

A4. Effects of globalisation: internationalisation of research and development (R&D)

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4.1 Introduction

The increased internationalisation of the world economy has for a large part been driven by new technological developments. In particular innovations in information and communication technologies in the 1980s and 1990s have made it possible to coordinate international production networks both within and between (multinational) enterprises at an unprecedented scale. Technological developments are not only one of the key drivers of the globalisation process, they are in turn affected by globalisation as well. Activities involving the creation of new products and innovative production processes – i.e. research and development – are increasingly carried out outside the home country of enterprises and coordinated internationally.

Given the size of the required investments and the often long time lines between the initial basic research and the marketable product, private sector expenditure on R&D is highly concentrated among a relatively low number of large, often multinational enterprises. For example, as we will illustrate in more detail below, more than 50 percent of the intra mural R&D in the private sector in the Netherlands is accounted for by ten enterprises. Hence, the way in which MNEs organise their R&D internationally importantly affects the role that these multinationals play in regional and national systems of innovation. In addition, since the motives for MNEs to invest in (or retain) R&D in certain countries also vary across different kinds of R&D and the way in which the MNE organises its R&D internationally, the effectiveness of policies aimed at attracting and keeping those MNE R&D investments that contribute most to national innovation and economic growth is also affected (Fortanier, 2007). This chapter aims to provide a better understanding of the way in which MNEs organise their international R&D, and the role of the Netherlands in such international networks of innovation. We will address the role of foreign controlled enterprises in R&D and innovation in the Netherlands, as well as the international R&D activities of Dutch controlled enterprises.

The remainder of this chapter is organised as follows. First, we provide a brief review of the academic and policy debates with respect to the internationalisation of R&D. Subsequently, the data and methodology section explains some of the

difficulties in actually measuring (international) R&D and innovation activities, and details our analytical approach. Section 4.4 then presents the results of our analysis: first with respect to R&D of foreign controlled enterprises in the Netherlands, then for Dutch controlled enterprises abroad. Section 4.5 summarises and concludes.

4.2 *Background*

Multinational involvement in overseas research, product development and innovation has increased significantly since the 1990s. Traditionally, the internationalisation of R&D by MNEs has been analysed in terms of a trade-off between the competing ‘centripetal’ forces for geographical centralisation and the ‘centrifugal’ forces for geographical decentralisation (see for example Pearce, 1989; Van Tulder et al., 2000). The former forces argue for performing R&D on a national scale with R&D facilities close to corporate headquarter, and stress the need to protect firm-specific technology (Håkanson and Nobel, 1993); to minimise organisational (coordination, control and communication) costs and benefit from economies of scale (Mansfield et al., 1979; Wortmann, 1990), and the strong embeddedness of enterprises and their R&D activities in home country factor markets and institutions (Porter, 1990).

However, while these factors still impose costs for enterprises, the increase in international R&D in the past decades indicates that these strong forces for centralisation of R&D are often counterbalanced by even greater forces for decentralisation of R&D. There is an extensive literature that identifies a wide range of (potential) factors that may induce enterprises to internationalise their R&D, and that explain the resulting locational choices of those R&D activities (see e.g. an overview by Von Zedwitz and Gassman, 2002; Fortanier, 2007). For example, it may be necessary or advantageous to adapt products (and/or processes) to local market characteristics, to provide local product support to customers, or to be in close proximity to lead users. In addition, the creation and maintenance of technological competitive advantages increasingly requires access to a wider range of scientific and technological skills and knowledge than is available in the home market. Hence, the presence of highly skilled labour, local specialists, universities and research parks also drives the internationalisation of R&D.

Parallel to the ongoing internationalisation of R&D, many member states of the European Union (EU), including the Netherlands, have expressed the ambition to stay or become knowledge-intensive economies. Policy goals are to preserve and augment existing R&D activities and to attract additional R&D from abroad. Against this background, the increased internationalisation of R&D poses policy questions related to for example the stability of current R&D activities of foreign controlled and Dutch controlled enterprises in the Netherlands. Fears are

sometimes expressed that R&D will partly follow production and will be transferred to other countries, or that new R&D activities will be started abroad instead of at home. In addition, the contribution of foreign R&D and innovation activities to the Dutch knowledge economy is sometimes questioned. For example, a Finnish study showed that domestically owned enterprises invest substantially more in basic research than foreign controlled enterprises (Pajarinen et al, 1999). Finally, questions remain as to the (location and policy) factors that attract (or hamper) additional R&D.

4.3 *Data and methodology*

The wide variety of questions posed with respect to the trends and consequences of internationalisation of R&D for the Dutch knowledge economy require an in-depth analysis of the available data. Indeed, a number of developments in the internationalisation of R&D can be illustrated with data captured in the bi-annual R&D Surveys, the CIS (Community Innovation Survey) surveys and other surveys of Statistics Netherlands, or administrative statistical sources, although numerous challenges with respect to measuring R&D remain (see box 1).

The description of the internationalisation of R&D will be presented in two parts. First, we address the role of foreign controlled enterprises in R&D and innovation in the Netherlands. We analyse how foreign controlled enterprises compare with Dutch controlled enterprises with respect to their propensity to engage in a variety of R&D and innovation activities, and also pay attention to differences in their perceptions of potential barriers to innovation. Since other factors such as firm size, selling to international markets, and being part of an enterprise group, may influence the propensity to engage in R&D as well, we also present the results of a logistic regression analysis that controls the effect of foreign ownership for such factors. The second part describes the internationalisation of R&D by Dutch MNEs.

Box 1 Challenges in measuring R&D

The production and distribution of knowledge is more difficult to measure than that of goods. In some cases knowledge transfers are invisible, e.g. within worldwide operating MNEs. In other cases knowledge is really and explicitly sold, e.g. royalties, and thus recorded as a transaction. R&D activities are another example of measurable 'production' of knowledge. The increasing international specialisation of the production and usage of knowledge makes it more urgent to have an adequate measurement of these transactions.

Statistics Netherlands has compiled data on the performance and funding of R&D in the Netherlands over a long period. This collection of data is done via an internationally harmonised survey. This work has proved to be very useful over the years. The methodological framework of this survey is fixed in the so called *Frascati Manual* (OECD, 2002). However, there is a growing feeling that the scope and treatment of the information gathered about R&D should be re-evaluated. The main reason is the increasing discrepancy between performing R&D, funding R&D and the actual use of the R&D results. The cornerstone of the actual R&D survey is the intramural expenditure on R&D and its focus is on R&D performance by enterprises located in the Netherlands. However, bearing in mind the increasing international specialisation of R&D, the question is if performing or funding R&D is an adequate proxy for who actually is using the output of R&D investments.

Capitalising R&D in the National Accounts

The re-evaluation of the treatment of R&D in the System of National Accounts (SNA) has led to the conclusion that R&D should be treated as a capital good and not any longer as intermediate consumption. So a methodology has been developed of how to capitalise R&D in the National Accounts as was done before for software in the 1993 SNA revision. These recommendations will be included in the next SNA revision. So, an adequate measurement of (cross-border) R&D transactions becomes even more important because of their direct impact on the level of a country's gross domestic product (GDP).

4.4 Results

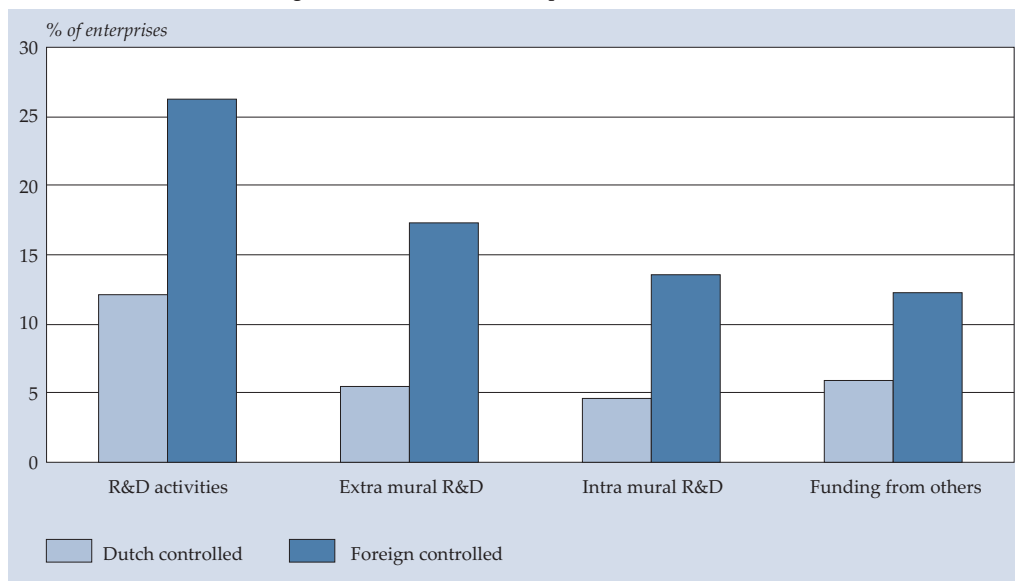
R&D and innovation of foreign controlled enterprises in the Netherlands

In 2006, roughly 22 percent of R&D expenditure of the Dutch business sector was controlled by foreign affiliates. This percentage seems stable over the last few years (see also the annotated table in part B of this publication). Graph A4.1 and graph A4.2 give an overview of the differences between foreign controlled and Dutch controlled enterprises in the Netherlands with respect to their R&D (graph A4.1) and innovation (graph A4.2) characteristics (more detailed results can be found in the annotated tables in part B of this Internationalisation Monitor).

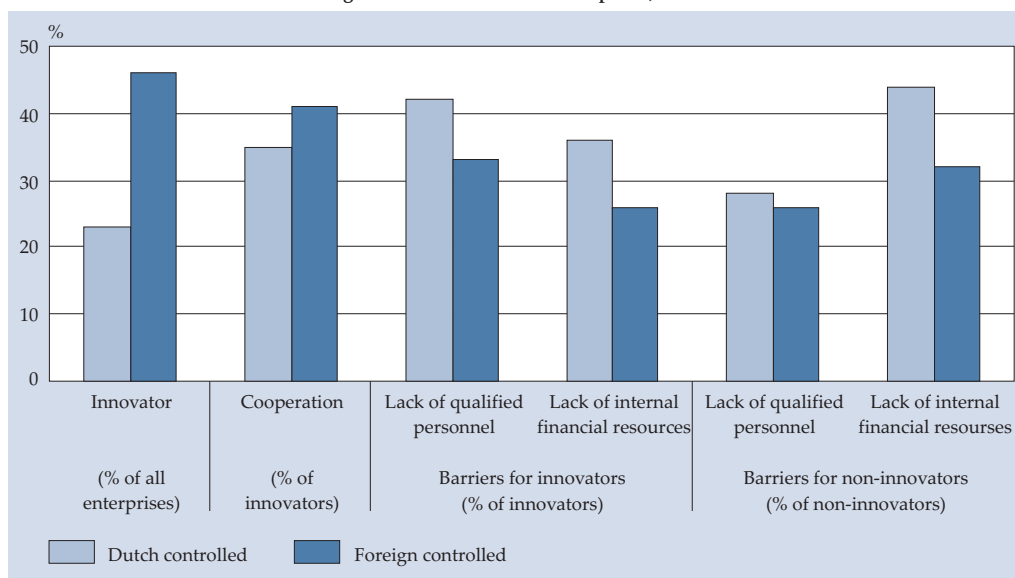
Graph A4.1 shows that foreign controlled enterprises are more often engaged in R&D activities, more often subcontract R&D to others (abroad and in the Netherlands), more often perform intra mural R&D (according to the international harmonised definition) and more often receive funding from others (abroad and within the Netherlands), as compared to Dutch controlled enterprises. Similarly, graph A4.2 shows that foreign controlled enterprises are more innovative than their

Dutch counterparts and cooperate more often during the innovation process. Foreign affiliates, innovators as well as non-innovators, experience fewer barriers to innovation compared to Dutch enterprises – both with respect to the availability of human capital and financial resources.

A4.1 R&D characteristics of foreign and Dutch controlled enterprises, 2004–2006



A4.2 Innovation characteristics of foreign and Dutch controlled enterprises, 2004–2006



Hence, it appears that the contribution of foreign controlled enterprises to R&D and innovation in the Netherlands is substantial. However, there are also other factors – in addition to foreign ownership – that may affect whether or not an enterprise

Table A4.1
Results of logistic regression of R&D and innovation variables

	Foreign controlled affiliate ¹⁾	Enterprises within an enterprise group ²⁾	Operating on international market ³⁾	Branch of industry		Size class	
				manu- facturing ⁴⁾	other ⁴⁾	50–249 employees	250 and more employees
Innovator coefficient	0.218***	0.276***	0.908***	0.713***	–0.002	0.540***	1,147***
S.E.	(0.067)	(0.052)	(0.049)	(0.053)	(0.074)	(0.051)	(0.076)
Cooperation coefficient	–0.042	0.343***	0.324***	0.357***	0.307**	0.347***	1,087***
S.E.	(0.094)	(0.085)	(0.082)	(0.081)	(0.126)	(0.082)	(0.110)
Barriers for innovators							
internal financing							
coefficient	–0.135	–0.055	0.156**	0.602***	0.277**	–0.031	0.117
S.E.	(0.092)	(0.083)	(0.079)	(0.079)	(0.123)	(0.080)	(0.106)
lack of personnel							
coefficient	–0.264***	–0.009	0.168**	0.367***	–0.100	0.285***	0.365***
S.E.	(0.093)	(0.084)	(0.079)	(0.080)	(0.123)	(0.081)	(0.107)
Barriers for non-innovators							
internal financing							
coefficient	–0.136	–0.81	0.138**	0.469***	0.200***	–0.870	–0.229**
S.E.	(0.099)	(0.060)	(0.062)	(0.069)	(0.078)	(0.061)	(0.116)
lack of personnel							
coefficient	–0.319***	–0.135**	0.206***	0.223***	0.217***	0.159***	0.224**
S.E.	(0.101)	(0.060)	(0.062)	(0.071)	(0.077)	(0.061)	(0.111)
R&D activities							
coefficient	0.018	0.257***	1.077***	1.091***	0.150	0.593***	1.322***
S.E.	(0.074)	(0.062)	(0.059)	(0.059)	(0.092)	(0.061)	(0.084)
Extramural R&D							
coefficient	0.163*	0.477***	0.932***	0.754***	0.265**	0.628***	1.398***
S.E.	(0.084)	(0.081)	(0.075)	(0.073)	(0.113)	(0.078)	(0.097)
Intramural R&D							
coefficient	0.135	0.317***	1.365***	1.371***	0.085	0.851***	1.640***
S.E.	(0.090)	(0.087)	(0.088)	(0.078)	(0.145)	(0.086)	(0.107)
Funding from others							
coefficient	–0.057	0.204**	1.458***	1.359***	0.742***	0.536***	1.098***
S.E.	(0.092)	(0.082)	(0.086)	(0.077)	(0.12)	(0.080)	(0.106)

¹⁾ Compared to the enterprises with their head office in the Netherlands.

²⁾ Compared to the enterprises not belonging to a group.

³⁾ Compared to the enterprises only active on the domestic market.

⁴⁾ Compared to the services sector.

⁵⁾ Compared to the enterprises with 10–49 employees.

*** p < 0.01; ** p < 0.05; * p < 0.1.

engages in R&D. For example, firm size, being part of an enterprise group, or selling on international markets may all affect the probability of involvement in R&D and innovation activities. The results of the logistic regression analyses that address the impact of a number of these dimensions are displayed in table A4.1, and will be discussed in detail below.

Innovator

The model presented in the first row of table A4.1 has as its dependent variable whether or not an enterprise is considered an innovator (i.e., engaged in innovative activities). From the results we see that, also controlling for other factors, foreign controlled enterprises are more often innovative than Dutch enterprises. Yet other factors also play a role. Being part of an enterprise group (this variable differentiates between Dutch multinationals and other Dutch enterprises) positively affects the propensity of being an innovator. In addition, enterprises that are active on the international market are more likely to be innovative, and also enterprises in manufacturing, and larger enterprises, have a higher propensity to be innovative than to enterprises in services and SMEs, respectively.

Cooperation

Although our descriptive graphs above indicated that foreign affiliates tend to cooperate more during their innovation process than Dutch controlled enterprises, the analysis in table A4.1 shows that this effect is primarily driven by factors other than ownership. Being part of an enterprise group, and being active on the international market are much more important determinants of cooperation in innovative activities. Being active in the manufacturing industry contributes in a positive way to cooperation, compared to the services sector. And size class also plays a role. Primarily medium-sized enterprises (50–249 employees) are inclined to cooperate with others in innovation.

Barriers to innovation

The most frequently cited barriers to innovation are the lack of internal finances and the lack of qualified personnel. We analysed these for both enterprises that are engaged in innovation, and those that are not, but find that the barriers – as well as the factors influencing whether they are indeed experienced – are quite similar between innovators and non-innovators. The results of the regressions show that a lack of internal finances is a barrier that is mentioned across all types of enterprises, although enterprises in the manufacturing industry suffer more from this barrier than enterprises in the services sector. In addition, enterprises that are active on the international market have more problems with internal financing than enterprises operating only on the local or domestic market. The lack of qualified personnel experienced by innovators is a significantly smaller problem for foreign controlled enterprises. In addition, larger enterprises more frequently experience problems finding qualified personnel, as do enterprises that are

active on the international market. Similar results can be found for non-innovators.

R&D activities

Finally, table A4.1 provides the results for the regressions analysing engagement in R&D activities. The analysis shows that being a foreign affiliate only significantly influences whether enterprises engage in extra mural R&D – and not R&D activities in general, intra mural R&D, or external funding. The other variables – being part of an enterprise group, selling on the international market, being active in manufacturing, and firm size – have a much stronger influence on the propensity to engage in R&D.

R&D by Dutch MNEs abroad

In the 1960s and 1970s, corporate R&D activities were generally centralised in corporate laboratories in their home countries. However, from the 1980s onwards, enterprises integrated their R&D strategies into their overall business strategies, which became increasingly global. As a part of the trend towards globalisation and specialisation, international funding and subcontracting of R&D activities took off in the early 1990s. Funding from abroad became more and more important for private sector R&D, while also international subcontracting increased. Table A4.2 shows a breakdown of the extra mural R&D expenditures (subcontracting) and funding of R&D. It shows that in 2003, more than 20 percent (1,045 million euro) of the intra mural R&D expenditures in the Netherlands (4,806 million euro) was subcontracted and that more than 25 percent (1,273 million euro) was funded by non-Dutch sources. In 1970 these figures were 6 and 10 percent respectively.

In addition, the second column of table A4.2 presents the share of the ten largest enterprises – based on their intra mural R&D expenditures – in the various totals of the private business sector. It shows that these ten enterprises performed half of the R&D by the business sector.

Table A4.2 also shows that the extra mural R&D expenditures can be divided between expenditures in the Netherlands and abroad. The ten largest enterprises are responsible for 65 percent of the extra mural R&D expenditures of the business sector. It becomes clear that funding from abroad is the most important source of funding the R&D of the business sector. It has a share that is larger than that of the domestic private sector and the government together. Secondly, the funding from abroad consists almost entirely of financial flows within an enterprise group. Over half of these intra-company flows take place within the ten largest enterprises.

Hence the increased cross-border financial flows for R&D are dominated by a limited number of MNEs and the financial flows, especially the sources of funds from abroad, are almost entirely flows within an enterprise group. This picture

seems consistent with the increased international dispersion and integration of R&D activities of the MNEs with their overall business strategies, causing intra-company financial flows for R&D activities. The growing intra-company flows from abroad can partly be understood as flows from the production units of MNEs to their head offices in the Netherlands, because these production units make the money and have to contribute to the R&D of the company. The increased extra mural R&D expenditures abroad can partly be interpreted as subcontracting R&D within the enterprise group by their head office in the Netherlands to affiliates abroad.

Table A4.2
Share of 10 largest Dutch MNE's in R&D variables of the business sector, 2003 ¹⁾

	Total business sector	Top 10 intra mural R&D expenditures
	<i>million euro</i>	<i>% of total business sector R&D</i>
Intra mural expenditures for R&D	4,806	51
Extra mural expenditures for R&D	1,045	58
of which		
home country	548	51
abroad	497	65
of which		
within own enterprise group	264	54
other	234	77
Funded by others	1,273	46
of which		
home country	410	42
government ²⁾	183	49
abroad	679	48
of which		
within own enterprise group	618	53
other	61	1

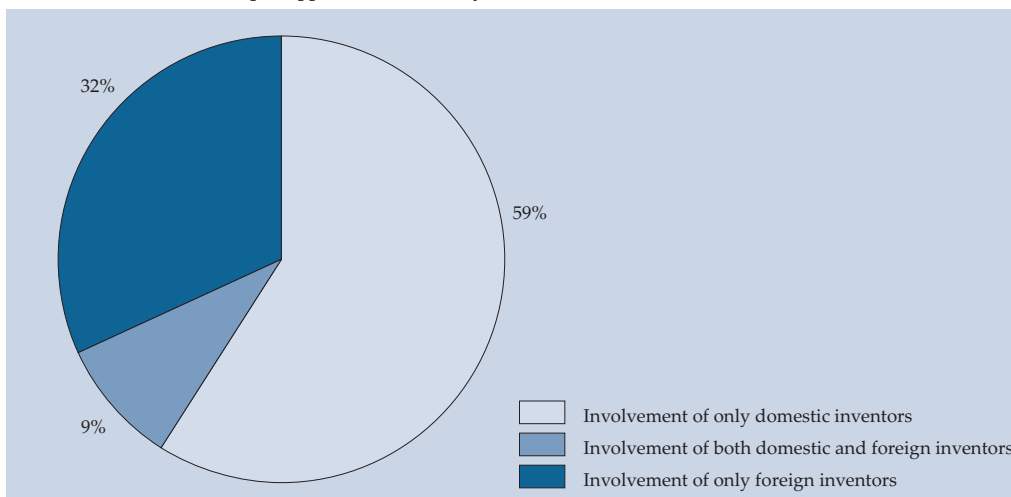
¹⁾ Ten largest multinational enterprises based on their intra mural R&D expenditures.

²⁾ Including subsidies from the EU.

Another approach to illustrating the internationalisation of research and innovation activities by Dutch controlled enterprises is to analyse the patents for which these enterprises apply. Patents are a rich source of information about technological performance and the organisational setting within which such performance was achieved. Patents show the inventor (i.e., an individual researcher) as well as the applicant (the owner of the patent at the time of the application), their addresses and country or countries of residence. In most cases, the applicant is an institution (generally a firm, university or public research institute).

Analysing the patent applications filed at the European Patent Office (EPO) by applicants from the Netherlands (see graph A4.3), we see that many are owned or

A4.3 Cross-border ownership of applications to EPO by Dutch residents¹⁾, 2001–2005



Source: EPO Worldwide Statistical Database, April 2008

¹⁾ Patent counts (EPO: Euro-direct and Euro-PCT) are based on the priority date and the inventor's country of residence, using simple counts

co-owned by applicants who are located outside the country of residence of the inventor(s). In the period 2001–2005 almost one third of the patent applications by applicants residing in the Netherlands were solely based on inventions made elsewhere.

An additional 9 percent of the patent applications were based on co-inventions of inventors located in the Netherlands and inventors located abroad. Such cross-border ownership is mainly the result of activities of MNEs, where the applicant is a conglomerate of enterprises with its head office in the Netherlands, and the inventor an employee of a foreign affiliate of this conglomerate. The results in graph A4.3 are consistent with the increased use of international subcontracting of MNEs to their foreign subsidiaries.

4.5 *Summary and conclusions*

This chapter analysed the internationalisation of R&D, addressing both the role of foreign controlled enterprises in the Netherlands, and that of Dutch controlled enterprises abroad. The increased internationalisation of R&D may not always be congruous with national policy goals to preserve and attract R&D. Questions remain with respect to a) the stability or 'stickiness' of R&D activities within

national borders, b) the contribution of R&D by foreign-controlled enterprises to national innovation and c) the locational and policy factors that attract (or deter) R&D.

The wide variety of questions posed with respect to the trends and consequences of internationalisation of R&D for the Dutch knowledge economy require an in-depth analysis of the available data. Given the high levels of concentration of R&D efforts – for example, more than 50 percent of the intramural R&D in the private sector in the Netherlands is accounted for by 10 enterprises – we explored in more detail how individual firm characteristics affect their R&D activities.

We started by addressing how foreign controlled enterprises compare with Dutch controlled enterprises with respect to their propensity to engage in a variety of R&D and innovation activities, and also pay attention to differences in their perceptions of potential barriers to innovation. We found that it is generally not the mere ‘foreignness’ of enterprises that affects the propensity to engage in R&D or innovation, but that it is the different composition of the sample of foreign enterprises with respect to other factors that affect R&D, such as company size, selling to international markets, and being part of an enterprise group, that determines that foreign controlled enterprises are more frequently involved in R&D and innovative activities compared to Dutch controlled enterprises. In particular, it seems that being part of an enterprise group (whether Dutch or foreign) is a much stronger predictor of whether or not enterprises engage in R&D and innovation.

While foreign controlled enterprises locate R&D and innovation activities in the Netherlands, Dutch controlled enterprises equally expand their R&D activities internationally to take advantage of a local market presence and proximity to foreign sources of highly skilled labour and specialists. The second part of our analyses describes the outward internationalisation of R&D from the Netherlands. For example, we established that by 2003, more than 20 percent of intramural R&D expenditures in the Netherlands was subcontracted (compared to 6 percent in 1970). Again, it is a small group of enterprises that is responsible for most international R&D: the top 10 enterprises accounted for 65 percent of all extramural R&D expenditure abroad.

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