Workpackage 6

State-of-the-Art Report on the Role of Multinational Enterprises for Information on R&D

Deliverable 6.1

2005

List of contributors:

Tero Luhtala, Mikael Åkerblom, Statistics Finland

Main responsibility:

Tero Luhtala, Mikael Åkerblom, Statistics Finland

CIS8–CT–2004–502529 KEI

The project is supported by European Commission by funding from the Sixth Framework Programme for Research.

`http://europa.eu.int/comm/research/index_en.cfm`

`http://europa.eu.int/comm/research/fp6/ssp/kei_en.htm`

`http://www.cordis.lu/citizens/kick_off3.htm`

`http://kei.publicstatistics.net/`

Preface

This report is the first 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 (`http://kei.publicstatistics.net`) 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. The first part of this report offers a review of what is known on R&D globalisation. The focus is on existing literature on the topic. The second part provides foundation for further work in efforts of measuring the scale and scope of cross-border R&D.

Contents

List of Figures

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, and indicators are 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 multinational companies have difficulties in properly splitting up their R&D resources between various countries. R&D flows within a multinational 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. In some countries R&D activities in the business enterprise sector are more and 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 scarce.

The aim of WP6 of KEI is 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. There are several issues to be tackled. The work package will address the problems in splitting global R&D resources of multinationals between various countries. The identification of multinationals, their parents and affiliates is one of the tasks. The main research topic, however, is 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).

This work package will as far as possible test recommendations in the OECD globalisation manual. 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.

The work is being performed in close co-operation with four countries: Germany, the Netherlands, Poland and Sweden from which experience and opinions will be collected in particular.

Three separate reports will be produced along with the work package. This first report is a review of what is known on the topic. The second one will discuss various methodological options in more detail as basis for testing. The final report will integrate the two first ones with the results, conclusions and recommendations of the whole work package.

This first state-of-the-art report will review two main issues. The first one covers country experiences so far on measuring internationalisation of R&D based on a selective review of the literature and interviews. The second issue is 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.

Chapter 2

What is currently known about internationalisation of R&D

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

2.1 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 and Eurostat 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. Data on the activity of foreign affiliates is based on the concept of controlling interest (over 50% of shares with voting rights on a company's board of management). Inward R&D is also covered by the FATS[1] statistics of Eurostat. A regulation including the variable 'total R&D expenditure by foreign affiliates in host country' is included. It is foreseen that in many countries this data collection will be co-ordinated with regular R&D statistics. (Götzfried, 2005)

The OECD collects as part of its globalisation surveys basic R&D data concerning the activity of multinational firms. This data deals with R&D expenditure performed in the countries by foreign affiliates and R&D performed by offshore affiliates of domestic firms. Supplementary information to that requested in the overall R&D surveys in the Frascati Manual framework, is collected by national authorities either via overall R&D surveys or via specific surveys concerning multinational firms. However, it is not systematically passed on to the OECD Secretariat.

[1]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.

The OECD surveys, which cover the activities of foreign affiliates in OECD countries and of national firms abroad (AFA[2] database), show foreign affiliates account for a growing share of R&D in the enterprise sector, ranging from less than 5 per cent in Japan to over 60 per cent in Hungary (78.5% in 1998), Belgium and Ireland. At over 30 per cent, the share of R&D conducted by foreign affiliates is also high in Czech Republic, Portugal, Spain, the United Kingdom, Sweden, Canada and Italy.R&D investments by foreign affiliates are highly sector-specific, with the ICT, chemicals (incl. pharmaceuticals) and transport sectors accounting for the vast majority.In the 1990s, inward R&D investments in the United States were aimed primarily at high-technology areas (OECD, 2003, 2004).

A considerable portion of the R&D performed by foreign affiliates remains in the OECD area. R&D internationalisation is mainly an intra-Triad phenomenon with mostly United States and EU the major locations for foreign R&D while EU and US firms have the largest shares of foreign R&D. In 2000, for example, USD 15 billion of the USD 23 billion in manufacturing R&D performed by foreign affiliates in the United States came from firms headquartered in the EU15 or Japan. Similarly USD 13 billion of the spending by foreign affiliates in the EU15 came from the United States or Japan. 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.

Total R&D performed by foreign affiliates in selected OECD countries increased by more than 50 per cent in nominal terms between 1995 and 2000, to more than USD 50 billion. The shares have risen most noticeably in the Czech Republic, Hungary, Sweden and the United Kingdom, and have remained relatively constant or increased only slowly in most other countries.

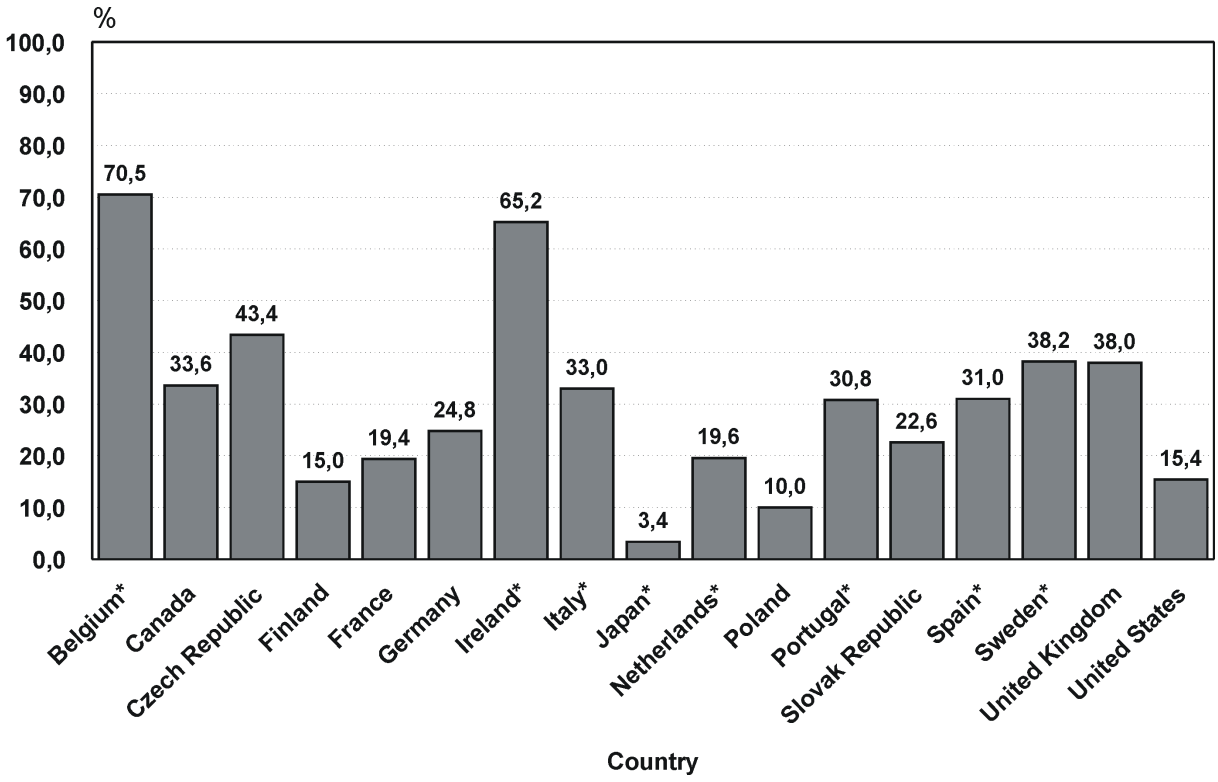
In almost all countries, foreign affiliates have a lower R&D intensity than domestic firms do. However, in Hungary and Ireland, foreign affiliates carry out relatively more R&D than national firms. In many OECD countries, the share of foreign affiliates in R&D is smaller then their share in manufacturing production, like in the USA, 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. These are described in more 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 (OECD and Belgian Science Policy, 2005). In 2000, an average of over 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

[2]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.

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.

Figure 2.1: Foreign affiliates‘ share of business enterpri R&D in some OECD countries in 2002



*Data from 2001. Source: OECD, Main Science and Technology Indicators; Statistics Finland; Belgian Federal Cooperation Commission, CFS/STAT.

Various measures in the development of normal routine R&D statistics also aim at spreading some light on the globalisation issue.

Eurostat and the OECD are collecting *R&D statistics* based on national R&D performers in line with the recommendations of the Frascati manual. Recently they have been reorganising the data collection of R&D statistics from countries in creating a common international core questionnaire, complemented by an OECD and Eurostat data module. Some tables being part of this reorganised data collection allow already the measurement of internationalisation of R&D with a number of indicators that can be compiled, such as the financing of BERD from abroad, broken down by size classes and economic activities.

From 2005 onwards more details will be available, when the common OECD/Eurostat R&D statistics questionnaire will further break down the category “source of funds: abroad” into the following subcategories: foreign companies (further divided between enterprises belonging to the same group and other enterprises).

For measuring the outflows, data on extramural R&D expenditure would provide information on R&D performed abroad, but financed by domestic enterprise or institutions. For the time being there is however no immediate intention to include such data in the current OECD/Eurostat R&D questionnaire due to the fact that the R&D surveys are reporting on national R&D performers and often leave out national enterprises which do not perform R&D, but which subcontract it however. Other (general) business surveys based on a broader survey population (such as Structural Business statistics) would seem to be more appropriate for measuring extramural R&D.

2.2 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 fairly limited.

2.2.1 General remarks on trends, motives and character of the R&D units in subsidiaries abroad

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, 1999; Pearce and Singh, 1992)[3] 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 multinationals' 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

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

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 rely 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.

2.2.2 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' motives for carrying out R&D abroad. Often a combination of sources has been used.

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

Some Finnish studies

Below we present four different studies on the globalisation of R&D done in Finland.

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, 1999) on the internationalisation of R&D. 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 (Räsänen, 1999). 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 the study by J.Koskinen 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).

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 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.

A Finnish-owned company was defined in this study according to the OECD guidelines to a company in which the percentage of voting stock owned by non-residents is less than 50 percent. A second criterion was that the shareholder-owner must be a single individual or entity. If there were multiple foreign owners who together had an absolute majority of the shares, the company was considered to be domestically owned. Thus, companies were not considered to be foreign-owned companies if their total foreign ownerships were over 50 percent but also highly diversified. Such company in Finland is Nokia, for instance.

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 9 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 by M.Pajarinen 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 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.

Investments by foreign-owned firms in Finland has been quite modest, but they had intensified the national economy during the 1990s. However, foreign ownership has had a positive impact on the development of the Finnish economy. Foreign firms often have positive spillover effects; these include the diffusion of technology in its new forms, which may benefit the whole economy.

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. The proportion of foreign-owned firms with R&D operations was larger than the corresponding proportion for all firms in the country.

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 in 1998 compared to less than 10 per cent in 1990. In 1998 total expenditure amounted to EUR 320 million (in 1995 some EUR 200 million). R&D by foreign-owned firms in Finland has mainly been concentrated in high technology. These industries (e.g. electrical engineering and manufacturing of chemicals and pharmaceuticals) accounted for around 80 per cent of all expenditure, and in these industries foreign-owned firms have accounted for a larger than average proportion of all R&D expenditure. 60 per cent of the foreign affiliates' R&D expenditure in Finland focused on telecommunications and other electrical engineering products, as was the case among Finnish-owned firms. Other major product groups were machinery and equipment as well as chemicals and pharmaceuticals.

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 these 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) 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 further 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 Industries. 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 general investment survey

The general investment survey can 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 2005 (EK 2005) mainly among businesses included in the EK business tendency survey sample was responded by 310 manufacturing companies in different branches.

Results published in June 2005 show that over 39 per cent of the R&D expenditure by the manufacturing industry was spent abroad in 2004 and in 2005 enterprises were *planning* to spend 38 per cent abroad. The greater part of Finnish firms' R&D investments abroad is located in the European Union and North America. In accordance with the one-year earlier survey the share of the EU15 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 currently go to countries in Asia.

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 remained around 94 per cent since 2000.

—

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. In fact, preceding results indicate the share of Finnish firms' foreign R&D to have come down by some percentage points in recent years. 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 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.

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, 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 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 (USA, France, Netherlands, Germany, United Kingdom) accounted together for nearly 95 per cent of all foreign controlled R&D.

Measuring cross-border R&D in Germany

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. The Stifterverband distinguishes between internal (in-house) and external (outsourced) R&D expenditure. In 2001 German industry spent EUR 36.4 billion on research and development in-house. External R&D spending, i.e. expenditure for R&D carried out abroad or contracted out to companies or public-sector research institutes, was EUR 7.8 billion. (Grenzmann, 2005)

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. The question 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. From 2003 on a control question if the enterprise has performed R&D in foreign affliates or not, has been introduced in the R&D survey. This data revealed the R&D expenditures carried out by German affiliates abroad to be EUR 11.9 billion, which is nearly 35 per cent of the total internal R&D expenditure by German companies. In 1995 the corresponding figure was just good EUR 5 billion.

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 nearly 25 per cent between 1993 and 2001. This clearly shows that the internationalisation of business enterprise R&D has proceeded notably. The share of European countries of the total EUR 11.5 billion foreign-owned R&D was 60 per cent and that of the North America 40 per cent.

Swedish surveys

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 in International Enterprises 2003' (ITPS, 2005), which was 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 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 R&D activities abroad. 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 eight large foreign owned groups, which all formerly had been Swedish-owned. This survey concerns their R&D activities in Sweden only. In addition to these questionnaires, the ITPS register of foreign-owned enterprises was 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 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 8 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 performed abroad. Swedish-owned companies' R&D overseas was highly concentrated in EU15 (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.

ITPS has some ongoing R&D studies in China and India. Preliminary results of these projects are expected in early 2006.

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

The study suggests 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, 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 concerning 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 member states (54% in 1999) of and North America (37%).

R&D internationalisation studies in the Netherlands

CBS (Statistics Netherlands) has conducted manual surveys in order to get information about Dutch companies' R&D expenditure abroad. In these efforts, annual national surveys and company reports have been utilised together with complementary straight contacts. There are plans to include a small block of internationalisation questions in the R&D survey in early 2006. 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 will be 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: (1) 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. (2) 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. Some initial results published already in 2002 have later on been updated. 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 current ministry-conducted paper by Erken *et al.* (2005b) focuses on the question which location factors are decisive for the attractiveness of a country in terms of foreign R&D investments. Results are 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) continue 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 combines both the outward and inward perspective insights. This research includes also the benchmarking the R&D investment climate between the Netherlands and the EU15, and the Netherlands and other small, open economies. Linkages between foreign R&D investments and the underlying location determinants are in focus.

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 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[4].

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)

The strength of the R&D performance of US-based companies has attracted the attention of firms elsewhere. Affiliates of foreign firms are increasing funds to conduct R&D in the United States. In the late 1980s, US companies provided USD 7.9 billion to their overseas affiliates for R&D, whereas foreign companies provided USD 6.7 billion to their US-based affiliates. However, these R&D investment trends have reversed in the course of the 1990s. (National Science Board, 2004)

Foreign-owned firms conducting R&D in the United States accounted for USD 27.5 billion of the total USD 190.8 billion industrial R&D expenditure in the USA in 2002. The share of foreign-owned R&D fluctuated between 11 and 13 per cent during the period 1994–2000 and rose to 14.4 per cent in 2002. European-owned subsidiaries accounted for USD 20.7 billion (75%) of foreign-owned R&D. Chemicals was the largest industry with a share of 29 per cent.

Parent companies of US multinational corporations accounted for almost three-fourths of the R&D spending by all industrial R&D performers in the United States in 2002. These parent companies had R&D expenditures of USD 138.0 billion, whereas their majority-owned foreign affiliates had R&D expenditures of USD 21.2 billion, for a total of USD 159.2 billion in global R&D expenditures. The percentage of R&D spending abroad

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

increased from 11.5 to 13.3 percent between 1994 and 2002. 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 as China, Ireland, 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 the US-owned overseas R&D.

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, have recently been engaged in a statistical data-linking project, aimed at a more detailed profile of international composition of US R&D activities. The US Internationalisation of R&D Data Linking Project (Jankowski, 2005) is 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 have been covered: 1997 for foreign direct investment in the USA and 1999 for US direct investment abroad. Data match to be linked include core items like the number and R&D expenditure of R&D performing companies.

Anticipated statistical benefits include (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 contain (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 to be presented in a written report summarise 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, preliminary results from spring 2005 have been encouraging, since 80–92% of the R&D data from the different sources in the three different phases matched. The study have 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. If successful, will be updated annually.

Patents as indicators on R&D 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. (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 (USPTO) 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 3

Premises for developing the information on globalisation of R&D

With the appearance of the new OECD globalisation handbook described in some detail below, there is a foundation for the development of improved indicators on the internationalisation of R&D. The new EU R&D Scoreboard is a source, which will be explored for the development of indicators on outward R&D in particular.

3.1 Handbook on Economic Globalisation Indicators

3.1.1 Introduction

An important feature of the increasing globalisation of the world economy has been the prominent role of multinational enterprises. The OECD *Handbook on Economic Globalisation Indicators* (OECD, 2005) which final version was published in spring 2005 defines the concepts and puts forward guidelines for data collection and the fine-tuning of globalisation indicators.

In this part of the report we give an overview of its contents, i.e. the describing, measuring and interpreting the proposed indicators; and certain methodological and conceptual questions in the field of internationalisation of industrial research and development activities of MNEs.

3.1.2 Definitions

The notion of *control for an enterprise* implies the ability to appoint a majority on board of directors to run the enterprise, guide its activities and determine its strategy. The control of an enterprise may be direct or indirect, immediate or ultimate. A recommended definition in *identifying foreign control* is: An enterprise is under the foreign control if more than half (50%) of shareholdings with voting rights is held directly or indirectly by a single foreign investor or a group of foreign investors acting in concert. The Handbook

mentions also other accepted but not recommended cases of control, where control can be demonstrated objectively (multiple investors, minority shareholding). Countries are recommended to follow special rules in these cases.

Affiliate under control abroad is an enterprise controlled directly or indirectly by a parent company which is controlled by residents of the investor country. In a compiling country, an *affiliate under foreign control* is an enterprise controlled by another enterprise located abroad which is its parent company.

A *foreign parent group* consists of (1) the foreign parent; (2) any foreign person, proceeding up the foreign parent's ownership chain, that owns more than 50% of the person below it, up to and including the ultimate controller and (3) any foreign person, proceeding down the ownership chain(s) of each of these members, that is owned more than 50% by the person above it.

Parent company.

a) Inward investment
The parent company of an affiliate under foreign control in a compiling country is the first foreign investor outside the borders of this country, exercising direct or indirect control over the foreign affiliate. If the first foreign investor is also under foreign control, the parent company could be a company other than the ultimate control company at the head of the group.

b) Outward investment
From the point of view of a compiling country, the parent company of its affiliates abroad controlled by residents of this country is the consolidated enterprise (enterprise group) comprising the domestic firms which the preceding firm controls directly or indirectly in the compiling country.

3.1.3 The economic activity of multinational enterprises

Chapter three in the Handbook presents indicators of economic globalisation, discusses the variables to be collected and considers conceptual and methodological issues. The focus is on the economic activities of multinational enterprises. OECD defines target populations for compiling data on activity of multinational enterprises (AMNE) so as to improve international comparability while meeting national requirements.

Four mutually exclusive categories of target populations for AMNE in **compiling country** are recommended to be included in the surveys of countries, which start producing AMNE data:

Under foreign control

1. Foreign controlled affiliates (CAs) without CAs abroad
2. Foreign controlled affiliates with CAs abroad (parent companies under foreign control)

Controlled by residents of compiling country

1. Parent companies with affiliates abroad
2. Companies other than MNEs (with no CAs abroad)

Most countries do not publish (even if they usually could) disaggregated data for each of the four categories above, only aggregate data for categories 1 and 2 and for category 3, while data on category 4 is obtained by subtracting the preceding categories from the national total.

For AMNE **abroad** two target populations are determined:

1. Parent companies controlled by residents of the compiling country and those under foreign control
2. CAs abroad including affiliates under direct and indirect control

It is recommended as the first priority that countries provide data on CAs activity abroad under direct control of all the parent companies in the compiling country.

Two options can be used to resolve double-counting problem. In the *immediate control approach* target population includes all parents but only measures the CAs abroad under the direct control of parent companies residing in the compiling country. In the *ultimate control approach* target population includes only enterprises under the ultimate control of residents of the compiling country with all CAs abroad (under direct and indirect control).

3.1.4 The internationalisation of technology

In view of the multidimensional nature of R&D internationalisation, with different forms, processes, actors, and channels involved, a wide variety of indicators should be examined. However, only a handful of indicators are available consistently across countries, industries and time. The OECD has also recognised this with respect to the dimension of globalisation of technology and has therefore opted to prioritise indicators for R&D internationalisation.

Chapter four in the Handbook characterises the phenomenon of the internationalisation of technology. Industrial R&D is the main technological input that can be developed by a firm or parent company in a particular country, or else under the control of the latter it could be developed in various countries via a network of affiliates and R&D centres.

The Handbook covers the internationalisation of R&D by placing the emphasis on the implementation of R&D in compiling countries, taking into account foremost foreign-controlled affiliates and parent companies in compiling countries (both nationally and foreign-controlled); and secondly (among others) affiliates performing R&D abroad. Implementation falls into two categories: the establishment of R&D activities by foreign-controlled affiliates in the host country (inward investment) and the setting up or relocation of R&D laboratories abroad (outward investment).

3.1.5 Proposed indicators

OECD has proposed three different types of indicators for measuring the degree of internationalisation of the R&D of multinational firms in the compiling country. *Reference indicators* are those to which the Handbook attaches the highest priority because they are relevant, analytically important, and also because they are available in a large number of OECD countries, which minimises respondent burden. It is essential that these data be comparable with other national R&D data. Reference indicators, which have the first priority, cover the activities of foreign-controlled affiliates and parent companies' activities, or else international technology transactions by all firms in compiling countries. Beyond these, *supplemental* and proposed *experimental indicators* have also been introduced. The supplemental indicators proposed are of lower priority in that they relate to data that only a limited number of countries possess. As a second priority, OECD recommends countries to collect data on the R&D activities of compiling countries' affiliates abroad. Experimental indicators are yet to be developed, and not to be taken into account in this study.

The following representation takes a look at those proposed indicators on the internationalisation of industrial R&D, which are relevant to WP6.

Reference indicators

- R&D expenditure (and number of researchers) performed by foreign-controlled firms (affiliates) as a proportion of the host country's total industrial R&D

This indicator, which is associated with inward investment, shows the share of industrial R&D which is under foreign control and which is controlled by the residents of the compiling countries. Expenditure on R&D performance of foreign-controlled affiliates located within the national territory of each compiling country which is a variable of prime importance, is also the basic data for building up the reference indicators.

- Share of R&D expenditure performed by parent companies in the R&D expenditure of the compiling country

This indicator measures within a given country, the share of total business R&D expenditure accounted for by that country's own multinationals (resident-controlled and foreign-controlled parent companies). For all R&D expenditure by parent companies (whatever their origin) to be taken into account, R&D expenditure by parent companies has to be added to the numerator of the ratio in question. Not all the R&D performed by these two categories of firm is automatically designed to meet the needs of the compiling country and does not directly enhance its innovative capacity.

- Share of R&D expenditure in multinational firms (parent companies and foreign CAs)

This ratio makes it possible to determine what share of a country's industrial R&D is performed by multinational firms. To avoid double counting, foreign-controlled parent companies should be counted just once –either as parent companies or as foreign CAs.

Supplemental indicators

Inward investment; in the case of R&D activities within the territory of a compiling country.

- The share of R&D performed for foreign-controlled affiliates and not by the said affiliates, compared with total domestic R&D expenditure by the business sector.

Thanks to this distinction it is possible to identify, at sectoral level, the research targeted at foreign-controlled affiliates, given that these affiliates perform R&D partly or totally on behalf of others.

Outward investment

- The share of R&D expenditure in affiliates abroad compared to R&D expenditure in the compiling country.
- The share of R&D expenditure in affiliates abroad compared to R&D expenditure in parent companies in the compiling country.

These indicators are some of the most significant for illustrating the scale of the internationalisation of R&D. For a compiling country, the R&D expenditure in its affiliates abroad can in some cases exceed R&D expenditure within the country (e.g. Switzerland). It is also interesting to know what shares of R&D expenditure parent companies perform abroad via their affiliates. The higher the preceding ratios, the more these countries' R&D is internationalised.

3.1.6 Main distortions in international comparisons

Most of the problems affecting the international comparability of R&D indicators stem from inappropriate definitions concerning foreign affiliates, their geographical origins or their sectors of activity. Some distortions, however, are due to the R&D data themselves.

Defining foreign-controlled affiliates: It should be borne in mind that an affiliate is deemed to be under foreign control if a majority of voting rights is held by a foreign investor. Accordingly, a separation must be made with data of firms under minority control (between 10 and 50%).

The main difficulty in determining the investor country stems from the intricate web of control relationships between firms. It is essential to be able to go to the end of the chain to identify the ultimate controller of an investment. Sometimes this will require the use of supplementary sources.

In some cases, investor countries and host countries do not adopt the same criteria (those of the Frascati Manual) in determining whether an activity is an R&D activity.

Differences between inward and outward R&D investment: In some cases, the level of aggregation, sectors of activity or majority control criteria are not applied in the same way to R&D data on foreign CAs and affiliates abroad of resident-controlled firms– in respect of either one and the same country or from one declaring country to another.

Other distortions may derive from the fact that definitions stray from the Frascati rules on the intramural R&D expenditure of affiliates, or from the fact that foreign funding has not been associated with its geographical origin, but with criteria involving ownership.

3.2 The 2004 EU industrial R&D investment scoreboard

3.2.1 Aims and objectives

This first EU Industrial R&D Investment Scoreboard, which was launched in December 2004, aims to provide a tool for companies and organisations to benchmark their industrial research, and to provide relevant information for policy-makers concerning research at the corporate level, particularly in the context of the Barcelona 3% objective. It has been produced as a pilot exercise to develop a closer understanding of company-level R&D in Europe and beyond. R&D investments are explored in several contexts: levels and growth, business performance and R&D, distribution, its specialisations and strengths, intensity and also in the sense of improving reporting.

3.2.2 General description

The Scoreboard refers to the worldwide R&D investments of the top 500 EU and top 500 non-EU ultimate parent companies. It provides up-to-date 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. The Scoreboard focuses on the major R&D-investing companies, regardless of where the R&D is performed. These companies are responsible for a high proportion of global business-financed R&D. It enables companies, investors and financial analysts to compare research investment among EU companies and sectors, but also with US and Japanese companies. In particular it shows how much companies are investing in R&D and in which industries the most R&D-active companies operate.

Enterprises are allocated to the country where their ultimate parent company has chosen to locate its registered office. Therefore the Scoreboard follows, in some way, the concept of ultimate beneficiary ownership (UBO). Companies listed on official stock exchanges, private and state-owned companies (which have their headquarters/ the registered office of the ultimate parent company in the EU) are included, but companies that are subsidiaries of any other company are excluded to avoid double counting. For example, if the R&D

expenditures of a US subsidiary performing R&D in the EU were included in the EU figure, it would appear in both the US and EU totals. In addition, it would not be valid to include foreign-owned EU companies in an EU listing which was then compared with US and Japanese companies' totals, which do not include foreign-owned companies. Majority-owned subsidiaries are consolidated in the accounts of the parent, whereas joint ventures that are 50% owned by each of two partners are included as stand alone companies.

The information used has been taken directly from annual audited company reports and accounts published up to 31 July 2004, and differs from official R&D statistics in significant ways. The principal strength of the data used here is that it provides a measure of global business-financed investments in R&D at the corporate level. The main limitations are the reliance on companies' disclosure of their R&D investments, and the absence of a territorial dimension to R&D performance.

The Scoreboard does not aim to replace other sources of information with which to monitor business enterprise expenditure on research and development (BERD). Therefore the data complement information generated by organisations like national statistical offices, and published by the OECD and Eurostat. The definitions of R&D used by companies, following accepted international accounting standards, accord with definitions used in official statistics.

The European Commission DG RTD intends to continue the production of this EU Industrial R&D Investment Scoreboard in the years to come. The number of listed enterprises will be increased to up to 2,000 (1,000 for the EU and 1,000 for non-EU countries).

3.2.3 Differences between the Scoreboard and BERD data

Comparing the Scoreboard figures and BERD data is difficult due to certain relevant reasons.

The term 'R&D investment' used in the Scoreboard refers to corporate R&D funded by companies themselves and their subsidiaries, regardless of where that R&D is performed. Where the relevant information is available the Scoreboard figure excludes R&D financed by governments or other companies, and also excludes the companies' share of any associated company or minority joint venture R&D investment. The Scoreboard therefore presents companies' global financial commitment to R&D. The officiall concept, BERD, refers to all R&D performed by businesses within a particular sector and territory, regardless of the home location of the business, and regardless of the sources of finance. Thus BERD includes R&D performed by a company but financed by government, research councils, non-profit foundations, or from overseas, by other companies and by itself. BERD includes R&D located in a given country and carried out by those parts of companies (including foreign-owned subsidiaries) that are located in the country. The distinction can be seen as 'funding vs. activity'.

The sampling processes are also different. The Scoreboard collects all the relevant data published in its sample of the 500 largest companies, provided the company's R&D investment is above the Scoreboard's minimum level. BERD typically takes on a stratified sample, covering all large companies and a representative sample of smaller companies.

R&D intensities are defined differently. BERD measures R&D intensity for a sector, region or country in terms of R&D as a percentage of value added. The Scoreboard measures company level R&D intensity in terms of the R&D/sales ratio, since value added data are not available by company for US or Japanese companies because of the limitations of accounting practices.

In terms of the sectoral classifications used, BERD information follows NACE (the European statistical classification of economic sectors), while the Scoreboard classifies companies' economic activities according to FTSE (Financial Times Stock Exchange index) classification. Bearing in mind that the sectoral classifications are different, the Scoreboard can nevertheless provide useful complementary information because it refers to overall industrial R&D performed by companies whose registered offices are located in the EU. This gives rather a different perspective on the scale of European R&D investment compared to official statistics.

3.2.4 Company data with indicators

The 2004 Scoreboard includes company data presented in for the last four available financial years (i.e. 2000/2001 to 2003/2004). The data section contains three sets of company data ordered by FTSE sector, by country and by size of R&D investment. Among the ten variables are e.g. the sector of main activity declared by the company, according to FTSE classification; country of registration (country in which the ultimate parent company has chosen to locate its registered office), and total R&D investment. Besides these, R&D investment/net sales ratio (company R&D intensity) and R&D per employee is given, among others.

Rankings of the companies is presented according to the following criteria:

- Current R&D investments for EU companies.
- Current value of R&D investments for non-EU companies.
- Value of R&D investments for EU companies by Member State and for non-EU companies by country of head office registration.
- Value of R&D investments for all companies by industry sector.

The analysis section with its three main levels aims to identify and discuss some of the main points and trends emerging from the collected R&D data. The first level is an overview of the whole set of largest R&D-investing companies both by world region (Europe, North America, Asia Pacific) and by major economy (EU, Japan, US). This overview rests on top-level measures such as total R&D investment and R&D investment as a percentage of sales. The second level of analysis is concerned with sectors, and the way in which differences in sector size, sector mix and sector R&D/sales ratio affect overall totals of R&D and the overall R&D/sales ratio.

The apparent or possible strengths and weaknesses of the companies within the main R&D investing sectors are explored by comparing major EU companies with those headquartered elsewhere, identifying the concentration of R&D by sector, and comparing company

distributions of R&D/sales ratios. The sectoral distributions highlight the importance of the overall investment intensity of a large sample of companies rather than just the small number of very large R&D investing companies. This comparison of distributions can only be made for the EU versus the USA (for which a similar R&D Scoreboard is available). Finally, there is a discussion of the links that exist between company input investments like R&D and capital expenditure, and company performance as output.

3.2.5 The Scoreboard with relation to another EU exercise

In autumn 2004, simultaneously with the 2004 Scoreboard, The European Commission Directorate General for Research prepared another paper (Ciupagea and Moncada-Paternò-Castello, 2004) with analysis of data on top R&D spending companies in some EU countries. EU Member States had been invited to provide the information at the CREST meeting in December 2003. The aim of this pilot exercise was to complement both the official R&D data, and the company level data collected in the EU Industrial R&D Investment Scoreboard, and provide a comparative link between them. Another objective in the exercise was to analyse the potential contribution from business enterprises to enable the 3% target.

Although the paper includes R&D information of 13 countries, it gives fairly comprehensive data on only a couple countries like Belgium, Finland, the Netherlands and Sweden. However, it is useful in order to make comparisons and checkings with other data sources concerning R&D internationalisation. This exercise proved the information on domestic R&D expenditure not usually to be available in public financial reports or official statistics due to confidentiality reasons. As a conclusion from the analysis it was stated e.g. that companies are inclined to concentrate their R&D activity in their home country.

Chapter 4

Summary

In this report we have made an attempt to analyse what has been done to measure the globalisation of research and development activities. There are quite a lot of special studies available on this subject but internationally comparable statistics is rather scarce.

Most countries have information on how much foreign affiliates spend on R&D in the host country. This information is published by the OECD. There are various sources such as surveys and registers for determining which enterprises are foreign. Sometimes the nationality of the enterprise may be difficult to determine in case of control from several countries. In practise there may be some difficulties in keeping this information up to date. The information on R&D in the foreign firms is often obtained from official R&D surveys. There is a rather big variation between countries in the shares of R&D performed by foreign affiliates. In several countries well over half of R&D is performed by affiliates of foreign groups.

Only a few countries like Germany, Sweden and the United States, have regular information on how much is spent on R&D in affiliates of domestic firms abroad. This information is mainly compiled by special surveys, general surveys of foreign direct investments or comparisons between global R&D figures for multinationals and R&D performed in the country concerned, either derived from the official R&D survey or other sources. For countries having information, the share of R&D abroad is around 20–40 per cent. Several studies have tried to investigate the type of setting up R&D units established abroad (greenfield, relocation of R&D, acquisitions) and their primary functions such as adoption to local markets or technology acquisition.

For some globally operating enterprise groups the distribution of R&D resources between various countries is a big problem. The R&D cost accounting system is operating on the global business unit level, which makes it very difficult to distinguish the R&D expenditure of enterprises in different countries belonging to the group. This may cause some quality problems in normal R&D statistics produced on the national level.

The observations reported here are preliminary and will be updated during the course of the KEI project to be included in the final report of work package 6.

Bibliography

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

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

Ciupagea, C. and Moncada-Paternò-Castello, P. (2004) Analysis of Available Data on top 20 Companies Spending in R&D within some EU Member States. European Commission, Directorate General Joint Research Centre, Institute for Prospective Technological Studies (DG JRC-IPTS), Seville, 8 December 2004.

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.

EK, Confederation of Finnish Industries (2005) Investment survey. June, 2005.

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.

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.

Götzfried, A. (2005) How to improve the measurement of international R&D on the basis of existing and new, upcoming data sources. A paper presented at the Forum on Internationalisation of R&D, EUROSTAT, Brussels, 30 March 2005.

Grenzmann, C. (2005) Globale FuE-Aktivitäten deutscher Unternehmen im Spiegel der Statistik. *Forschung und Entwicklung in der Deutschen Wirtschaft. Materialen zur Wissenschaftsstatistik* **13**, 65–77. Stifterverband 2004.

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.

ITPS (2005) Forskning och utveckling i internationella företag 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.

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.

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.

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

National Science Board (2004) *Science and Engineering Indicators 2004*. vol.1: 0-5.

OECD (2003) *Science, Technology and Industry Scoreboard 2003*.

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

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

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, 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.

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.

Räsänen, V. (1999) Effects of internationalization on R&D processes. In *Cross-Border R&D in a Small Country: the Case of Finland*, eds Pajarinen and Ylä-Anttila, pp. 41–90.

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.

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.

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.

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

23 August 2005	Stifterverband; Christoph Grenzmann and Joachim Wudtke
24 August 2005	CBS (Statistics Netherlands); Gerhard Meinen
6 September 2005	ITPS (the Swedish Institute for Growth Policy Studies); Lars Bager- Sjögren, Martin Daniels, Philip Löf & Anne-Christine Strandell