad in foreign affiliates. The surveyed population was a small number of R&D performing technology-based companies that have recently succeeded in their endeavours to enter international markets.

Nowadays, the main goal of Polish companies expanding their activities abroad and building foreign affiliates is to entry into world markets with Polish innovative products developed by themselves or in co-operation with Polish scientific institutions. Hence, outward R&D becomes a kind of by-work. However, R&D can also be a principal activity of the foreign subsidiary, since there are firms that are now organising foreign affiliates first of all to perform R&D by setting up a subsidiary to conduct R&D using local experience.

Firms expanding their activities abroad plan to conduct R&D activity in foreign affiliates first of all in order to: (1) give support to local production and marketing; (2) to get into closer contact with important markets; and (3) to acquire technology. Another important motive was co-operation better than competition with local enterprises.

R&D personnel was considered to be a variable that is easier to providing data than R&D expenditure. As regards the reliability of R&D activities' country division by foreign

[2]An adaptation of a paper by Dr. Grazyna Niedbalska, Central Statistical Office of Poland.

affiliates given by the two variables, opinions varied. R&D personnel seemed to have a little advantage over R&D expenditure.

Firms were rather not eager to reveal their plans concerning R&D activities abroad in a voluntary telephone interview. Such information was considered to be confidential although possible to transmit for research purposes on certain conditions.

A brief comparison between results in Finland and Poland tells that the ranking of motives in both the studies was alike. The same does not exactly apply to questions dealing with the easiness and reliability of the variables in the study. With relation to them, in Finland most of the respondents did not see much difference between R&D personnel and expenditure, but the latter was found somewhat easier in contrast to Polish experience.

Information provided by Dutch national R&D surveys[3]

Some comparison exercises were conducted also by Statistics Netherlands (Kuipers, 2006) within the KEI project in order to obtain information on R&D globalisation. An actual outward R&D pilot survey accordant with Statistic Finland's example is planned to be conducted later.

Statistics Netherlands has been compiling data on the performance and funding of research and development in the Netherlands for over a long period. Among others, the following variables are being captured in the actual R&D surveys: R&D funded by enterprises seated in the Netherlands, but performed by others and R&D performed by enterprises seated in the Netherlands, but funded by others. The category 'others' is broken down by different types: enterprises belonging to the same enterprise group, other enterprises, universities etc., and by location (own country, abroad).

During the last decade the growth of the R&D which is subcontracted by companies has been much higher than the growth of total R&D expenditure. And the part being subcontracted abroad has increased even more. A discrepancy between funding and actual performing of R&D has been growing in business enterprises. The amount of Dutch companies' R&D funds being re-allocated via subcontracting as a proportion of total BERD has increased from 16 per cent in 1990 to 26 per cent in 2003. And the share of R&D funds abroad of all the subcontracted money has grown from 36 to nearly 40 per cent during the same period. Despite increasing over the years, the share of R&D funds subcontracted abroad has always been substantial.

Likewise the part of funds being subcontracted, them received for performing R&D have grown more quickly than the overall level of R&D expenditure. And in the case of funding from abroad, the growth is even more extreme than in the case of subcontracting R&D abroad. The way these flows are captured in the actual R&D survey is not necessarily a closed circuit or a balanced bookkeeping.

Expressed as a percentage of R&D expenditure performed by the business enterprise sector, the amount of R&D funds coming from third parties (excluding government) have increased from 8.6 percent in 1990 (19.3 % including government) to 22.8 per cent in 2003 (26.7 % incl. government). The share of R&D funds coming from abroad in this total funding by third parties, has grown from 31.7 per cent (14.2 % incl. government) to 61.9 per cent (56.0 % incl. government) during the same period.

[3]An adaptation of a paper by Andries Kuipers, Statistics Netherlands.

If the cross-border financial flows are treated as imports and exports of R&D, they both have increased significantly over the years. The Dutch business enterprise sector is a 'net-exporter' of R&D. A relevant question is to which degree is this development dominated by a restricted number of large multinational enterprises?

KEI survey in comparison with other Finnish studies

Table 5.2 presents a collection of results in various studies[4] on globalisation of R&D in Finnish companies. A comparison between them seems to show that the information on the scale of foreign R&D activities provided by our pilot survey would match rather well with earlier studies. Taking into account the progression and pace of globalisation in recent years and the number and type of companies included in each study, we can state that it's possible to obtain useful and current information by implementing a simple ad hoc survey like ours.

Table 5.2: Comparison between data provided by various studies

Study	**No. of firms**	**Foreign share of R&D expenditure, %**	**Share of outward R&D, %**				**Foreign share of R&D personnel, %**
			North America	Europe	EU-15	Electronics, metals and engineering industry	
Koskinen 1999	19	30.5	28.3	67.2		79.3	30.2
Lovio 2005b	16	44.3					37.2
EK 2006	312	34.7	*37.5		*47.7	92.1	23.1
KEI 2006	27	38.5	49.8	43.8	40.9	91.7	34.6

Note: * EK, Confederation of Finnish Industries, 2004, estimates for 2004.

Companies' R&D performance abroad has strengthened notably as regards to our new results in comparison to the previous corresponding study (Koskinen, 1999) conducted in Statistics Finland. The foreign share of R&D expenditure has risen eight percentage points and also that of R&D personnel over four percentage points from 1998 to 2004. The proportions of outward R&D expenditure and personnel in major Finnish corporations were around 30 per cent in 1998. Both electronics, metals and engineering as industry and North America as area of location have clearly increased their significance. The share of Asia and Australia has remained unchanged at 5 per cent since 1998, but that of Europe has gone down.

Following the results of the general investment survey by EK, the Confederation of Finnish Industries, nearly 35 per cent of the R&D expenditure by Finnish manufacturing companies was spent abroad in 2004 (EK, Confederation of Finnish Industries, 2006). Thus, there is a difference of four percentage points in the proportions of outward R&D expenditure provided by our survey and the general investment survey. This was expected since the samples of firms in these surveys were totally of a different size. However, the deviation in the results was not greater than that because the great majority of Finnish companies' overseas R&D performance is conducted by a rather few actors. According

[4]These studies were presented in the first deliverable (D6.1, 2005) of KEI work package 6.

to both the studies as well, the share of electronics, mechanical engineering and metals branch was about 92 per cent of all outward R&D. Surely discrepancies can also be found, since the share of R&D personnel in foreign affiliates is remarkably low according to EK in comparison with the results in KEI. In addition to this the proportion of Europe exceeds that of North America along with the more extensive sample in the general investment survey. In accordance with the one-year earlier investment survey the estimated shares were 48 per cent for the EU-15, nearly 38 per cent for North America and 13 per cent for Asia.

On the other hand, in R.Lovio's studies the shares of outward R&D expenditure rose apparently higher than in the KEI survey. According to the results of his data analysis in the context of MEFIS studies (Lovio, 2005b) based on company information and author's estimates, the foreign shares of R&D in 16 most relevant large Finnish companies were 44 per cent for expenditures (in 2001) and 37 per cent for personnel (in 2002). Hence, the difference in the share of R&D personnel was minor, only 1.4 percentage points compared with the KEI figure.

Practically the ranking order of motives for conducting R&D activities in foreign host countries has not changed compared to Statistics Finland's previous study in late 1990s. Demand-side factors: giving support to local production and marketing, and getting into closer contact with important markets (lead market) were estimated the most important motives behind the internationalisation of R&D both in 1998 and in 2004. Supply-side factors like acquiring technology and good availability of skilled R&D personnel were found notably less significant in both years, respectively. Neither close connections with local universities nor research institutes did particularly motivate in either year. In 1998 local regulations and technology policy and co-operation with local enterprises had the least importance, in 2004 cost savings in R&D. However, a combination of different demand and supply side motives: proximity to customers, and the availability and skills of personnel were decisive locational factors according to a recent Finnish study by Ali–Yrrkö and Palmberg (2006), which was based on insights from 17 large Finnish firms. Also various intermediating factors relating to the broader institutional setting for R&D were important.

5.2 Comparison with the EU R&D Scoreboard data

Along with the objective to test the feasibility of the survey as a source of data and to produce some real estimations on outward R&D, another aim in this exercise was to match external sources on multinationals' global R&D with the national R&D survey data. Therefore the target was to find out and describe the usefulness of the EU R&D Scoreboard as an alternative way of providing data on R&D globalisation. It is possible to get company-specific information on funding of R&D activities by division Finland versus other countries as a combination of R&D data derived from Statistics Finland's annual survey and the EU Scoreboard. Scoreboard's information on globally financed R&D can be compared with what is funded nationally according to the official R&D survey for the domestic parts of the corporations included in the R&D Scoreboard (roughly intramural+extramural-externally funded R&D).

Data contents of the EU Industrial R&D Investment Scoreboards (European Commission 2004, 2005) includes the total business enterprise R&D investment by country and sector of economic activity, among others. The 2004 edition contains data on 28 biggest Finnish firms (ultimate parent companies) in terms of R&D investments in 2003, and the 2005 edition data on 43 firms in 2004. Information presented in the publication have been prepared from companies' annual reports and audited accounts. R&D includes only investments funded by, and performed for, the companies themselves. R&D undertaken under contract is excluded always when clearly identified.

Funding vs. activity distinction must be borne in mind once again. It is not possible to calculate the amount of outward R&D directly by deducting domestic R&D expenditure (excluding external funding) based on annual surveys from the total R&D funding, which are available in the R&D Scoreboard. The reason is that the net difference contains both R&D performed abroad and outsourced (subcontracted) R&D which could either have been done in the home (Finland) or in the host (overseas) country.

Table 5.3 includes a comparison of outward shares of R&D expenditure and personnel with the foreign share of R&D funding. The former are derived from the KEI survey and the latter from the EU Scoreboard. It appeared that complete data for a brief comparison like this was possible for only seven companies in 2003 and two more in 2004. KEI figures for companies in two enterprise groups were aggregated in order to make possible comparisons with the Scoreboard information. The share of outward R&D of total R&D funding was 53 per cent in the 43 Finnish companies included in the EU Scoreboard. According to the KEI pilot survey, the share of outward R&D expenditure was 39 per cent in 2004.

We can see in the tables that in some cases the three R&D figures match fairly well. These are companies number 2, 4 and 7 in 2003, and number 2, 4, 7, 9 and 10 in 2004. Otherwise it seems the outward R&D shares based on KEI data Statistics Finland's annual survey have a lot of differences compared with the Scoreboard information. In general, share of overseas R&D funding derived from the latter are higher than proportion of R&D expenditure, which is expected because of the outsourced R&D which can be done either home or abroad. Overall, 2004 figures correspond better than 2003 ones.

In any case, the R&D Scoreboard appeared to be useful tool in the efforts of measuring the share of foreign subsidiaries of a corporation's total funding for research and development. Overall, it seems to work well as a data source for firms' R&D investments. The publication is, indeed, fairly comprehensive in the sense that it contains complete and selected information and this allows the user to avoid lots of time-consuming data collection. Information presented in the Scoreboard and in companies own financial reports matched precisely apart from a couple of exceptions. Noticed differences were modest, however.

The R&D Scoreboard does not include, however, a few Finnish groups, which are remarkable R&D conducting companies. Respectively it contains some foreign-owned firms. In this sense the 2005 edition is more precise than the 2004 publication, but the fact that one of the most important Finnish R&D performing firms lacks from both of them puts on a big question mark. This particular company does not publish R&D figures in its reports, which might be the explanation.

Statistics Sweden also conducted a brief comparison survey (Daniels, 2006) between Swedish national R&D data and the EU Scoreboard 2004 (European Commission, 2004) data

Table 5.3: Comparison between KEI and EU Scoreboard R&D data in 2003 and 2004

A: 2003	**KEI survey**		**EU Scoreboard***
Company or group, no.	Share of outward R&D expenditure	Share of outward R&D personnel	Foreign share of R&D funding
1	21.6	18.0	37.1
2	65.3	60.5	65.2
3	51.2	63.3	65.3
4	23.1	18.2	19.6
5	37.5	56.4	15.2
6	3.1	2.8	51.1
7	2.1	1.5	0.0

B: 2004	**KEI survey**		**EU Scoreboard***
Company or group, no.	Share of outward R&D expenditure	Share of outward R&D personnel	Foreign share of R&D funding
1	22.3	25.6	31.2
2	64.3	63.2	65.4
3	50.9	64.1	48.6
4	21.6	20.3	20.6
6	1.8	2.2	10.9
7	3.7	2.7	5.5
8	41.0	36.7	56.6
9	49.8	46.7	52.0
10	1.1	4.3	3.6

* Domestic R&D funding (intramural+extramural-external R&D) by regular R&D survey in relation to total R&D funding obtained from Scoreboard.

in order to find out the data quality and usefulness of an alternative data source for future needs. It focused on the 20 biggest groups spending R&D in Sweden and abroad according to the report 'R&D in international firms 2003' (ITPS, 2005). Former Swedish R&D firms, before and after they got foreign owned, were also compared. The aim in this exercise was to verify the 2004 EU R&D Scoreboard on an aggregated level as a proxy for outward R&D, for the companies in the Scoreboard.

In the 43 enterprise groups presented in the EU Scoreboard the share of outward R&D of total R&D funding was 49 per cent. The corresponding share for the 20 groups in the Swedish business enterprise R&D survey was 43 percent.

As regards to the 17 groups included in both the Scoreboard and Swedish statistics, the following table concerning the share of number of groups and difference between R&D costs resulted. The majority of the companies where inside ± 5 per cent interval and grade with 'very good', and only one out of five companies had a difference that was larger than ± 15 per cent.

As a conclusion the EU Scoreboard was noticed to include both undercoverage (some missing enterprises) and also overcoverage. Generally there appeared to be a good comparability between Swedish data and EU scoreboard data despite some problems.

Table 5.4: Comparison between the EU Scoreboard 2004 and Swedish national 2003 data

Very good	58 %	± 5 %
Good	18 %	± 10 %
Acceptable	6 %	± 15 %
Worse	18 %	> 15 %

In the Netherlands, a confrontation of national R&D surveys and the EU Industrial R&D Investment Scoreboard may shed light on the relation between these two sources (Kuipers, 2006). Under certain restrictions the worldwide R&D expenditure of Dutch multinationals could be estimated by the variables from the national R&D survey by the following approach:

+ R&D expenditure with own personnel

+ R&D expenditure subcontracted

– R&D financed by others

– R&D expenditure, subcontracted within the same enterprise group

+ R&D financed by enterprises within the same enterprise group

= R&D expenditure

The aggregated result of this approach is shown for 17 multinationals being part of the 2004 Scoreboard and also of the national R&D survey. Only 43 percent of the R&D investment of these companies can be traced via the national R&D-survey. There are a number of methodological reasons concerning the definition of R&D and the 'true' nationality of an MNE. One of the reasons for these large differences may be the fact that although there is a large increase of financial flows between enterprises belonging to the same group, this covers not the whole budget for R&D and the allocation of this budget of these large multinationals. In the R&D survey enterprises are asked to estimate their R&D expenditure with own personnel as far as performed in the Netherlands. Besides that they are asked to estimate the amount of money available for R&D but actually subcontracted to others. And, the opposite of this, the amount of money made available for R&D by others but performed by the enterprise involved here. Maybe not all R&D funds are centralised completely within a multinational and allocated from there, even if it concerns 'headquarters'.

Chapter 6

Conclusions and recommendations

This report has dealt with indicators of R&D globalisation in order to show the role of multinationals for information on R&D. This is a part of a broader spectrum of globalisation indicators, which are needed to understand the phenomenon.

As it was shown in chapter 2, there seems to be a clear policy need for improved indicators on globalisation. There are several policy measures to increase the amount of R&D globalisation. Several kinds of indicators are needed to monitor progress. Some of them exist already, but some have to be developed. A specific policy interest is to know better the relation between foreign owned R&D performed in the country and R&D performed abroad by domestic companies. This report deals in particular with this issue.

A survey of the literature described in chapter 3 shows special ad hoc studies of this in many countries. The comparability of these may be rather limited. A few countries, however, produce these indicators on a regular basis. The aim of the whole subproject of KEI on which this paper is based is to stimulate regular data production in more countries and discuss various possibilities of how this could be done.

On the basis of the methodological options suggested in chapter 4, some pilot studies have been described in chapter 5 to outline options for how to go further with the work.

The results of the piloting exercises explained above show that it is possible to integrate the aspect of measuring outward R&D in several ways to existing statistics. A lot of experience is already available in countries and it is now an issue on further harmonisation of the data.

It is possible to develop a simple survey instrument to be used in connection with the R&D survey to collect information on outward R&D. Maybe it could also be possible to only add some questions on outward R&D in existing R&D surveys. A concrete proposal for this, which is based on the questionnaire tested by Statistics Finland, is available in the annex. This can be done for both R&D expenditure and personnel. Some details about country or country group breakdowns and some simple questions on reasons for having R&D abroad could also be included.

A matching between the company data of the EU R&D Investment Scoreboard and the corresponding company data from the R&D surveys is also feasible and can be done with rather limited resources (a few days work). This does not give the same result as the

survey, but gives indication of the order of magnitude. Only outward R&D expenditures can be estimated in that way. Neither breakdown by country or motives for globalisation is possible to be evaluated.

Both for information on outward and inward R&D, it is very important to ensure the quality of the information on ownership. Multiple sources for information on the UBO ownership including special questions in surveys could be used to check the information.

As the activities of the multinational companies are becoming more and more global and a split of activities between various countries will be more and more difficult, perhaps in the future data collection on R&D and other variables will be on the group level, and less on the enterprise level, which is now the standard practise. Some exploratory work in that direction has already started in a joint ECE, OECD and EU project lead by Statistics Canada. The EU plans to establish a register over enterprise groups in EU also contributes to this.

Bibliography

Åkerblom, M. (1994) Internationalization of Research and Development Operations of Finnish Companies. Science and Technology 1994:1B, Statistics Finland.

Ali–Yrrkö, J. and Palmberg, C. (2006) Location advantages in R &D - Insightsalliance from large Finnish firms. In *Finland and the Globalisation of Innovation*, eds J. Ali–Yrrkö and C. Palmberg, pp. 59–82. ETLA Series B 218.

BEA, U.S. Direct Investment Abroad (2004) Final Results from the 1999 Benchmark Survey. U.S. Bureau of Economic Analysis. Washington, DC: U.S. Government Printing Office.

Bloom, N. and Griffith, R. (2001) The Internationalisation of UK R&D. *Fiscal Studies* **22**(3), 337–355.

Census Bureau, Bureau of Economic Analysis and National Science Foundation/Division of Science Resources Statistics (2005) Research and Development Data Link Project. Final Report.

Cornet, M. and Rensman, M. (2001) The location of R&D in the Netherlands. Trends, determinants and policy, Central Planning Office, CPB , no. 14, The Hague.

Cozza, C. and Perani, G. (2006) International flows of R&D expenditure: a note from the Italian business R&D. A paper prepared for the KEI Workshop, Helsinki, 3 March 2006.

Daniels, M. (2006) Measuring Globalisation of R&D - Swedish experience. A paper prepared for the KEI project, Statistics Sweden.

DTI (2004) The 2004 R&D Scoreboard. United Kingdom Department of Trade & Industry.

EK, Confederation of Finnish Industries (2004) Investment survey. June, 2004.

EK, Confederation of Finnish Industries (2006) Investment survey. June, 2006.

Erken, H. and Gilsing, V. (2005) Relocation of R&D – a Dutch perspective. *Technovation* **25**, 1079–1092.

Erken, H., Gilsing, V. and van Hoorn, A. (2005a) Internationalization of R&D within small, open economies – The Dutch case (a draft). Ministry of Economic Affairs.

Erken, H., Kleijn, M. and Lantzendörffer, F. (2005b) Improving theR&D investment climate: Sharpening a double-edged sword. Research Series Ministry of Economic Affairs, PUBnr 05O121.

European Commission (2004) The 2004 EU Industrial R&D Investment Scoreboard.

European Commission (2005) The 2005 EU Industrial R&D Investment Scoreboard.

Florida, R. (1997) The globalisation of R&D: results of a survey of foreign-affiliated R&D laboratories in the USA. *Research Policy* **26**, 85–103.

Francoz, D. (2003) The R&D activity of firms under foreign control in France. Working party on statistics, OECD, DSTI/EAS/IND/SWP(2003)5.

Grenzmann, C. (2006) Measuring the globalisation of R&D - the German experience. A presentation at the KEI Workshop, Stifterverband, Helsinki, 3 March 2006.

Hatzichronoglou, T. (2005) Measurement issues concerning the internationalisation of R&D: challenges and opportunities. A paper presented at the Forum on Internationalisation of R&D, OECD, Brussels, 30 March 2005.

Hicks, D. and Hedge, D. (2005) The Maturation of Global Corporate R&D: Theory and Evidence. Working paper #3, School of Public Policy, Georgia Institute of Technology.

ITPS (2005) Research and Development at International Enterprises 2003. Report S2005:005.

Jankowski, J. E. (2005) Measurement of MNE R&D: Insights from Microdata Linking of BERD and Affiliate Data. A presentation at the Forum on Internationalisation of R&D, National Science Foundation, Brussels, 30 March 2005.

Jankowski, J. E. (2006) Measuring R&D Globalisation: the U.S. Experience. A presentation at the KEI workshop, National Science Foundation, Helsinki, 3 March 2006.

Karlsson (ed.), M. (2006) The Internationalization of Corporate R &D - Leveraging the Changing Geography of Innovation. A2006:007, ITPS 2006.

Koskinen, J. (1999) Internationalization of R&D in Finnish firms. In *Cross-Border R&D in a Small Country: the Case of Finland: 11–39*, eds Pajarinen and Ylä-Anttila.

Kuemmerle, W. (1999) FDI in industrial research in the pharmaceutical and electronics industries: results from a survey of MNEs. *Research Policy* **28**, 179–193.

Kuipers, A. (2006) Internationalisation of R&D in the Netherlands. A paper (draft) prepared for the KEI Project, Statistics Netherlands.

Lovio, R. (2005a) The Globalization of Finnish Corporations – Similarities and Differences in Their Current Profiles. In *Multinational Enterprises in the Finnish Innovation System*, eds J. Ali-Yrkkö, R.Lovio and P. Ylä-Anttila, ETLA Series B 208, pp. 11–38.

Lovio, R. (2005b) Internationalization of R&D Activities of Finnish Corporations – Recent Facts and Management and Policy Issues. In *Multinational Enterprises in the Finnish Innovation System*, eds J. Ali-Yrkkö, R. Lovio and P. Ylä- Anttila, ETLA Series B 208, pp. 39–74.

LTT Research Ltd (2005) Assessment of the Impact of Off-shoring R &D on the Innovation Potential of EU Companies. ENTR/05/014. Proposal Prepared for European Commission DG Enterprise and Industry.

Madeuf, B. (2001) *La globalisation de la recherche-developpement: le cas des enterprises francaises*. Education & formations nr 59-avril-juin 2001.

National Science Board (2006) *Science and Engineering Indicators 2006*. vol.1: 4-56–62, Arlington, VA.

Niedbalska, G. (2006) Measuring Globalisation of R&D - the Polish experience. A paper prepared for the KEI project.

OECD (2002) *Frascati Manual. Proposed Standard Practice for Surveys on Research and Experimental Development*. OECD, Paris.

OECD (2004) *Science, Technology and Industry Outlook 2004*.

OECD (2005a) *Economic Globalisation Indicators. Measuring Globalisation*. OECD, Paris.

OECD (2005b) *Handbook on Economic Globalisation Indicators. Measuring Globalisation*. OECD, Paris.

OECD (2005c) *Science, Technology and Industry Scoreboard 2005*. OECD, Paris.

OECD (2006a) *Note on R&D internationalisation: a pilot exercise undertaken by the NESTI task force*. DSTI/EAS/STP/NESTI(2006)22.

OECD (2006b) *Main Science and Technology Indicators*. OECD, Paris. Volume 2006/1.

OECD and Belgian Science Policy (2005) Background Report. Internationalisation of R&D: Trends, Issues and Implications for S&T policies. A review of the literature. Forum on Internationalisation of R&D. Brussels, 29–30 March.

Pajarinen, M. (1999) Foreign firms and their R&D in Finland. In *Cross-Border R&D in a Small Country: the Case of Finland*, eds Pajarinen and Ylä-Anttila, pp. 91–134.

Pajarinen, M. and Ylä-Anttila (eds.), P. (1999) *Cross-Border R&D in a Small Country: the Case of Finland*. Taloustieto Oy, Helsinki.

Palmberg, C. and Pajarinen, M. (2004) The Global Dispersion of Innovative Activities – the case of Finnish Multinationals. ETLA Discussion papers No. 916.

Palmberg, C. and Pajarinen, M. (2006) Alliance captalism and the internationalisation of Finnish firms. In *Finland and the Globalisation of Innovation*, eds J. Ali–Yrrkö and C. Palmberg, pp. 85–121. ETLA Series B 218.

Patel, P. and Vega, M. (1999) Patterns of internationalisation of corporate technology: location versus home country advantages. *Research Policy* **28**, 145–155.

Pearce, R. and Singh, S. (1992) Internationalisation of R&D among the world's leading enterprises: survey analysis of organisation and motivation. In *Technology Management and International Business*, eds O. Granstrand, L. Hakanson and S. Sjölander, pp. 137–162. Wiley & Sons.

Sachwald, F. (2005) The development of global differentiated R&D networks. A presentation at the Forum on the Internationalisation of R&D, IFRI, Brussels, 29 March 2005.

Stifterverband (2006) FuE–Datenreport 2005/2006. Forschung und Entwicklung in der Wirtschaft. Bericht über die FuE–Erhebungen 2003/2004. Wissenschaftsstatistik, Stifterverband für die Deutsche Wirtschaft, Essen.

Teirlinck, P. (2005) Location and Agglomeration of Foreign R&D Activities in a Small Open Economy. In *Beyond Borders*, eds A. Spithoven and P. Teirlinck, Internationalisation of R&D and Policy Implications for Small Open Economies, pp. 207–234. Elsevier 2005.

UBS (2003) Prices and Earnings. A comparision of purchasing power around the globe / 2003 edition. UBS, Zürich.

UNCTAD (2005a) Transnational Corporations and the Internationalization of R&D. World investment report 2005, United Nations Conference on Trade and Development, New York and Genova.

UNCTAD (2005b) Survey on the Internationalization of R&D. Current patterns and prospects on the internationalization of R&D. Occasional note, United Nations Conference on Trade and Development, UNCTAD/WEB/ITE/IIA/2005/12.

Veugelers, R. (2005) Internationalization of R &D: Policy Implications. Note prepared for Commissioner Potocnik's Group on „Knowledge for Growth". European Commission, Bureau of European Policy Advisers.

Zeile, W. J. (2004) Operations of U.S. Affiliates of Foreign Companies: Preliminary Results From the 2002 Benchmark Survey. *Survey of Current Business* **8**, 192–217 (BEA's monthly journal).

Interviews

17 August 2005 Nokia Corporation, Espoo; Erkki Ormala and Ida Andersson

23 August 2005 Stifterverband für die Deutsche Wissenschaft, Essen; Christoph Grenzmann and Joachim Wudtke

24 August 2005 CBS (Statistics Netherlands), Voorburg; Gerhard Meinen

6 September 2005 ITPS (the Swedish Institute for Growth Policy Studies), Stockholm; Lars Bager-Sjögren, Martin Daniels, Philip Löf and Anne-Christine Strandell

19 September 2005 GUS (Central Statistical Office of Poland), Warsaw; Grazyna Niedbalska and Dariusz Piechal

Annex: a proposal for a questionnaire concerning companies' outward R&D activities

Annex: a proposal for a questionnaire concerning companies' outward R&D activities

1. General Information

Group _____

Contact person _____

Contact information (telephone, fax, e-mail) _____

_____

2. Does the Group or Company have Foreign Subsidiaries conducting R&D in 2005 and/or 2006 ?

YES ☐ If the answer is yes, we ask for an estimate for R&D expenditure and personnel (HC) by country 2005 in/or 2006

NO ☐ If the answer is no, we ask you to return this questionnaire or let us otherwise know it

Country	**R&D personnel** Head count (HC) as at 31.12.		**R&D expenditure** (EUR 1,000)	
	2005	**2006**	**2005**	**2006**
Total				

Questions related to preceding information

Which were the most important problems providing the information?

_____

_____

Which of the following two variables gives a more reliable picture of R&D activities' country division by foreign subsidiaries in your group:

R&D personnel ☐ R&D expenditure ☐ No difference ☐

Which of the following two variables is easier as for providing data:

R&D personnel ☐ R&D expenditure ☐ No difference ☐

3. Motives for R&D Activities in Abroad

Please estimate the importance of the following reasons in conducting R&D activities in the host country by circling the appropriate figure. A general view of all host countries is requested.

	Unimportant	Slightly important	Important	Extremely important
Giving support to local production and marketing	0	1	2	3
Getting into closer contact with important markets (lead market)	0	1	2	3
Acquiring technology	0	1	2	3
Good availability of skilled R&D personnel	0	1	2	3
Close connections with local universities and research institutes	0	1	2	3
Cost savings in R&D	0	1	2	3
Other reasons (which?)	0	1	2	3

Further information (e.g. relevance of the motives, important motives missing?)

_____

_____

_____

_____

_____

_____