TECHNOLOGY CENTRE AS CR

Localisation Motives for Research and Development Investment of Multinational Enterprises

European Trends and Situation in the New Member States

Vladislav Čadil, Zdeněk Kučera, Michal Pazour et al.

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Preface

The share of R&D carried out by multinational enterprises (MNEs) outside their home country headquarters has increased rapidly in recent years, especially in the connection to the new phase of globalisation in the 1990s. The close association of internationalisation of R&D to production is mainly caused by the fact that the large companies engaged in foreign direct investment (FDI) play also a key role in the creation of innovation and their global diffusion. The dominance of MNEs in international R&D investments is evident. It is mainly due to the size advantages related to financial power and ability to achieve a critical mass of R&D. Nevertheless, the international spread and globalisation of R&D activities is not a new phenomenon. Some R&D activities have been localised abroad for a long time. In some way, R&D globalisation may date back to the earliest days of FDI; MNEs have always had to adapt technologies and products for the markets abroad and in many cases R&D activities have been necessary for this purpose.

New is the pace and extent of internationalisation of R&D activities affecting not only the developed but also the post-communist transition countries. In the transition economies of the new EU member countries, foreign affiliates have become important R&D players since the mid-1990s. The rationale of the increasing R&D dissemination rate in transition countries is the rapid technology change which often requires a close interaction between R&D and production. Nevertheless, this is mainly the case of emerging technologies while production using mature technologies doesn't necessarally need additional R&D activities.

In the context of the Lisbon Agenda (supporting European Union "to become the most competitive and dynamic knowledge based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion"), the issue of large private companies R&D activities and their localisation in the EU member states has become very important in the European, national and regional political agenda as well as barriers of localisation and further development of R&D activities. One of the first attitudes towards this topic is represented by the international (inter-regional) project LocoMotive that aims at providing regional policy makers with a better understanding of the current R&D investment policies of large private sector companies in Europe.

The aim of this publication is to summarize main conclusions of the LocoMotive project that has created an appropriate methodology and research framework for studying international localisation motives of R&D activities. Analytical results based on this methodology are presented and interpreted in particular chapters and cover experiences from both developed and transitional European countries. These results represent a significant source of information for policy makers at regional, national and European level who are responsible for stimulative environment for R&D activities creation. The publication consists of six subsequent chap-

tures, which are based on papers presented an the conference and workshop that took place on March 8, 2007 in the hotel Marriott in Prague as a part of the LocoMotive project.

The first chapter deals with the localisational attractiveness of regions for private sector investment in R&D and localisational motives and organizational structure of R&D activities within MNEs. The chapter outlines the background of the LocoMotive project, explaining in detail the project's approach and methodology. Subsequently, the results of one of the key components of the project – the interviews – are discussed and clustered to the main themes of the project.

The second chapter aims at analysing business R&D in the Czech Republic. It addresses the significance of MNEs in business R&D of the Czech Republic and the main trends of their investment in R&D.

Establishment and development of MNEs R&D activities in the Czech Republic is influenced by many factors and barriers. Some of them were important only in the recent history; however, the majority of them are still significant at present. These barriers are the main subject of the third chapter dealing with summarising strengths and weaknesses and trying to find possible solutions for identified problems. According to the LocoMotive methodology the chapter further deals with types and organization of R&D realized by MNEs in the Czech Republic and the level of co-operation and linkages of R&D units to the local economy.

Identified problems and barriers can be solved by specific strategies and programmes prepared and implemented by ministries or state agencies. The introduction of initiatives governed by the Ministry of Industry and Trade of the Czech Republic that support innovation and R&D activities among companies and business environment make the basis of the fourth chapter. The chapter shows that business R&D is not only a matter of individual firms but is strongly supported by many programmes financed by national and European funds.

The fifth chapter deals with development of R&D activities of MNEs located in Hungary with special attention to local factors. This chapter allows an interesting comparison of MNEs R&D activities in two post-communist transforming EU New Member States. More specifically it offers a general picture of the current situation in the area of R&D in Hungary. Chapter conclusions are based mainly on available statistical data and deal in more detail with the factors responsible for relatively slow integration of the foreign R&D in the country. Chapter also includes a few concrete examples of corporate-university relations.

Setting up and development of R&D activities of MNEs represent a very complex issue in terms of types, scope and organization of business R&D, types and degree of cooperation with local R&D infrastructure including universities. Possible attitude towards promotion and further development of business R&D represents the concept of open innovation which is introduced in the sixth chapter.

1. R&D in European Regions: Overview and Findings of the LocoMotive Project

Introduction

Is Europe still an attractive location for private sector investment in R&D? What are the motives for a firm to invest in a European region, and what do R&D managers think are a region's weaknesses as R&D location? These questions provide the core of the LocoMotive project. LocoMotive is an FP6 Regions-of-Knowledge funded project that aims to provide a better understanding of the characteristics of, and motives for, the way in which MNEs organize their international R&D across European regions, in order to contribute to better and more effective policy making at the regional, national and European level, thus contributing to the Lisbon Agenda.

One of the main problems in developing and implementing effective innovation policies is the difficulty in establishing a dialogue between on the one hand, the significant private sector R&D actors, usually multinational enterprises (MNEs), and on the other hand, those from public sector (including governments and universities). They are worlds apart. LocoMotive aimed to bridge this gap in a highly pragmatic manner, by offering a framework for discussion and analysis. Over the past year, over 40 interviews were conducted with the top R&D managers of European R&D facilities, and a series of regional round tables were held across Europe that brought together R&D managers, policy makers and university representatives.

The LocoMotive project consortium represented this diversity of actors involved in the R&D process, and consisted of eight partners from a range of different backgrounds, including representatives from university (academics and tech-transfer offices), private sector consultancy firms and regional development agencies:

- **CEU Consulting** (Budapest) and the **Centre for Regional Studies, Hungarian Academy of Sciences** have been responsible for developing national and regional innovation policies for Hungary.
- **Culminatum Ltd Oy** Helsinki Region Centre of Expertise is a regional development management company acting on behalf of Helsinki and the Uusimaa region, one of the most successful regions according to the Lisbon Agenda.
- **Interlace-invent ApS** is a research-based consultancy firm associated with Copenhagen Business School located in five places in Europe and others further afield, and working with a number of regionally based organisations to create innovation environments.

- **Oxford Science Enterprise Centre** is part of the **Said Business School at Oxford University**, and operates as part of the University's Knowledge Transfer strategy by supporting academic entrepreneurs. Oxford represents one of the most dynamic regions in Europe for research based enterprise.
- **Réseau Universitaire Toulouse Midi-Pyrénées** is supported by a regional consortium of research and university entities, and socio-economic partners acting for a region with dominant clusters in aerospace and bio-medical technology.
- **Rotterdam School of Management, Erasmus University** is one of Europe's top business schools which has for many year's been studying MNE R&D investment.
- **Technology Centre of the Academy of Science of the Czech Republic** works on analytical and strategic studies in RTD and innovation, and transnational technology transfer and has carried out many policy forming studies for the Czech government.
- **TuTech Innovation GmbH** (Project Coordinator) is a technology transfer company belonging to Hamburg University of Technology and the Free and Hanseatic City of Hamburg and has a public mission to act as a facilitator for cooperation between research and private enterprise.

This chapter outlines the background of the LocoMotive project, explaining in detail the project's approach and methodology. Subsequently, the results of one of the key components of the project – the interviews – will be discussed in the following sections, clustered around the main themes of the project. Finally, the last section outlines the further steps in the LocoMotive project.

The LocoMotive Project

The way in which multinational enterprises (MNEs) organize their R&D internationally, and across regions, importantly affects the role that these multinationals play in regional systems of innovation. In addition, since the motives for MNEs to invest in (or retain) R&D in certain regions also vary across different kinds of R&D and the way in which the MNE organizes its R&D internationally, the effectiveness of regional policies aimed at attracting and keeping those MNE R&D investments that contribute most to regional innovation and economic growth is also affected. The LocoMotive project was set up in such a way as to combine detailed *regional* information on R&D facilities with an analysis of *global* trends in R&D, in order to answer three main (research) questions:

1. What are the *locational determinants* for R&D activities by MNEs in European regions?
2. How do MNEs *organize and coordinate* their R&D activities within their firm and across borders?

3. What is the *regional contribution* of MNE R&D activities in terms of employment, innovation, and spillovers?

The combination of information on each of these three issues eventually leads to concrete prioritized recommendations for policy makers, taking into consideration the types of R&D investment that contribute most to regional innovation, and the prime factors that attract such investments.

In order to answer these questions, the project consisted of three empirical components. First of all, a series of more than 40 interviews were conducted with senior R&D managers. Subsequently, round table discussions were held in each region in the project, bringing together regional stakeholders such as government representatives, regional development agencies, universities with corporate R&D managers in order to discuss the interview findings and explore future innovation policies. The third component consists of a 'global view', in which secondary data are combined with firm-level data in order to sketch trends in R&D strategy of firms the global and regional context. Table 1 illustrates how each of these three empirical components contribute to illuminating the three main themes (following the research questions) of the LocoMotive project.

Table 1: Project research themes and sources of empirical data

	Interviews	Round table	Global View
Theme 1 – Motives	●	◐	◐
Theme 2 – Organization	◐	○	●
Theme 3 – Impact	◐	●	◐

● Main source of information for this theme

◐ Additional/secondary source of information for this theme

○ This source of information is not used for this theme

In this chapter, the results are presented of one of these empirical components, viz. the interviews. Although the interviews contained questions on each of the three research themes, particular attention was given to gathering information on the motives of MNEs for locating R&D in a particular region.

In total, more than 40 interviews were conducted across the 8 regions in the project. The firms selected for the interviews were chosen on the basis of the criteria that they were considered regionally important i.e. had considerable R&D activities in the region, and preferably also in one of the other partner regions,

and that they are in the Fortune Global 500 list (hence, were very large). Examples of interviewed companies include Siemens, Philips, Sanofi-Aventis, and Airbus. A substantial number of the interviewed companies came from the electronics industry, and also chemicals/pharmaceuticals and aerospace firms were well-represented in the sample.

The interviews have been conducted with the most senior directors/managers of MNE's R&D units. They were semi-structured in nature, with a limited number of open questions, based on the research themes. If necessary, the open questions have been followed-up by more specific questions for clarification, so that as much information as possible can be systematically obtained from subsequent content analysis of the interview transcripts. The interview questionnaire was pilot-tested with one interview in each region; the results were compared at a project meeting at the beginning of April 2006, which resulted in some small textual modifications, and a separate slightly different version for interviews with headquarters (e.g. Nokia in Helsinki). The interview transcripts were coded so that (be it relatively crude) quantitative variables could be obtained, and systematic comparisons could be made across firms and across regions.

The results of the interviews are discussed in the following sections, each focusing on one of the main locomotive themes. The sections all start with a brief introduction of the theme and the theoretical considerations regarding that theme, before presenting the empirical findings.

Locational determinants of R&D

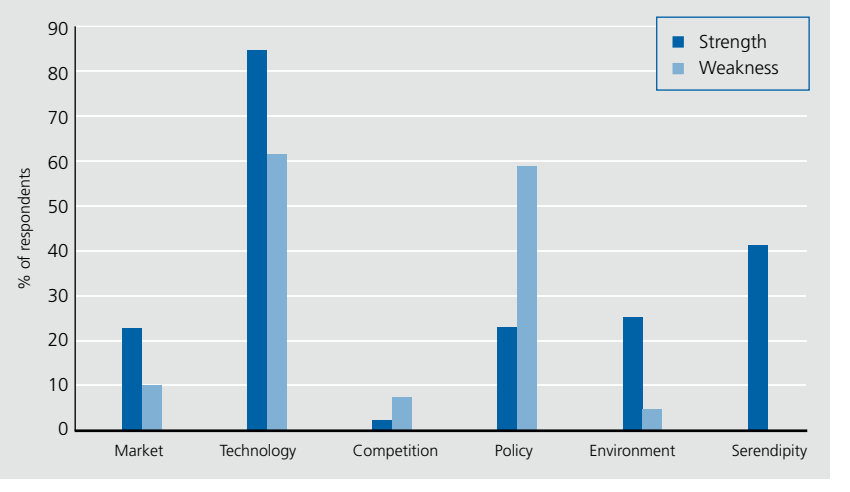
Multinational involvement in overseas research, product development and innovation has increased significantly during the 1990s. There is an extensive literature that identifies a wide range of (potential) factors that may induce firms to internationalize their R&D, and that explain the consequent locational choices of those R&D activities. From this literature, six broad groups of determinants can be distinguished:

1. The first type of motivating forces are *market* or *demand-side factors* abroad, which may make it necessary or advantageous to adapt products (and/or processes) to local market characteristics. Examples include local market requirements that require product adaptation; global customers requesting local product support; proximity to large groups of customer and lead users; the need to create an image of being a 'local citizen', and the support of local manufacturing (process innovation).
2. The second broad group of centrifugal forces are *technology* or *supply-side factors*. Examples of such factors include the presence (and costs) of highly skilled labour, access to local specialists, proximity to local universities and research parks, tapping into informal networks and proximity to centers of innovation.

3. The third motive for FDI in R&D is to anticipate or imitate a competitor's investment behaviour, e.g. *competitor-driven FDI*. This motive refers to the need to closely monitor, and learn from, the technological developments and strategies of an MNEs competitors abroad.
4. The fourth group of forces arguing for decentralising R&D activities are *political factors*. These factors include 'host country' factors like a friendly regulatory legislation for intellectual property and patenting, tax advantages, subsidies for R&D, trade policy, and government pressures to improve the subsidiary's capabilities beyond the simple assembly of proven products and into innovative activities.
5. The fifth set of reasons constitutes of factors that help create a dynamic urban environment, such as a rich cultural environment (theatre, museums) but also climate (weather) and natural environment, and the presence of international schools. These locational factors help to attract and keep highly qualified and educated staff, and facilitate informal contacts that stimulate innovation.
6. Finally, serendipitous factors, or chance, can be an important determinant of why MNEs locate their R&D in a particular region. Examples include path dependencies (historical developments), or a merger or acquisition where one company also inherits the other firm's R&D activities.

In the interviews held with managers, they were asked which of these six motives were important in deciding to locate R&D activities in the place where they are now. Also, we asked which of these six aspects were considered as a weakness of the region in which the respondent was located. Figure 1 graphically represents the findings.

Figure 1: Locational strengths and weaknesses mentioned by R&D managers (n=40)



The results indicate that historically, technology factors have been most important, as well as accidental factors. The latter category refers mainly to path dependencies and the consequent high cost of relocating R&D facilities. Technology related factors such as a highly educated labour force and the presence of other knowledge intensive firms are also among the motives that are currently important in keeping R&D investment in the region. Closeness to markets is far less important. Policy and environmental factors are mentioned by a quarter of the interviewed firms as reasons to stay in the region. Often, this is a reflection of the substantial costs of relocating (i.e., giving up existing regional ties).

At the same time, technology (both costs and quality) is also an important weakness (often 'threat') in many of the EU regions. Among the weaknesses mentioned by the 42 interviewed managers was primarily the lack of quality of the educational system. Firms often reported to experience difficulties in cooperation with universities – both the not always up-to-standard level of specialists (especially at regional universities) as well as the bureaucratic procedures were mentioned. But also the level of training and 'eagerness' of graduates, particularly when also the costs of these graduates are compared with Chinese or Indian employees, was often mentioned as an important point of concern. This means that firms have often (historically) decided to locate R&D in Europe because of the innovative and technology intensive environment, but that Europe seems to be loosing out in those dimensions.

Similarly, policy and regulation were often considered as weaknesses for locating R&D in a particular region. Two key points were mentioned: high taxation, and the great variation and variability in regulation both across Europe and over time. Perhaps remarkably, the relative – in comparison with China and India – small market growth in Europe is far less often considered as a detrimental factor in the location of R&D.

Table 2 sheds more light on the two issues (policy and technology) that were mentioned as key weaknesses of the EU regions. Firms were asked to name three policy recommendations at either the regional, national or European level. The recommendations in the area of taxes are not surprising: companies especially asked for reduction of taxes on labour, in order to keep both total staff costs down, and make wages for experts more attractive (i.e., to attract the best international experts). Issues related to research funding were among the most often mentioned. Firms stressed a need for more funding and subsidies, but especially also a more focused or better prioritized way of distributing government funds, and to avoid regional or thematic fragmentation. In addition, it was suggested that funds and subsidies should focus on facilitating industry cooperation and cooperation with research institutes and governments.

The technology and policy issues that were addressed as weaknesses are also echoed by the policy recommendations in the areas of education and governance quality. With respect to education, firms suggested that governments should invest

Table 2: Areas of policy recommendations given by R&D managers (n=40)

	n	%
Taxes	11	28.2
Education	16	41.0
Funding	16	41.0
Governance Quality	12	30.8
Other	11	28.2

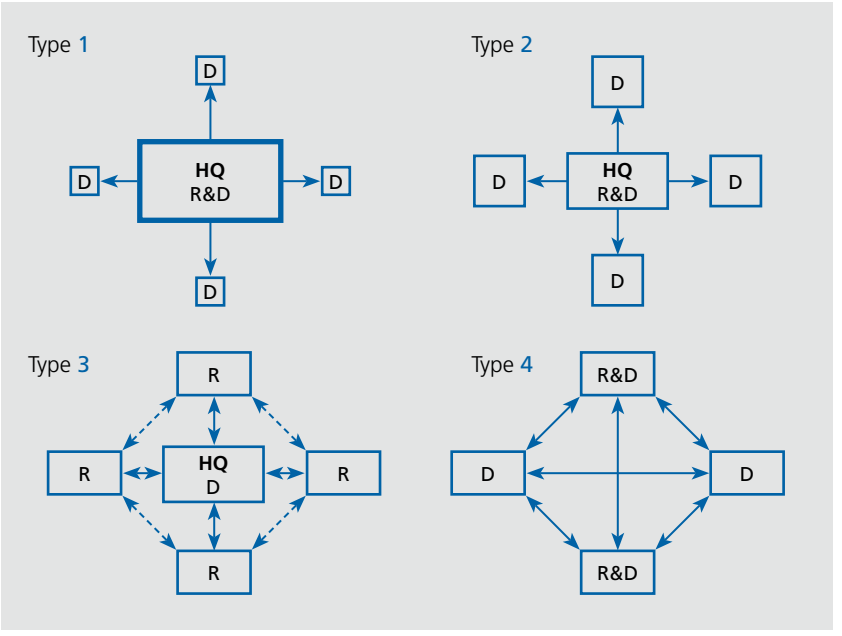
in better trained graduates, but also in for example high school science teachers, and to pay attention to basic engineering skills as well. The statement by one of the respondents that the education system should focus on "top class expertise and sound base of engineering, *not* large mass of average know-how" reflects the opinion of many. The term governance quality covers both stability or regulation and policy (no sudden or opportunistic policy changes), and the simplification and harmonization of national, EU and regional regulations. Such comments were not only made in the area of e.g. R&D and Science policy or IP protection, but also with respect to pricing of products in strongly regulated markets such as pharmaceuticals and energy. The lack of a consistent policy and indecisiveness strongly deters R&D.

Organizational Structure

While obtaining information on the opinion of R&D managers regarding the reasons for investing in European regions (as well as their ideas on how to strengthen Europe as an R&D location) was the main aim of the interviews, several questions were asked about the other two themes – organizational structure and regional linkages – as well. Based on the academic literature, four ideal types of organizational structure were distinguished (see figure 2).

Type 1 represents those firms that fully centralize their R&D activities at headquarters, only engaging in limited local product development and adaptation abroad. Type 2 represents those firms that are similarly centralized, but with a much stronger emphasis on product development near markets: the majority of basic research is still concentrated at headquarters, while product development is decentralized. Type 3 firms instead locate their research activities abroad, close to the world's top research centres, while conducting all product development at home. Finally, type 4 firms organize their R&D in networks with various centers of excellence for research, development, or both, which may be located anywhere worldwide and communicate strongly. In each of these four types, the functional linkages (between research and development, and with e.g. marketing, and manufacturing) are different, as well as the hierarchical links.

Figure 2: Four ideal types of R&D organizations



In the interviews, we asked about the activities carried out in the selected R&D locations. In addition, we introduced the four different organizational types, asking which one resembled most the organizational structure of the respondent's organization. Table 3 gives an overview of the results. The R&D units that were interviewed are slightly more often primarily active in product development, while less are engaged in basic and fundamental research. The final panel of the table shows that most of the R&D units are part of a 'network type' organization (type 3 or 4).

Table 3: Organizational Structure

	Nature				Type	
	n	%			n	%
Basic Research	13	33.3		Type I	5	14.7
Product Development	19	48.7		Type II	5	14.7
Other	2	5.1		Type III	11	32.4
Missing	5	12.8		Type VI	11	32.4
				Other	3	8.8
				Missing	4	11.8

Regional Contribution

The final theme on which we interviewed the senior R&D managers consisted of the links of the R&D unit with organizations in the region. These links provide the main channel through which the R&D efforts of MNEs can spill over to the local region, and hence benefit regional innovation. Spillovers refer to unintended leakage of knowledge to other market participants, as well as to voluntary transfers of knowledge between market participants. Involuntary leakage can take place through informal contacts or personnel transfer, while voluntary transfers occur through licencing, R&D contracting or R&D cooperation agreements. Both types of knowledge spillovers require geographical proximity and often face-to-face contact, indicating why it is important for policy makers to try and increase (or keep) high-quality R&D within their region.

In the interviews, we asked R&D managers to indicate the strengths of their regional ties with a range of different organizations, including local firms (suppliers, buyers, and competitors), research institutes (universities and others), employees (extent of labour migration), and other contractual and informal ties, such as corporate venturing and intermediary agents, and ties with policy makers and government.

Table 4 first indicates the number of interviewees that mentioned that the linkages with a particular group of regional stakeholders through formal contracts and informal contact were non-existent (0), weak (1), or strong (2). Although such classifications based on interview results have a substantial subjective connotation, the final column calculated the average of the respondents' answers in order to indicate the relative importance of ties with stakeholder groups. Table 4 shows that the links between the interviewed R&D units and organizations in the region are primarily strong with universities, local suppliers and network organizations. As not all respondents answered the question for each of the individual categories, the total number of observations differs slightly for the various categories.

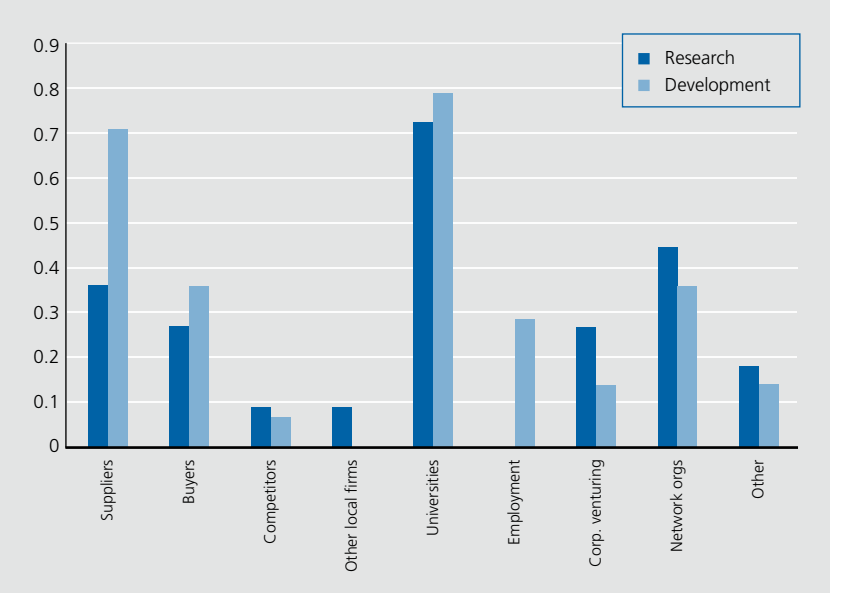
Table 4: Extent or Regional ties (formal and informal)

	0 (none)	1 (weak)	2 (strong)	Average
Suppliers	8	12	14	1.2
Buyers	14	12	5	0.7
Competitors	28	2	1	0.1
Other local firms	25	6	0	0.2
Universities	5	7	25	1.5
Employees (e.g. labour migration)	18	13	1	0.5
Corporate Venturing	21	7	4	0.5
Network organizations	17	10	6	0.7
Other organizations	22	7	2	0.4

Subsequent steps in the LocoMotive project

The results presented in this chapter are the first to come from the LocoMotive project, and as such are preliminary. With specific reference to the interview results, one of the steps that will be taken in follow up research includes a combination of the results across the three main themes. An example of the things that are planned is displayed in figure 3, which displays the difference in regional ties between basic research and product development units. It shows that in particular product development organizations have strong regional links, especially with suppliers, buyers and universities. It is expected that these results will finally contribute to developing strong and specific policy recommendations.

Figure 3: Regional linkages from research and development units



2. Investment of Multinational Enterprises into R&D in the Czech Republic

Introduction

Although the Czech Republic has always belonged to industrially developed countries with highly advanced research and development, extensive R&D infrastructure and skilled and technically well educated labour force, R&D investments of MNEs represent a quite new phenomenon in the Czech Republic. It raises a question about the current position of the Czech Republic in global R&D operations of MNEs and more concretely about the localisation motives of MNEs to set up their R&D operations there.

The main aim of this chapter is to assess the significance of MNEs in the Czech economic development and in business R&D investments. The assessment of the present state is an important assumption for consequent analysis of the crucial localisation motives and barriers for R&D investments of MNEs in the Czech Republic.

Foreign direct investment in the Czech Republic

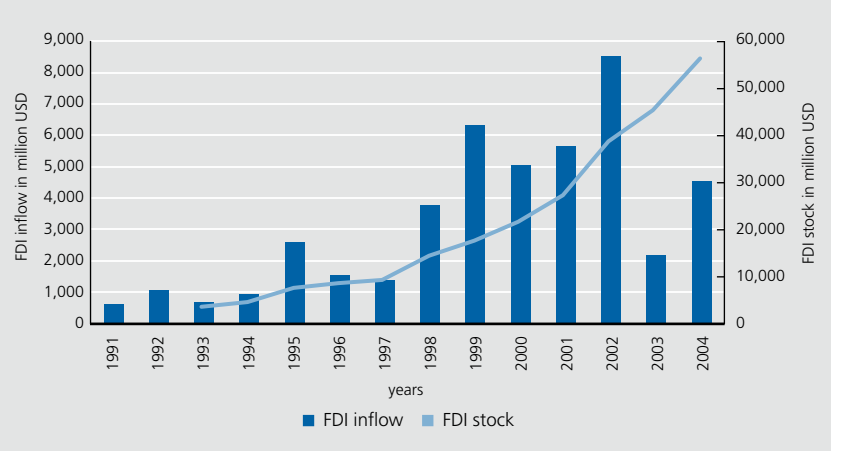
Foreign direct investment is a relatively new factor of economic development in the Czech Republic since its inflow has started after the fall of socialism in 1989. On the basis of the economic transformation and privatisation strategy and progress, it is possible to distinguish three development stages of FDI inflow (Pavlínek 2002):

- Since 1990 to the parliamentary election in 1992: despite the negative attitudes of many politicians to privatization (in the form of sells to foreign companies), there was a pragmatic approach to foreign investors based on individual negotiations and sells of selected companies (Zemplinerová, Benáček 1997).
- In the period of 1993–1997 there was an entirely negative attitude to foreign investors and a massive support of domestic investment in privatization. Moreover, the inflow of FDI was affected by the split of Czechoslovakia resulting in the reduction of domestic market and political uncertainties.
- The approach to foreign investors was changed significantly by new political representation in the turn of 1997 and 1998. In the spring of 1998, the system of investment incentives was established to encourage the economic recovery. At the same time the privatization of state banks, infrastructural companies and telecommunications to foreign investors has started.

The differences in FDI inflow in these three stages of economic development are illustrated in Figure 4. During the first stage the inflow of FDI was relatively low.

The sole significant foreign investment in this period was realised due to the privatization of Škoda Auto, an important car producer, and its sale to Volkswagen. The low FDI inflow in the second stage reflected the official reserved attitude to foreign investors. The sale of a state share in the monopoly telecommunication company of SPT Telecom to the Dutch investor was the main foreign investment carried out in this stage. A massive FDI inflow in the Czech Republic started in 1998 in the context of launching an investment incentives scheme. Investment incentives provided as a part of state aid in business sector resulted in boom of greenfield investments. The privatization of large enterprises (especially in the banking sector) to foreign investors was another important impetus for the FDI inflow in this period.

Figure 4: Development of FDI inflow and stock in the Czech Republic



Source: Czech National Bank

Since 1998 three types of investment incentives have been implemented continuously. The first type has been focused on the manufacturing sector and has involved corporate income-tax relief, job-creation grants, training and retraining grants, transfer of land with infrastructure at a discount and transfer of land owned by the Czech state at a discount.

The second type has been the job creation support programme designed for regions affected by above-average unemployment which has been valid since June 2004. The support financed by this programme has been designed only for enterprises in the manufacturing sector. It has been provided in the form of financial grants for the creation of new jobs and financial grants for the training or retraining of employees.

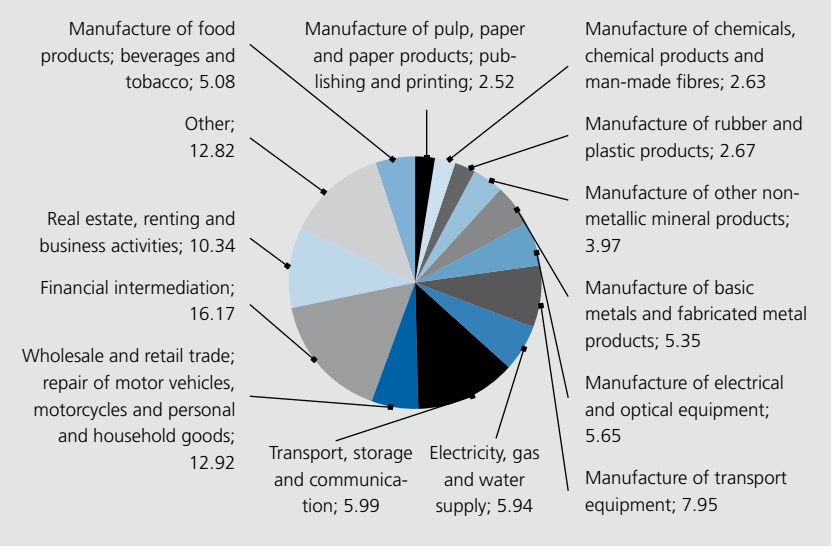
The third type of investment incentives has constituted the Framework Programme for the Support of Technology Centres and Centres of Business Support Services. It has been an important tool for the establishment and development of

R&D activities. Technology centres have been defined as innovation units especially concentrated on periodic changes of products and technologies and closely linked to production. Business support services have been services with a high added value, aiming to support employment of qualified experts in software development centres, expert solution centres, high-tech repair centres, shared services centres, centres of customer support. The support has been provided in the form of subsidies to business activity and subsidies for training and re-training. The support of technology centres has been focused on the following sectors: aerospace, office and computer equipment, electronics and microelectronics, telecommunications and pharmaceuticals, scientific instrument and professional equipment, motor vehicles, industrial electrical machinery, production of chemical products, road transport equipment, engines, turbines and agricultural machinery.

Up to the end of 2005 investment incentives were assigned to 314 foreign firms (225 in manufacturing activities, 23 in a job creation support programme and 66 in the Framework Programme for the Support of Technology Centres and Centres of Business Support Services). Supported investors should invest more than CZK 327 billion (EUR 12 billion) and create more than 77.000 new jobs.

Sector distribution of FDI stock is very uneven as it is visible from the Figure 5. FDI stock was mainly concentrated in the services sector (58%) especially in branches that were underdeveloped during socialism – in financial intermedi-

Figure 5: Branch structure of FDI stock in 2004 (in %)



Source: Czech National Bank

ation and trade services. About 35% of the total FDI stock in 2004 was invested in manufacturing, where investments in the automotive industry play the most significant role.

The importance and attractiveness of the automotive sector for the foreign investors is more evident if we look at the sector structure of investments supported by investment incentives. In investment incentives scheme of 2004, there were 39 % of private firms, and 47 % of the total investment within the automotive sector. The electronic sector was also important (10 % of firms and 18 % of investment). Generally, foreign investors focused mainly on industries with a long tradition in the Czech Republic, developed industrial basis, qualified labour force and industries that promised a rapid investment return.

Distribution of FDI stock according to technological progress shows that foreign investors see a comparative advantage of the Czech economy mainly in medium-tech industries. In 2004, only 9,2 % of FDI was invested in high-tech industries (35,2 % in medium high-tech and 30,2 % in medium low-tech). This way of FDI distribution among less progressive industries doesn't stimulate development of high-tech R&D and commercialization of R&D results in the Czech Republic.

Regional variability of FDI has increased significantly since 1998. It was caused particularly by the increase of FDI concentration to Prague and other main metropolitan areas. The share of FDI stock invested in the Prague agglomeration increased from 47 % in 1998 to nearly 60 % in 2004. The privatization of banks and other large companies having their headquarters in the capital was one of the most important factors of the increase of FDI concentration in Prague.

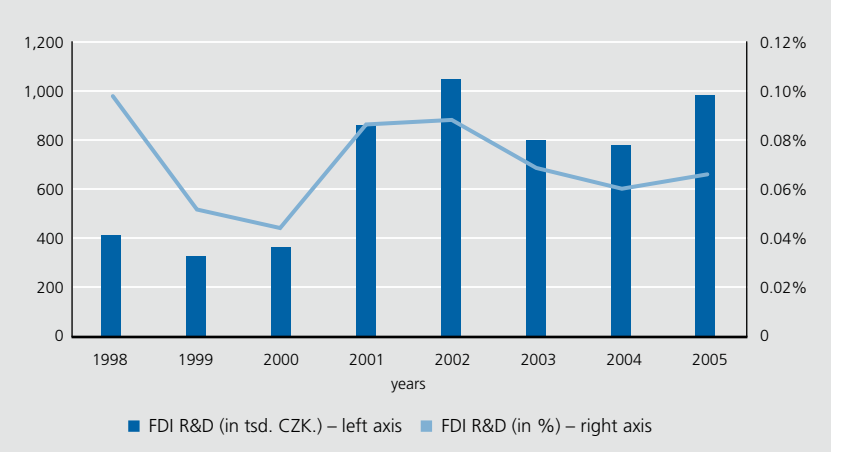
Concerning the other metropolitan areas, FDI has flown mainly to agglomeration of Ústí nad Labem and Brno. The agglomeration of Ústí nad Labem represents the old industrial and structurally affected area. This region received FDI mainly through privatization of large industrial concerns and greenfield investments. Investments in Brno were focused on the sector of progressive services and high tech manufacturing. The American company Honeywell which has established the Global Design Centre in Brno is an example of this kind of investments.

Technology centres supported by the Framework Programme for the Support of Technology Centres and Centres of Business Support Services are localised to the important industrial centres with high innovation potential. The highest investments into technology centres were in the Central Bohemia region where 5 centres were built up to the end of 2005. The two largest technology centres were built by Škoda-Auto (CZK 1,2 billion, EUR 43 million) and by Lonza Biotec (CZK 412 million, EUR 15 million). Prague (4 centres), the region of Zlín (4 centres) and the region of Pilsen (5 centres) were other regions with high level of investment into technology centres.

When we look at FDI invested in R&D sector (see Figure 6), there is a significant increase of the FDI stock from CZK 421 million in 1998 to CZK 1.047 million in 2002 and a stable development since 2002 till 2005. However, the importance of

FDI invested in R&D sector (NACE 73) remains insignificant in a relative amount of about 0,7%. The low ratio is partly caused by statistical classification because investment channelled into R&D activities realized in other branches (e.g. in the automotive industry) are not displayed as R&D investments. Nevertheless, these figures mirror a prevailing interest of foreign investors in investment into production in the Czech Republic.

Figure 6: Stock of FDI in the R&D sector (NACE 73) in the Czech Republic



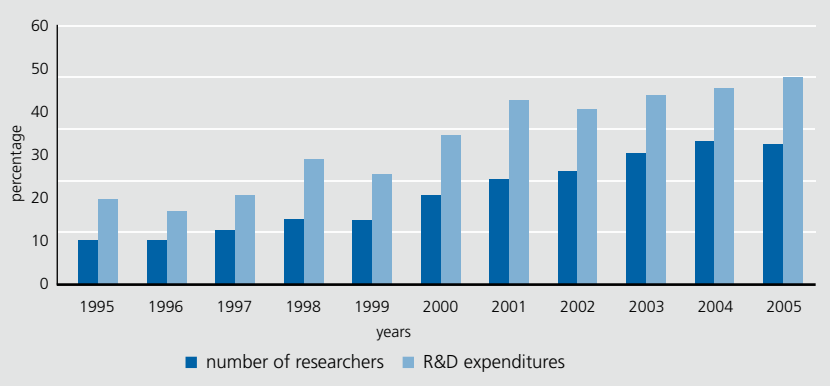
Source: Czech National Bank

Business Research and Development in the Czech Republic and the importance of MNEs

Development of business R&D activities since 1989 has been influenced by privatization and other economic reforms. These factors have been reflected in significant decrease of R&D expenditures and number of researchers. Business R&D expenditures decreased by more than 50 % in the first years of the economic transformation. The development of business R&D has been stabilized during the second half of nineties.

The share and scope of R&D activities of MNEs in the Czech Republic have increased as a consequence of an increasing importance of MNEs in the Czech economy and globalization of R&D activities in general (see Figure 7). The higher share of R&D expenditures in comparison with the share of researchers indicates that MNEs are concerned to build new R&D infrastructure or to modernise older ones. These figures also demonstrate higher R&D intensity achieved by MNEs compared to domestic companies.

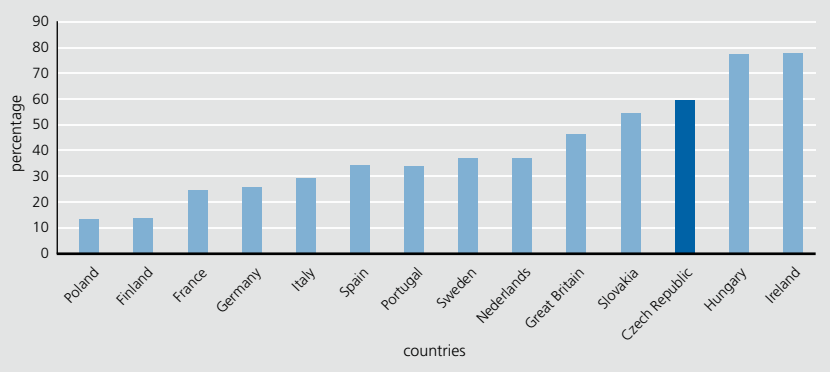
Figure 7: Share of researchers in the business sector and business R&D expenditures in MNEs in 1995 – 2005



Source: CZSO

In the international comparison, the share of R&D expenditures realised by MNEs in the Czech Republic is above the average of European countries (see the Figure 8). Higher share of MNEs in total business R&D expenditures was reached only in Ireland and Hungary – in countries with economic development strategy based mainly on the use of benefits from MNEs. On the other hand, a lower share of MNEs in the business R&D expenditures is characteristic for countries disposing of a developed domestic R&D (e.g. Germany or Finland). These results also reflect relative openness of an economy, whereas in small open economies the importance of MNEs in R&D investments significantly rises.

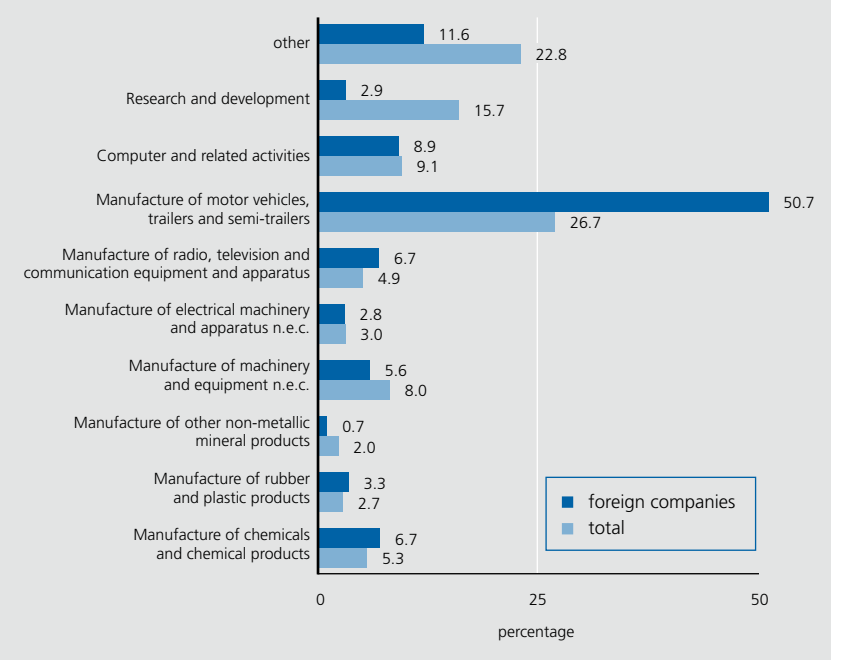
Figure 8: Share of business R&D expenditures in manufacturing launched by MNEs in 2003



Source: OECD

The structure of R&D activities performed by foreign companies corresponds to the structure of the total FDI inflow to the Czech Republic, whereas R&D foreign investments are disseminated among few industries. According to the Figure 9, R&D expenditures of MNEs have been expended mainly within medium high-tech industries, in particular in automotive industry. By contrast R&D expenditures of foreign enterprises performed directly in the R&D sector (NACE 73) persist insignificant.

Figure 9: Branch structure of business R&D expenditures

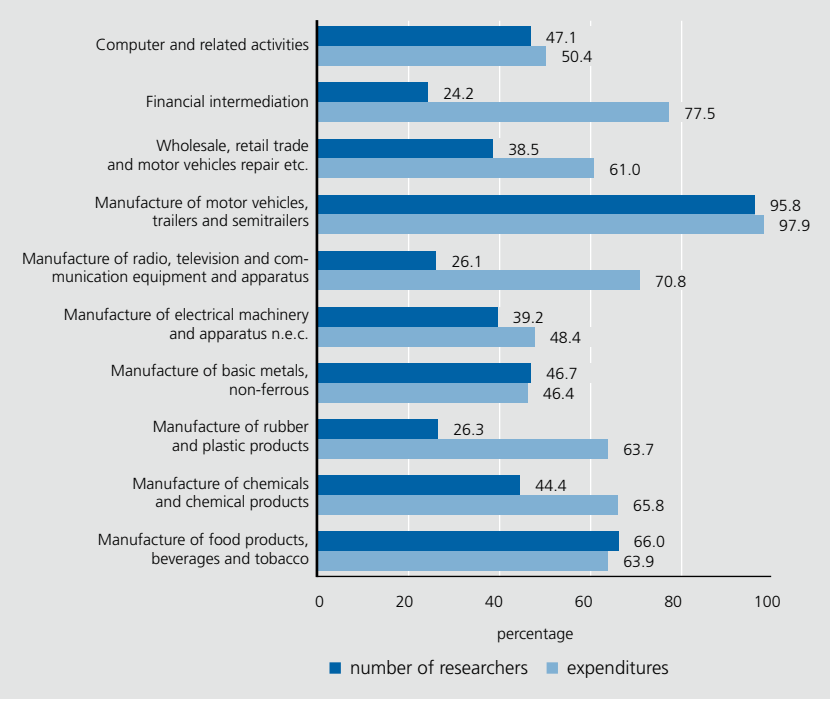


Source: CZSO

More detailed view on the importance of MNEs in R&D activities is featured by the Figure 10. MNEs achieve the highest share in R&D expenditures and the highest number of researchers in the automotive industry, which is definitely the most attractive industry for foreign investors. However, as apparent from the Figure 10, MNEs are also significant investors in R&D in less technologically developed traditional industries, e.g. food processing or metallurgy. Since the share of R&D expenditures launched by foreign enterprises exceeds their share in production, there is a potential for knowledge and technology diffusion into domestic enterprises. A sufficient absorption capacity of the Czech enterprises in terms of technology

equipment and skilled labour force is a crucial assumption for a successful utilization of the technology knowledge held by MNEs.

Figure 10: MNEs share of business R&D expenditures and researchers in branches of economic activity



Source: CZSO

R&D activities of foreign companies are geographically unevenly distributed among the Czech regions. The crucial share of business R&D is concentrated into the economically strongest regions, especially metropolitan areas concentrating the highest share of public R&D. More than a half of business R&D expenditures in recent years has been concentrated to Prague and the Central Bohemia region which creates the Prague's surrounding. There are many former state research institutes transformed into private research institutes in these regions. Moreover, many R&D centres are settled there, e.g. Sun Microsystems and Honeywell in Prague or Škoda Auto and Lonza Biotec in the Central Bohemia region. During the last years there has been an important development of R&D activities of MNEs in some of the Moravian regions with technical universities that attracted foreign investors. Brno

(the South Moravian Region) is a typical example that attracted R&D activities of companies like Honeywell, Siemens, IBM, Tyco or IMI Norgen.

Conclusion

Localisation of FDI to R&D in the Czech Republic has been influenced by the complexity of the transition process and the EU accession in 2004. The Czech Republic disposes of low cost and skilled labour force on one hand and high experiences in R&D on the other. Moreover, the proximity to German borders and technologically strongest European regions plays an important role in the localisation of R&D activities in the Czech Republic.

Although the number of MNEs investing into R&D and the amount of FDI to R&D has been increasing, a further development of such investments is limited mainly by the lack of qualified labour force, low quality of R&D management, low level of cooperation between research institutes and MNEs and low support to R&D activities in large MNEs. More detailed analysis of the main localisation determinants and barriers in the Czech Republic make up the core of the next chapter, which presents partial results of the Locomotive project.

3. R&D Localisation Determinants, Weaknesses and Possible Solutions – Results of the LocoMotive Project in the Czech Republic

Introduction

The localisation of business R&D activities is influenced by many factors (economic, technology, policy, etc.) resulting from the complex character of present R&D. Business operations connected to R&D activities are located near companies' headquarters in the most developed regions, however, in the recent years some of the R&D capacities have been relocated or new ones have been established in several "emerging" regions, especially in the post-communist European countries, China and India.

This chapter aims at presenting partial results of the LocoMotive project in the Czech Republic, i.e. results of interviews with managers of important MNEs and conclusions from discussions with experts on R&D and innovation.

Interviews with R&D managers of MNEs were launched to identify main localisation determinants (motives, barriers, etc.) of MNEs located in the Czech Republic and the nature, scope and organization of R&D in MNEs as well as the way and level of cooperation with local actors.

The following criteria have been used to select the interviewed MNEs:

- the importance of their R&D activities in the Czech Republic,
- the importance, development and growth potential of branches in the economy,
- the scope of FDI penetration
- and the mode of entry into the Czech economy (greenfields investment or privatization).

On the basis of these criteria, 7 following MNEs were selected and interviewed:

- Hexion Specialty Chemicals
- Siemens, s.r.o.
- Honeywell Czech Republic
- Sun Microsystems Czech s.r.o.
- Microsoft
- Danone a.s.
- Škoda – Auto a.s.

These companies operate in the automotive industry, chemistry, ICT, food industry, electronics and electric industry and machinery.

In addition to these interviews there were two workshops organised with experts from business, academic and policy sphere, which aimed at discussing selected issues of R&D localisation in the Czech Republic.

Results of interviews

Main localisation motives

Localisation motives for setting up R&D activities have changed significantly since the beginning of 90s when post-communist transformation started. At the beginning of the transformation the Czech Republic was an unknown country in transition with a high level of risk for establishment and development of R&D activities for many investors. However, an important milestone for R&D investment was the beginning of privatization. Thus, privatization was the crucial localisation factor for R&D provided by MNEs. In addition, detection of market situation and gain control of the market segment were the key factors for companies operating mainly on the domestic market.

Other historical motives for setting up R&D activities in the Czech Republic resulted from its long industrial tradition. Before the fall of socialism the Czech Republic belonged to the most industrial countries around the world. The result of massive extensive development of industry was an abundance of highly qualified labour force in many industrial branches which was attractive for many foreign investors. A high quality and low cost of human resources were the second historical localisation motive for R&D activities. MNEs invested into R&D in order to utilize technical and knowledge potential of the Czech Republic and to participate in new opportunities after the fall of the Iron Curtain. Cost reduction leading MNEs to transfer a part of their R&D into lower costs countries was another aspect of this localisation motive.

Last group of historical localisation motives has its origin in geographical location of the Czech Republic. For many investors, not only from Germany but also from the USA, the strategic location of the Czech Republic in terms of proximity to Germany, good traffic accessibility and infrastructure was one of the most important localisation motives.

Historical localisation motives are still significant at present, however, with respect to the economic and social progress of the transformation the importance of localisation motives has shifted from the extensive low cost strategy (low cost of R&D) to the more sophisticated intensive strategy based on quality of domestic R&D infrastructure, results and potential. A high quality of domestic R&D is the most important localisation motive. The Czech Republic offers a wide spectrum of well developed and equipped universities and research institutions not only in Prague but also in many industrial regions like Plzen, Brno, Ostrava, etc. Therefore the decision about localisation is not only limited by a high concentration of R&D. MNEs can build new production capacities in industrial regions and their R&D units can cooperate with local universities.

Since 2000 the business R&D has been supported by investment incentives provided by the Ministry of Industry and Trade. Investment incentive scheme is now considered as one of the most important factors for establishment of R&D activities. Moreover, the development of business R&D has been stimulated by tax incentives since 2005.

Regarding the importance of historical localisation motives at present, the skilled labour force, industrial tradition and geographical position of the Czech Republic are still important.

Weaknesses of the Czech Republic for localisation of R&D activities

Representatives of the interviewed companies identified some barriers for setting up and enhancing R&D activities in the Czech Republic. Surprisingly, the most severe barriers are narrowly connected to localisation motives mentioned above. The main weaknesses related to R&D activities of MNEs can be summarised as:

- shortage of human resources (real or expected), especially skilled and technically educated labour force, low mobility of the workforce, low flexibility of students ("universities do not produce specialists according to labour market needs"),
- insufficient cooperation between MNEs and (public) research institutions and universities,
- low governmental support of R&D, lack of the complex policy of R&D and education
- and small market in the Czech Republic, especially for large projects.

These localisation issues of R&D activities that are relevant to the Czech environment were further processed and analysed. Subsequently representatives of the private sector were invited to discuss these issues with other actors in the field of R&D and innovation (e.g. policy makers, researchers, academicians, etc.). Conclusions and proposals for improvement emerged from these discussions are summarized in the second part of this chapter.

Types and organizational structure of R&D

Business R&D in the Czech Republic has been always more focused on the applied research and development than on the basic research. The group of interviewed companies is not an exception. Applied research (and particularly product development) dominates in R&D performed in interviewed companies.

Selected companies represent various types of R&D corporate strategies of MNEs in the Czech Republic. Interviews identified realisation of the main R&D strategies of MNEs (for definition of different types see UNCTAD 2005):

- global innovating R&D strategy,
- innovating R&D for local and regional markets
- and adaptive R&D, adaptation of global products into Czech user's environment.

Regarding the organisational structure, MNEs selected for interviews reported different (and often mixed) types varying from relatively free organisational structure to a hierarchy having strong ties of the Czech affiliate to headquarters abroad.

The most often organisational structure can be characterised by a strong research activity of local R&D, central coordination ensuring all research can be integrated in product development and frequent contacts with R&D units of the same MNEs.

The organizational structure of interviewed companies is affected by the corporate strategy, specific historical development (privatization) and the type of investment (Greenfield, acquisition).

Linkages to the region

To maximize the potential benefits of R&D investment launched by MNEs it is crucial to ensure sufficient level and the scope of connection between R&D unit and subjects of the hosted economy (regional economy). In general, this connection is related to the level of development of the local economy. It is obvious that a more developed local economy can achieve a higher positive impact of R&D located by MNEs in this economy.

R&D units of MNEs can cooperate with many actors of the regional innovation system. Universities usually represent the most important partner for cooperation. Companies cooperate within joint research projects, in training of students (including orientation of study programmes and introduction of new topics into curricula). Local companies are usually suppliers of products and services (including R&D). MNEs also cooperate with CzechInvest, an investment and business development agency.

Conclusions from the workshops

The results of interviews were summarised and mutually compared in order to obtain the most important determinants and barriers of R&D localisation in the Czech Republic in view of MNEs. These results were subsequently discussed in two workshops with the main actors – representatives of R&D university management, representatives of the Academy of Sciences of the Czech Republic, The Association of Research Organizations, R&D Council, ministries, business development agencies and many others. The major purpose of these workshops was to assess weaknesses of the Czech environment concerning R&D investments, to find their main sources and finally to propose solutions for an improvement. Proposals and recommendations adopted at the workshops can contribute to improving policies towards increasing attractiveness of the Czech Republic for localisation of R&D activities. Conclusions from the workshops are transparently summarised in subsequent three paragraphs. The structure of partial conclusions corresponds to the groups of weaknesses identified in previous interviews, i.e. human resources, cooperation of R&D institutions and MNEs and financial support of R&D within MNEs.

Human resources

The foregone interviews with R&D managers of MNEs identified some weaknesses in the area of human resources, namely the lack of human resources in R&D (as well as other qualified personnel), the structure of graduates not corresponding to companies' requirements and low flexibility of graduates. During the discussion with actors some more general issues resulting from the conditions of the whole business and innovation environment in the Czech Republic were added.

Issues	Solutions
▪ Insufficient support of Natural and Technical Sciences within universities ▪ Lack of qualified labour even in big cities ▪ Tendency to mediocrity caused of the financing universities from public sources (based on the number of students) and of the approach of students to creating their individual studying plans (effortless accomplishment) ▪ Lack of excellent graduates results in enterprises headhunting for staff in other enterprises ▪ Lack of prestige of scientific and technical sciences in the Czech society ▪ Poorer education in engineering (in terms of acquired skills, transfer of thoughts into practice) ▪ Insufficient preparation for further studies at secondary schools (e.g. mathematics is currently not obligatory as a leaving exam) ▪ Education system based on memorizing rather than solving problems and providing a good basis for adaptation on the labour market ▪ Decrease in the overall studies quality due to the possibility of graduating as Bachelors ▪ Low labour mobility caused by legislative barriers concerning labour market, (even though the barriers are not that tough as in the USA)	▪ Technical education is slowly being recognized as a basis for professional life ▪ Direct technical secondary education towards practice and focus more on problem solving than on memorizing ▪ Give chances to the elite, e.g. through supporting differentiated study programmes ▪ Change the management structures at universities (e.g. representatives of industry in Boards, matrix structure for R&D management, etc.) ▪ Implementation of quality criteria ▪ Amend law regulations to make it easier for foreigners (researchers) to work and study in the CR ▪ Change the ratio of support of targeted research and institutional support to 60:40; some universities can influence this proportion within their university budget ▪ Focus the university education more on business related knowledge ▪ Care more about the employability of students at universities – Labour offices statistics etc. ▪ Create bachelors programs in cooperation with business sector (good practices are Skoda or Siemens) ▪ Create friendlier and less xenophobic environment and educate more tolerant people to stimulate job migration ▪ Use EU Structural Funds (Operational Programme Education and Competitiveness) to stimulate labour and students mobility

Cooperation between R&D institutions and MNEs

Cooperation between R&D institutions (including universities) and MNEs in the Czech Republic is still insufficient, which hamper the knowledge transfer and generally the development of the Czech innovation environment. The national government and regional authorities can stimulate cooperation between R&D institutions and MNEs by using direct and indirect tools. Direct tools consist of financial support of businesses and promoting scientific incubators and technology parks creating essential infrastructure for commercialization of scientific knowledge into practice. Indirect tools like decreasing bureaucracy could influence the cooperation especially in terms of reduction of transaction costs.

Issues	Solutions
■ Absence of legislative regulation specifying obligation for universities to participate in business incubators, centres of technology transfer activities, etc. ■ Bad marketing and self presentation of universities (contact on universities is for companies very hard to find) ■ Lack of information at universities about the demands of MNEs ■ Different language, interests and mentality at universities (research institutions) and in business sector ■ Low patent activities and intellectual property rights protection, venture capital (mainly seed and pre-seed), spin-off activities, low job mobility (mainly horizontal)	■ Create of well arranged web side of faculties´ technical abilities catalogue ■ Initiate more workshops for MNEs and universities to arrange contacts etc. ■ Organize students' papers competitions sponsored by companies ■ Start a debate on legislative regulation of the third role of universities (initiation Universities Council). ■ Establish mediators between researchers and industry to find a common language and mediate mutual understanding ■ Build loyalty feelings in students towards their alma mater, so that they are in contact with the university after leaving it

Direct and indirect support of R&D in MNEs

The public support to R&D activities in large MNEs consists (as mentioned above) of direct and indirect policy tools. Despite of the significance of direct financial support interviewed companies emphasized also barriers in the general business environment, consulting services and intermediation of business contact between MNEs, universities and domestic companies. Following issues and recommendations were discussed by experts during the workshops.

Issues	Solutions
▪ Insufficient financial support of R&D activities at universities ▪ Absence of a clear state strategy/vision concerning the fields of knowledge in which the Czech Republic wants to be good at (investments, research priorities) ▪ Too broad orientation of the Long-Term Principal Research Directions (strategy of research priorities) – cover almost all the fields of research provided in the CR. ▪ Complicated bureaucracy and general issues of business environment	▪ Launch tax incentives in companies in the field of R&D (good practice in Hungary); importance of a clear definition of the boarder between R&D and other activities provided within MNEs ▪ Present Czech R&D results abroad (good practice is CzechInvest – Brochure on Czech Republic in the magazine Technical Scientific or invitations of Asian companies to technical universities in the CR etc.) ▪ Create stable strategies and policies towards public support of R&D in businesses (change of relevant policies and public support programmes is contraproductive and creates chaos) ▪ Focus public support on the applied research instead of basic research.

Conclusion

Discussions with experts representing many institutions and enterprises helped to get interesting information which can be used to improve the national and regional innovation policies as well as operations and processes in R&D institutions and universities.

Concerning human resources it is necessary to make system changes in the secondary as well as in the tertiary education. The aim of these changes should be to increase the number of graduates in technical branches. Another important task is to support immigration of highly qualified labour force and researchers.

Policy measures dealing with improvements in cooperation between research institutes and MNEs should focus on designing conditions for successful transfer of knowledge into practice, e.g. by means of promoting incubators established at universities, encouraging setting up spin-offs from universities etc.

Considering public support of R&D activities launched by MNEs emphasis should be put mainly on indirect tools consisting in the creation of stable business environment as well as on long-term strategies of direct support towards R&D and innovation. Selected state aid programmes supporting R&D activities of MNEs are mentioned in the next chapter.

4. Promoting Business R&D and Innovation at the Ministry of Industry and Trade of the Czech Republic in 2007–2013

Introduction

There is an agreement that the innovation process financing should be based above all upon the enterprise's funds. Previous experiences in knowledge based economies show that it is advisable to complement these funds by the public support of the innovation activities in form of subsidies. Nevertheless, we must be aware of the fact that the direct support of innovation activities in the business sector (by means of industrial policy measures like subsidies, preferential loans, guarantees, etc.) forms only one pillar of the Czech innovation policy tools. This type of tools should be a supportive mechanism of the innovation policy system where the main emphasis should be put on creation of favourable conditions for innovations by means of the second pillar – the indirect tools.

This chapter is focused on introduction of initiatives governed by the Ministry of Industry and Trade supporting innovation activities among companies and business environment. Dealing with the supporting activities of the pre-competitive phase of R&D, which are generally managed by the Ministry of Education, Youth and Sports is not the main purpose of this paper since.

The funds for the direct support of innovation activities within the business sector can be currently drawn, above all, from the state budget and from the EU Structural Funds. Especially the possibility of drawing the funds from the ERDF opens a considerable space for enhancement of the innovation activities of the Czech enterprises. The basic framework for direct support of innovations at the Ministry of Industry and Trade forms the Operational Programme Enterprise and Innovation 2007–2013.

The financial resources from the state budget together with those of the EU Structural Funds are used as subsidies especially for:

- developing infrastructure for industrial research, development and innovation,
- executing needs-driven industrial R&D projects
- and increasing competitiveness of innovative companies.

Infrastructure for industrial research, development and innovation

Innovation environment analysis shows that one of the main challenges in this area is to improve the infrastructure for industrial research, development and innovation. The research, development and innovation (R&D&I) infrastructure is under-

stood in this perspective as a system of a relation between the basic and applied research with the following phases of the innovation process. The lack of competent R&D&I infrastructure prevents the efficient utilization of the scientific research results for development of innovation products. Therefore the R&D expenditures are not compensated by the corresponding revenues from a potential sale of the innovative products based on R&D results.

The proposed innovation policy measures that are to be launched in the new programming period 2007–2013 intend to promote establishing closer relations of the scientific and research institutions, including universities, with the business sphere. An improvement of the infrastructure for the industrial development, research and innovation is also aimed at ensuring synergic benefits resulting from the geographical concentration of prosperous enterprises. The efficient networking of science and research with the business area generates basic pre-requisite for a long-term sustainable growth of competitiveness of the Czech enterprises.

Taking into account the need of closer relations of the R&D institutions with the business sector, a significant role should be played by the science and technology parks, business incubators and technology transfer centres. These entities feature an extremely high potential in view of their geographical concentration and density. The proposed measures address these challenges by supporting particular entities, which should form the core of the innovation environment in the Czech Republic. Another positive aspect of these technological entities is the fact that there are mostly small and medium-sized enterprises in the scope of their activities, which are flexible enough to reflect the changes on the market.

The industrial policy measures within this area that are going to be launched in 2007 focus mainly on the following three interventions:

- Building capacities for industrial R&D.
- Increasing quality of innovation infrastructure.
- Identifying, founding and developing clusters, poles of excellence and technology platforms.

Building capacities for industrial R&D

"The objective of this intervention is to strengthen the research and innovative capacities of the firms, to increase the number of firms that carry out their own research, development and innovation, to increase employment through creation of new qualified jobs and to deepen the cooperation between firms and research and development institutions." (Ministry of Industry and Trade CR, 2006, pp.66)

The provided support will be granted to the firms that intend to build new or expand existing infrastructure and facilities for R&D. The public support aims at creating conditions for the firm involvement in research programmes together with other entities (firms, R&D institutions or universities). Strengthened research and innovative capacities of Czech firms should lead to an increase of the firm competitiveness in both R&D and production efficiency.

Increasing quality of innovation infrastructure

"The objective of this area of intervention is to create a favourable environment for enterprise, to improve the conditions for enterprise and innovation and to develop competitive advantage by improving the links between research, educational institutions, the enterprise sphere and the public administration." (Ministry of Industry and Trade CR, 2006, pp.69)

Taking into account the need of closer relations of the R&D institutions with the business sector, the science and technology parks, business incubators and technology transfer centres play a significant role. These entities feature an extremely high potential in view of their geographical concentration and density. Another positive aspect of these technological entities is the fact that there are mostly small and medium-sized enterprises in the scope of their activities, which are flexible enough to reflect the changes on the market.

The final beneficiaries of the support will be innovative entrepreneurs (mainly SMEs). The benefits to the entrepreneurs will be intermediated by the other important subjects of the innovative environment (e.g. associations of entrepreneurs, collaborative structures, regional self government entities and organisations established and founded by them, public research institutions, universities and other educational institutions, non-profit organisations, public welfare institutions, etc.).

Identifying, founding and developing clusters, poles of excellence and technology platforms

The objective of this intervention is "to create and develop regionally concentrated sector groupings of firms and supporting institutions – clusters, to establish and develop poles of excellence which are groupings of research, entrepreneurial and other subjects focused on research in advanced technologies." (Ministry of Industry and Trade CR, 2006, pp.68)

The purpose of supporting cooperation activities is to increase the efficiency of the production processes and an innovation potential multiplication at the sector level, mostly by means of the efficient experience inflow. The main advantage of the creating cooperation platforms is the close linking of the business sector to the scientific and research institutions as well as universities, which provide them with relevant knowledge flow for the innovation process. Creating cooperation between all subjects of the innovation process also opens space for the multiplication of financial subsidies effect as they enable to draw subsidies both at the level of individual entities and at the level of cooperating group. The regional strategies within the Euro regions may also play a significant role.

Needs-driven industrial R&D

The research and development on the company's level is an important pre-requisite of a long-term character of innovation activities in companies. As the coordi-

nation in the field of the science and research is currently split among more top bodies of the state administration, one of the tasks concerning this objective is to establish a closer cooperation among these bodies. It is desirable to strengthen the importance of the applied research in form of increasing budget for specific subsidies and development of these activities. The purpose of support granted to the area of applied research is on one hand to establish proper scientific-technical basis at the companies level and on the other hand to create relations between companies and research institutions and universities.

The TANDEM Programme

"The objective of the programme is the improvement of the co-operation of industrial organisations with research workplaces (academic, university, and other ones), the theoretical and technological support of small and medium-size enterprises, the improvement of the competitiveness of future products and technologies, and significant improvements in transfers of results of the basic research to industrial applications and consequently to the lowering of differences between the economic levels of the Czech Republic and the other countries in the European Union." (Prnka et al., 2006, pp. 41)

The support aims at stimulating target-oriented research projects. The R&D results should have a potential to be used in new products, technologies, and services. The particular project solutions should be completed by target-made groups, which put together workers coming from industrial organisations and researchers from academic sector and research institutions.

The IMPULS Programme

„The programme objective is the increased performance of manufacturing organisations, the support of small and medium-size enterprises, the improved competitiveness of products, and the modernisation of technologies leading towards making the difference between the economic levels of the Czech Republic and other states of the European Union smaller." (Prnka et al., 2006, pp. 43)

The support provided by means of this programme focuses on execution of R&D projects related to new materials, industrial products, production technologies, information and management products, and technologies implemented by individual organisations or project teams. "The programme always envisages the solution of one specific research and development project, usually up to the level of a verified sample, functional model, prototype, semi-operational, pilot, or trial facility." (ibid)

The PERMANENT PROSPERITY Programme

The programme "Permanent Prosperity" is an essential part of the National Research Programme II, where represents one of the four thematic programmes. The objective of this programme is to support (for more details see Prnka et al., 2006, pp.46):

- preparation of new materials and new processes utilised in relation to renewable and non traditional energy resources, including the hydrogen energy,
- increase of reliability of systems for electric power transfers,
- preparation of new processes for nuclear power technologies,
- decrease of energy demands in building operations,
- creation of new non conventional machine structures and constructions,
- creation of new materials with new usable properties, including nano-materials and new material diagnostic methods,
- preparation of new semiconductor parts for diagnostics and management,
- increase of utilisation of the transport safety systems,
- introduction of new processes in selected branches within the chemical and pharmaceutical industries
- and development of new materials, new additives for products in other industries, and new polymers and catalysts.

Increasing competitiveness of innovative companies

Innovation and extensive use of the results of research and development in industry and business services increase the competitiveness of businesses and stimulates economic growth.

Since implementing innovation covers in principle relatively costly activities, where costs are carried by innovative firms and benefits gains the whole society, the role of state is essential, at least in the initial stage of the innovation process. The Ministry of Industry and Trade intends to focus on supporting the projects with high technical and utility value of products and services (product innovation), on growth of the efficiency of manufacturing processes and providing services (process innovation), and also on introducing advanced management methods, introducing significant changes of organisational structure or strategic orientation changes of the enterprises (organisational innovation) and on introducing new highly developed distribution channels (part of marketing innovation).

Development of innovative firms will also increase their demand for R&D results. Therefore, the measures focused on increasing innovation activities of the Czech business sector will subsequently stimulate the research and development in the Czech Republic and application of its results into the industrial praxis. Functioning system of the correlation of research and development and industrial needs covering an efficient use of technology transfer mechanisms appears to be a targeted status. Consequently the patent activity both of the business sector and universities and research institutions should increase. The substantial part for implementation of R&D results is a right direct motivation for all parties concerned, in other words the way of assessment of R&D results.

An important assumption for a successful innovation process is the protection of intellectual property rights and consequent technology transfer. Even with

respect to this fact we can consider the current status in this area in the Czech Republic as alarming. Conclusion resulting from the international comparisons is that the Czech Republic lags far behind the advanced world and European countries.

In this context it is also important to deal with the protection of industrial property rights (IPR). A significant barrier for innovative Czech firms in this field represents high costs of international patent protection, which can prevent the businesses from fully exploiting the results of their research and development. Currently there are no instruments in the Czech Republic to reduce the financial burden of innovative firms, which decide to patent their R&D results or protect them with other instruments of IPR.

The industrial policy measures in this area proposed for the period 2007–2013 target mainly the following interventions:

- Increasing the innovative performance of firms.
- Increasing the use of IPR protection.

Increasing the innovative performance of firms

"The objective of this intervention is to stimulate and increase innovative activities of SMEs and large firms in both manufacturing and services. The support provided will improve the financial stability of firms producing innovative products, technologies and services." (Ministry of Industry and Trade CR, 2006, pp.65)

The support aims generally at strengthening the long-term ability of business competitiveness and their sustainable development. The support will be granted in form of the direct financial support to companies, being a part of the innovation environment in the Czech Republic. There are supported especially companies that use results of the industrial research and development, transfer of technologies and know-how and develop innovation products and technologies both for the regional and worldwide markets. The emphasis is put also on the support of non-technological innovations and eco-innovation.

Increasing the usage of IPR protection

"The objective of this intervention is to support patent activities of enterprises, research and development institutions and universities to improve the conditions for the transfer of the results of research and development to practice." (Ministry of Industry and Trade CR, 2006, pp.65)

The support, which will be provided to small and medium enterprises, research institutions and universities, aims at enabling IPR protection especially of R&D results originated from these subjects. It purposes to decrease financial costs of IPR protection proceedings paid by applicants and thus to increase their motivation for protecting the R&D results. Aside from this main goal the support aims also at enhancing broad awareness about ways and advantages of IPR protection for successful completing of the innovation process.

Conclusion

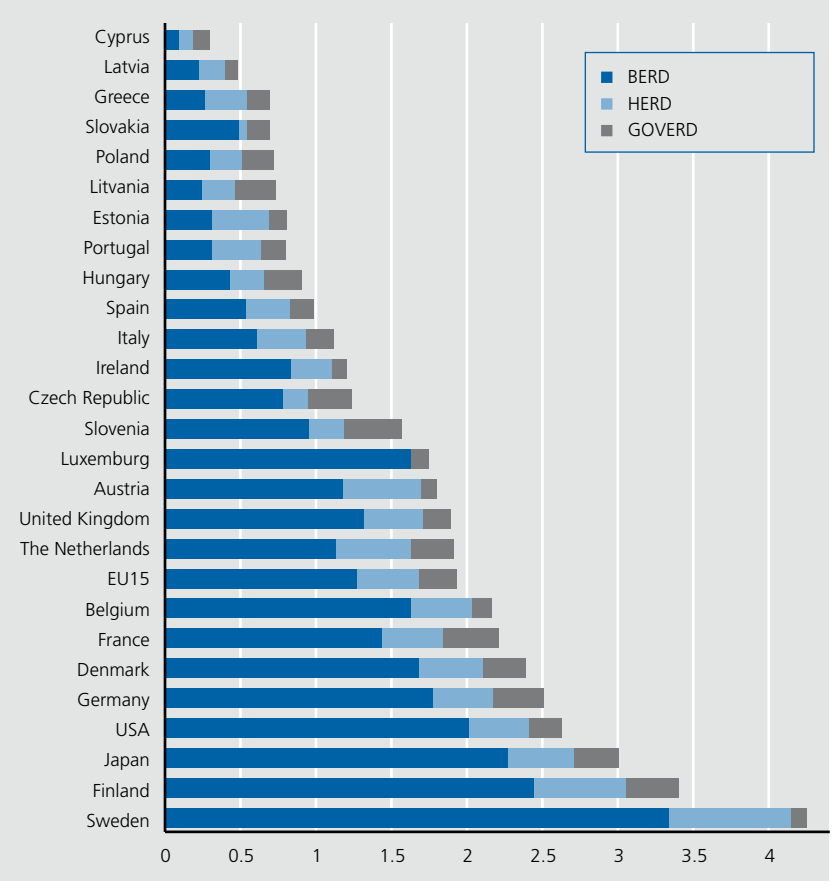
In this chapter, there were introduced the main initiatives of the Ministry of Industry and Trade for promoting R&D and innovation activities in the period 2007–2013 by means of industrial policy measures (i.e. direct support). These policy measures respond to the weaknesses and barriers identified by means of interviews and discussions launched by the LocoMotive project. In accordance with conclusions of the LocoMotive project the Ministry of Industry and Trade is also aware of the fact, that appropriate economic tools of the indirect support facilitate the flexible market investment allocation into the research and development and innovations in the competitive technologies and sectors. They make possible faster alterations of the resources allocation among the different technologies by reflecting the rapidly changing technologies and the market situation development. In contrast to the direct tools, the indirect ones differs by the possibility that the enterprise itself, based on its economic results, may decide the investment amount to allocate for research and development and innovations.

5. Local R&D Activities of Multinational Enterprises in Hungary

Introduction

This chapter reviews some findings of the Hungarian part of the project. It will try to assess the R&D activities of multinational companies located in Hungary with special attention to local factors. More specifically, it will consider four points of particular interest:

Figure 11: R&D expenditure/GDP of Hungary in international comparison



Source: Szendrődi, L. & Széll, É. (2006), 748.

- it offers a general picture of the current situation of the R&D sector in Hungary mainly relying thereby on available statistical figures;
- highlights the impressively rapid expansion of R&D activities of multinational companies in Hungary;
- it deals in more detail with the factors responsible for the relatively slow integration and embedding of foreign R&D in the country including a few concrete examples from the world of corporate-university relations;
- it provides a summary description of one important governmental scheme aimed at stimulating the growth of the Hungarian R&D sector.

Research and development in Hungary

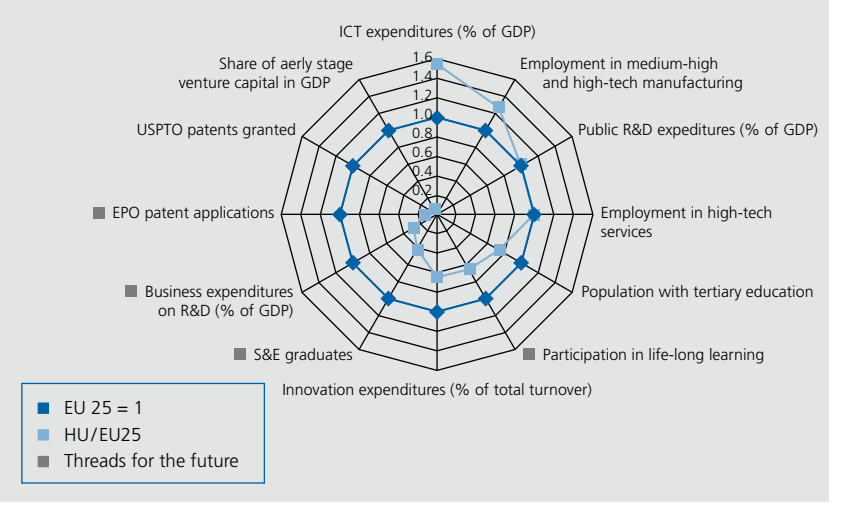
In international comparison, Hungary is among those developed countries which spend the lowest amount on research and development in relation to their economic power. It belongs to the group of countries in the European Union which devote less than 1% of their national GDP to R&D (Figure 11).

Almost all new members of the European Union belong to this group with the exception of the Czech Republic and Slovenia. There is an obvious correlation between the level of a given country's economic development and the respective amount of R&D expenditure. However, R&D expenditure also reflects the relative importance of R&D in the policies of national governments and corporate strategies. In Finland and Sweden, for instance, R&D stakeholders spend comparably larger amounts on R&D than what would correspond to the level of development of these countries. Unfortunately, modest R&D expenditures in countries at the bottom of the above list have a negative impact on indicators directly or indirectly related to the activity of the R&D sector as well.

High foreign direct investment and a positive sectoral structure explain why the relative share of the Hungarian ICT sector in the national economy and the number of those employed here well exceed the EU average (see Figure 12). At the same time, the structure of university-level higher education (i.e. the relatively lower share of graduates in natural sciences and economics, limited opportunities for life-long learning, etc.) is not well-suited to meeting the new challenges and falls behind the corresponding EU-average. In addition, the number of patents—one of the most important indicators of R&D activities—is strikingly low in Hungary.

Players in the R&D sector can be divided into three groups on the basis of the organizational characteristics of their activities: independent research institutes, universities and corporate R&D units. This last group includes Hungarian R&D units of companies in foreign ownership. As regards the distribution of Hungarian R&D institutions, although two-thirds of all R&D units are associated with universities, R&D workforce (including researchers, technical and administrative staff) divides roughly equally among the three different types of R&D organiza-

Figure 12: Innovation indicators of Hungary vs EU-average



Source: EU Innovation Scoreboard, 2004

tions mentioned above. While R&D units in foreign ownership account for only 4% of all R&D organizations, 17% of the total R&D workforce is employed here. In terms of R&D expenditure, independent research institutes spend 3.5 times more and R&D units in foreign ownership 8 times more than the average. It is worth not-

Table 5: Structure of R&D in Hungary (2005)

Sector	R&D units		Staff		Expenditure / R&D units	
	numbers	%	numbers	%	in million euros	%*
R&D institutes	201	8.0	7652	32.9	1.16	364
Universities	1566	62.2	8194	35.3	0.13	42
R&D of enterprises	749	29.8	7393	31.8	0.48	151
Thereof: R&D of foreign enterprises	106	4.2	3976	17.1	2.48	779
Total	2516	100.0	23239	100.0	0.32	100

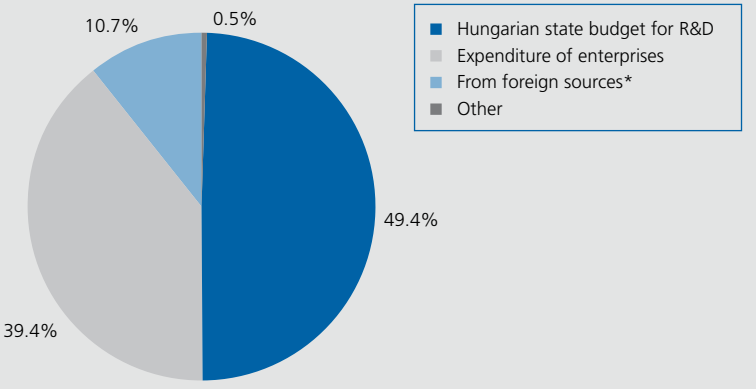
**Remark: Percentage for partial subjects are calculated in relation to the Hungarian average (Total Hungary = 100%)*

Source: Research and Development, Hungarian Central Statistical Office, Budapest, 2006.

ing the very poor financing of research units at universities which is currently at 40% of average expenditure (Table 5).

In recent years, the resource base of the R&D sector including state, foreign and corporate stakeholders has been changing rapidly in Hungary. Even one or two years ago most analysts would have agreed that low overall R&D expenditure was mainly to be attributed to small amounts spent by companies on R&D and *not* to the lack of government funding which was at the time on par with the country's general level of economic development. The latest data, however, paint a different picture (Figure 13).

Figure 13: R&D financing (2005)



* Calculated from the expenditure of R&D of enterprises (39.4%):
28.8% is the foreign part; total foreign expenditure is 39.5%, accordingly.

Source: Research and Development, Hungarian Central Statistical Office, Budapest, 2006.

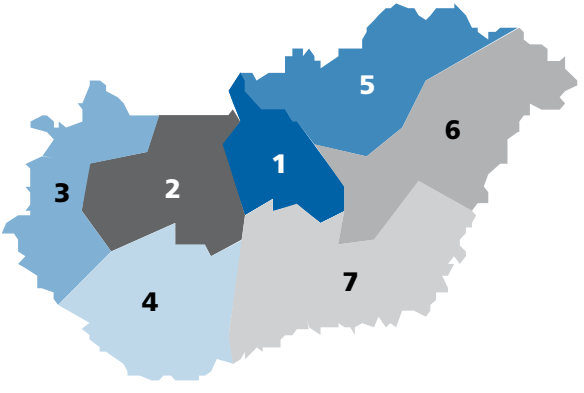
Government spending on R&D is slightly below 50%, while the share of corporate R&D expenditure has reached in the meantime 40%. The quick increase of the latter figure is mainly explained by the higher spending of foreign companies. These are responsible for 73% of total *corporate* expenditure amounting to 28.8% of all R&D-related spending in Hungary. In sum, it is striking that, taking corporate and non-corporate foreign expenditure on R&D together, approximately 40% of all spending in the Hungarian R&D sector comes from foreign sources!

The regional distribution of R&D activities is seriously unbalanced. As much as 50% to 70% of the R&D sector is concentrated in the region of Central Hungary (meaning, in practice, almost always Budapest). This includes half of all R&D units and 70% of total R&D-related expenditure. Regions in the Hungarian countryside,

with the universities of Szeged and Debrecen located there, are in a somewhat better position, while the regions of Southern Transdanubia and Northern Hungary rank the lowest despite having important university towns (Pécs and Miskolc). The weak R&D positions of the Hungarian regions (Western and Central Transdanubia) with the fastest growing economies have improved somewhat in recent years. At the same time, they are still lagging behind regions the R&D activities of which are chiefly organized by large and traditionally strong universities (Table 6).

Table 6: Regional distribution of R&D resources (2005)

Region	Number of R&D units		Number of R&D personnel (FTE)		R&D expenditures Million HUF/%	
1. Central Hungary (incl. Budapest)	1 199	(51,3%)	14 756	(64,3%)	93 113,1	(69,1%)
2. Central Transdanubia	158		1 352		8 023,7	(6,0%)
3. Western Transdanubia	150		1 013		6 693,6	(5,0%)
4. Southern Transdanubia	195		1 148		4 883,2	(3,6%)
5. Northern Hungary	118		777		2 639,5	(2,0%)
6. Northern Great Plain	250		1 756		9 139,2	(6,8%)
7. Southern Great Plain	267		2 140		10 044,9	(7,5%)
Total	2 337	(100%)	22 942	(100%)	134 537,2	(100%)



Source: Imre, J.: Research and development 2006; Hungarian Statistical Office Budapest, 2006.

Corporate R&D

R&D activities of large companies of the state-planned economy – which fell apart, went out of business or were privatized by mainly foreign investors during the system change around 1989 – ceased or were reduced to a fraction of their former levels. The new foreign owners often closed down R&D units since their Hungarian subsidiaries were primarily intended for mass assembly production. R&D activities of strategic importance were mostly conducted at the company headquarters during these times (Inzelt 2000, Barta 2002).

It was only around the last years of the 1990s that a few foreign-owned R&D units began operation in Hungary. A few years later, however, the number of such units began to rise quite rapidly. One must therefore also assess corporate R&D activities in terms of ownership structure analyzing how the efforts of Hungarian companies to promote R&D compare with those of foreign companies operating in Hungary. The figures discussed above already give a good indication of the fact that there is a marked discrepancy between the R&D activities of Hungarian as opposed to those of foreign companies. Foreign-owned R&D units enjoy a six-fold advantage in terms of their average size and a 15-fold advantage in terms of their average expenditure (Table 7). This gap has diminished only very slightly in the last couple of years.

Table 7: R&D units and number of researchers: average size and expenditure*

Proprietor of enterprise	Number of staff /unit		Expenditure /R&D unit Million Euros		Expenditure/researcher Million Euros	
	2003	2005	2003	2005	2003	2005
Hungarian	6.1	6.0	28.3	42.8	4.6	7.2
Foreign	36.3	37.5	477.0	619.6	13.1	16.5

* Remarks:

– The Hungarian research units are very small, and not increasing, compared to the foreign units which are 6-times bigger!

– The difference in capital equipment is 15-fold.

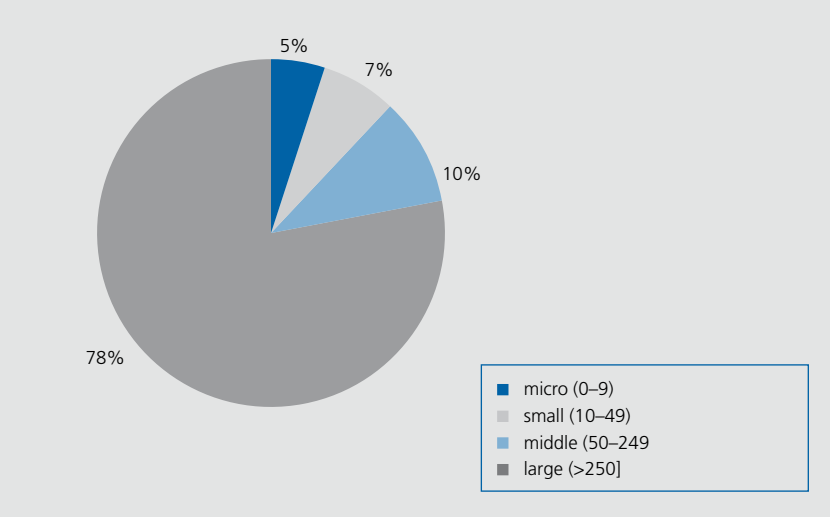
Source: Research and Development, Hungarian Central Statistical Office, Budapest, 2006.

The relevant statistical figures indicate, therefore, a similar discrepancy between R&D units in foreign as opposed to those in Hungarian ownership as there can be generally observed to exist with regard to factors of production, i.e. in terms of company size, average capitalization and productivity. This gap has been apparent since the system has changed and the FDI have started to flow into Hungary. It continues to impact negatively on the economy even today to an extent that it is safe to talk about a 'dual economy' in Hungary. This dual structure is mainly to be attributed to differences among foreign and Hungarian companies and shows few signs of disappearing.

It is worth emphasizing the fact that this duality is reproduced in the R&D sector as well. Rather that the growth of this sector may prove to be the key to the further development of Hungary's economy. It is therefore in the country's foremost interest to promote the rapid and comprehensive integration of the fast growing and expanding foreign-owned corporate R&D into the Hungarian economy.

The other important indicator of the unequal distribution of R&D relates to average company size. Small and medium-sized enterprises account for as much as 99.8% of the Hungarian corporate sector, while this overwhelmingly dominating company type is responsible for as little as 22% of R&D expenditure (Figure 14).

Figure 14: R&D expenditure of different sized enterprises as percentage of BERD (2003)*



* Remark: While the share of small and medium size enterprises is 99.8%, their R&D expenditure amounts to only 22 %. R&D is dominated by the big enterprises.

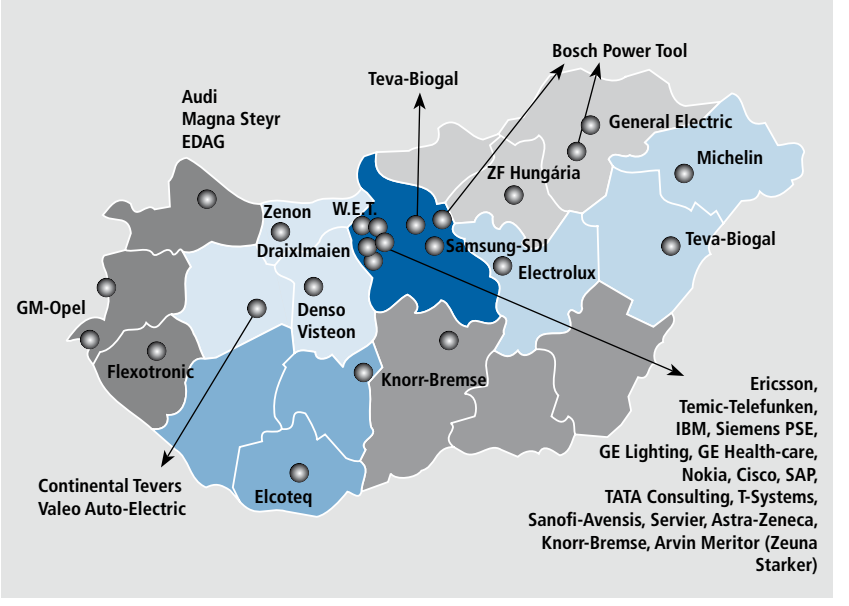
Source: Imre, J. 2007.

The reasons include lack of capital, technological handicaps and low intensity of exports. In any case, it is no exaggeration to claim that in Hungary today practically only large companies spend on R&D. The Hungarian Tax Authority lists approximately 500 companies (i.e. 0,14 % of all companies and partnerships) with significant R&D expenditure. In practice, however, the R&D spending of only a few large companies is responsible for these figures (leading among them is Ericsson and the pharmaceutical company, Richter Gedeon). Since the overwhelming majority of large companies are in foreign ownership, this means that R&D in Hungary today is pursued predominantly by foreign companies. In view of their poor

R&D capacities, Hungarian SMEs are unable to establish contacts with independent, foreign-owned R&D units, even as suppliers or subcontractors.

Currently there operate approximately 30–35 significant R&D units in Hungary (Figure 15). Most of these are located in Hungary, but many of the manufacturing companies located elsewhere also have research, and more typically, development units. Quite often, independent research units are organized globally within the multinational corporation in the same way as production. The result is that there may be no direct connections between production and R&D units of one and the same multinational company operating in Hungary (as in the case of Nokia, for example).

Figure 15: R&D of multinational enterprises in Hungary



- *Lighting technique* (GE-TUNGSRAM)
- *Medical equipment* (GE-Medicor)
- *Pharmaceuticals* (Sanofi-Chinoin, Astra, Teva-Biogal, Akzo Nobel/Organon)
- *Information and telecommunication* (Ericsson, IBM, Compaq, Nokia, Siemens, Motorola, Tata Consultancy, T-Systems/Matáv)
- *Machinery* (Audi, Volkswagen, TEMIC, Michelin, Knorr-Bremse, Mannesmann-Rexroth, Flextronics, Continental Teves, Visteon, W.E.T.)
- *Agrifood* (Novartis/Sandoz Seeds)
- *Household chemicals* (Unilever)
- *New materials* (Furukawa, Zenon Systems)

Relations between foreign companies and universities

What has been said above already points to some important characteristics of R&D activities of foreign companies in Hungary. First, there can be no doubt that the R&D sector is rapidly growing in this country. This is, all in all, a welcome fact since FDI was mostly criticized in earlier times for concentrating on simple, low value-added production and assembly operations in the companies established here. However, two features of the R&D sector are disadvantageous for the domestic economy. First, the regional, sectoral and corporate concentration of R&D activities is exceptionally high. That is to say, R&D is located mostly in Budapest's economy, in a small number of sectors (especially info-communication technologies and pharmaceutical industry) and only in a few companies. As a result, the growth of R&D sector can only intensify the already strong discrepancies and inequalities within the Hungarian economy.

Second, although a complete overview of the various activities conducted at different R&D units is not available, investigations carried out so far show that they are mainly involved in development while basic research is relegated to a distant second place. This aspect clearly ought to constrain expectations concerning the value and expected impact of these activities.

LOCOMOTIVE pays considerable attention to the local impact of the operation of R&D units. This interest is explained by the fact that the local impact of R&D is of course what concerns host countries the most. In Budapest, seven companies (pharmaceutics: EGIS, Richter, Sanofi-Aventis; ICT: Ericsson, Magyar Telekom, Siemens; lighting: GE Tungsram) were interviewed for LOCOMOTIVE. Our findings confirm the point already made, namely that the integration of independent research units into the Hungarian economy is currently low and slow to improve.

The integration of the R&D units of foreign companies could be significantly enhanced by boosting their ongoing cooperative efforts with universities. The points presented here regarding such cooperations are based not only on interviews conducted in Budapest, but also on additional research targeting universities outside Budapest.

- Existing links between the research units of multinational companies and universities have been largely based until now on personal or informal ties. Researchers who are employed by large companies often take on teaching duties, endow scholarships, organize special courses for gifted doctoral students, etc.
- The same researchers often provide financial and professional support to set up laboratories at universities.
- University faculty tend to cooperate with large companies in small-scale, typically development-oriented projects.
- More significant cooperative projects have usually been carried out within the framework of government-initiated R&D programmes. These have been mainly aimed at establishing research and knowledge centres.

- Industry practitioners at large companies usually explained why cooperation has remained so limited by pointing to the fact that the required expertise is frequently unavailable at universities. The faculty's training is often seriously out-of date, while teaching is ill-adjusted to the demands of the industry.
- University and corporate interests are often inconsistent. This conflict of interests is manifest, among others, in their divergent approach to handling patents. Further, universities lack the required business know-how and project management skills.

Two case-studies deserve special attention: the cooperative project of Audi and Széchenyi University in Győr and that of Bosch and Miskolc University. These large multinational companies act as 'flagships' in the local economies of these two medium-sized towns. They have a vested interest in building strong ties with local universities in order to develop joint research projects and gain access to a significant pool of skilled workforce. These relatively new educational institutions lacking historical university traditions are also keen to cooperate with local multinational companies for such cooperation supports both their teaching and R&D activities. Both companies have established independent university departments, created intra-mural laboratories at these universities also spending considerable sums to finance these projects. These two cases can be regarded as important examples which could be followed elsewhere by multinationals prepared to assume such a 'flagship' role. Such institutionalized forms of corporate-university cooperation could be effectively supported by relevant policies of national and local governments.

Governmental efforts at strengthening R&D cooperations

For the 2005–2013 period, the government adopted four strategic objectives with respect to the development of the R&D sector. Accordingly, the government will seek to:

- strengthen corporate R&D activities;
- assist the creation of internationally-competitive innovation centres and research universities;
- promote ties between basic research and technological development;
- enhance the innovation capacities of the regions.

The so-called 'competence pole' programme was launched with the express intention of furthering these objectives. This programme rests on the theory of growth poles and is aimed at developing the knowledge-base of regional centres. In Budapest, specifically, the principal goal of the programme, which is referred to here as the Budapest Innopolis Programme, is to support cooperation among the stakeholders—i.e. universities, key players of the relevant industries and R&D units—in the local knowledge-base. The 'competence pole' programme thus seeks to promote innovation-oriented economic development. Horizontal as well as vertical

programmes were introduced. Horizontal programmes concentrate on available and expected resources, enhance organizational efficiency and assist technology transfer. The vertical programmes are associated with specific industries such as the info-communication technology sector, medical industries and environmental management.

The launching of 'competence pole' programmes raised hopes by providing new incentives to the relevant stakeholders at regional centres. At the same time, some doubt whether these programmes have been adequately prepared and whether they will really be able to accelerate the development and modernization of entire regions and not just that of regional centres. It is also questionable whether the resources made available will suffice for the stimulation of development. There are also doubts that the somewhat overlapping programmes of regional centres may be at cross-purposes mutually reducing each other's chances of success.

6. The Locational Challenges of Open Innovation

Introduction: shift towards a new paradigm?

In 2003, Henry Chesbrough, wrote an influential article in the California Management Review in which he explained the 'logic of open innovation'. He stated that we are witnessing a paradigm shift in how companies commercialize industrial knowledge. The shift is from 'closed innovation' to 'open innovation'. In the closed innovation paradigm successful innovation requires internal control and ownership of technology. This worked well for most of the 20th century, but has been susceptible to erosion factors such as the increasing mobility and number of skilled people, the growing presence of private venture capital that enabled new high-tech 'start-up' firms, the faster time to market needed for the successful commercialization of products and services, and the set-up of a number of new innovation poles around the world (in particular in large developing countries like India and China). The 'open innovation' paradigm holds that successful innovation requires less control. Firms can and should use external ideas as well as internal ideas, and organize external as well as internal networks to reach the required levels of flexibility, profit from start-ups and external suppliers of knowledge, whilst shortening the time to market to effectively compete in global markets.

The *Economist* in a special briefing on the 'rise and fall of corporate R&D' (March 3rd, 2007: 69–71) further illustrates the move towards the 'open innovation' paradigm by referring to two major changes that are already taking place in big companies: (1) the 'hollowing out' of big corporate laboratories towards technology firms, and (2) the shifting emphasis in corporate R&D from research to development. Two quotes can illustrate this:

- "Modern technology firms are much less vertically integrated. They use networks of outsourced suppliers and assemblers, which has led to the splintering of research divisions. Even though big (....) firms still spend billions of dollars on R&D, none has any intention of filling the shoes left empty by Bell labs or Xerox PARC. [...] Old-fashioned R&D is losing its ampersand."
- "the new model of R&D turns researchers into the shock-troops of innovation. Bell labs [...] is turning its attention almost entirely towards development. [...] In 2002 Xerox PARC became an independent subsidiary able to provide research services and intellectual property to outside clients, not just its parents".

Table 8 shows some of the most prominent characteristics of the closed versus the open paradigm of innovation. The closed innovation model has been part and parcel of the business model in the leading western economies. The open innovation model has already been pioneered in some of the upcoming economies, in particular in Japanese and South-Korean firms where the organization of innovation has

Table 8: Contrasting Principles of Closed and Open innovation

Closed Innovation Principles	Open Innovation Principles
The smart people in our field work for us	Not all the smart people work for us. We need to work with smart people inside and outside our company
To profit from R&D, we must discover it, develop it	External R&D can create significant value; internal R&D is needed to claim some portion of that value
If we discover it ourselves, we will get it to market first	We don't have to originate the research to profit from it
The company that gets an innovation to market first will win	Building a better business model is better than getting to market first
If we create the most and the best ideas in the industry, we will win	If we make the best use of internetal and external ideas we will win
We should control our IP (Intellectual Property), so that our competitors don't profit from our ideas	We should profit from others' use of our IP and we should buy others' IP whenever it advances our own business model

Source: Chesbrough, 2003: 38

already been based on such principles as pre-competitive collaboration (in which competitors collaborate on the acquisition of patents and in basic research) and 'black box engineering' (in which suppliers engage in sizable R&D themselves). The two 'paradigms' therefore are not that new or radical, and are closely related to the institutional environment of the firm.

Many industries in the world at the moment are in between the two paradigms, either because their activities require a hybrid approach, because they are in a transition process moving between the two paradigms, or because of institutional reasons. Firms that are moving from a closed to an open organization of innovation face a large number of internal and external transition problems: for instance the 'splintering' of research divisions or the new competition to the old parent company provided by the new high-tech 'spin-off'. In this transition process, the 'locus' of innovation (and of control) is becoming an increasingly important factor deciding on the success or failure of particular business models. Although it has been acknowledged that the 'locus of innovation' is moving beyond the confines of the central R&D laboratories of the largest companies towards start-ups, universities and to 'other outsiders' (Chesbrough, 2003: 39), it is not clear exactly what this implies for the geographical locus of 'control of control' from the perspective of the multinational enterprise. In a move towards Open Innovation, a number of factors of innovation have become more 'mobile', but this does not need to be followed by a comparable organization of the firm. What observers might note as the end of 'closed innovation', therefore, might not necessarily be equated with the

end of centralized and/or or coordinated corporate R&D in the hands of a small number of multinational enterprises.

It points, however, at the changing role of the corporate R&D laboratory with MNEs. More than ever the multinational enterprise has become part of a network of supply and demand relationships in which the R&D function has become more important than ever. Is it possible to move from internal control to external control or does the paradigm of open innovation always imply loss of control? What are the possible consequences for the organization of the firm across borders? In particular for multinational enterprises the movement towards open innovation creates a number of additional managerial challenges (opportunities as well as threats), which in turn define the degree to which the new 'paradigm' of open innovation in practice can and should be implemented:

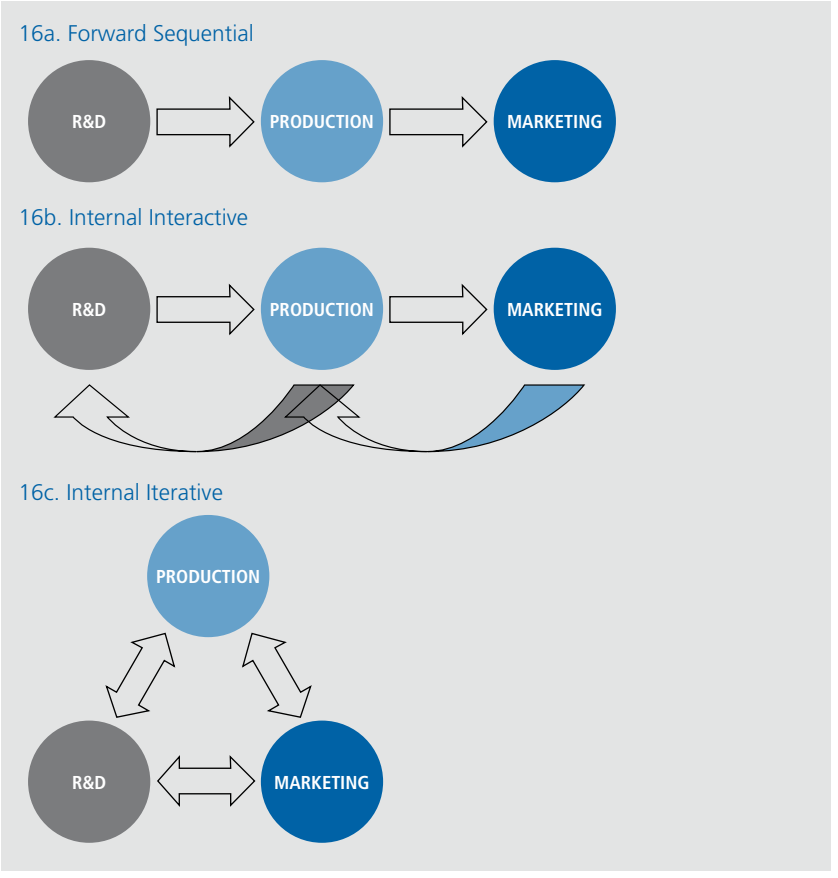
1. internal coordination challenges: across departments (marketing, production, finance) in various countries and across borders in the internal R&D organization;
2. external coordination challenges: across borders between an increasing number of partners and suppliers.

Internal challenges: from sequential to interactive…

Figures 16a–16c picture the internal transition process that many companies are faced with. The traditional business model is based on a forward sequential organization of R&D and production (1a). The (big) corporate R&D department engaged in fundamental research (stress on R) invented a product, which then confronted the production department with the problem how to produce this efficiently. Finally, the marketing department was faced with the challenge how to sell the thus produced product. Each department had its own organization, but also each department confronted the other department with considerable problems. In many companies Chinese walls were erected between the departments, which represented closed circuits of hiring, careers and management logic. The competitive advantage of firms often was based on the excellence of one of these departments. So, whereas many Japanese firms had reached excellence in the manufacturing department, leading American firms had reached excellence in their sales (marketing) and German firms competed primarily on their research excellence (for instance by linking basic to applied research in which vocational training proved a factor of particular competitive advantage).

To address some of the transaction costs related to the sequential business model, backward (feedback) linkages have been established by many firms (16b). For some firms this created competitive advantages, for instance because only products were further developed that were easy to produce or sell. One of the models applied here has been 'design for automation'. This business model requires feedback loops between the various departments. It added to the inter-

Figure 16: Basic business models



nal transaction costs of firms. The more firms internationalize their sales activities across a wide variety of markets, the more difficult it becomes to coordinate this feed-back loop to the central R&D laboratories. The pressure on the decentralization of the R&D department mounts and the department is stimulated to concentrate on R as well as on D. This model still seems to represent the majority of firms in particular in the United States and Europe. It also explains why the internationalisation of R&D develops much slower than the internationalisation of sales and production (assets). In the 1994–2002 period, the share of R&D in the affiliates of US MNEs for instance rose from 11% to 13% (UNCTAD, 2005). As a result, foreign affiliates are assuming more important roles. It is estimated that between 1993 and 2002 the R&D expenditure or foreign affiliates of MNEs worldwide climbed from around U$ 30 billion, to U$ 67 billion (or from 10% to 16% of global business R&D) (UNCTAD, 2005).

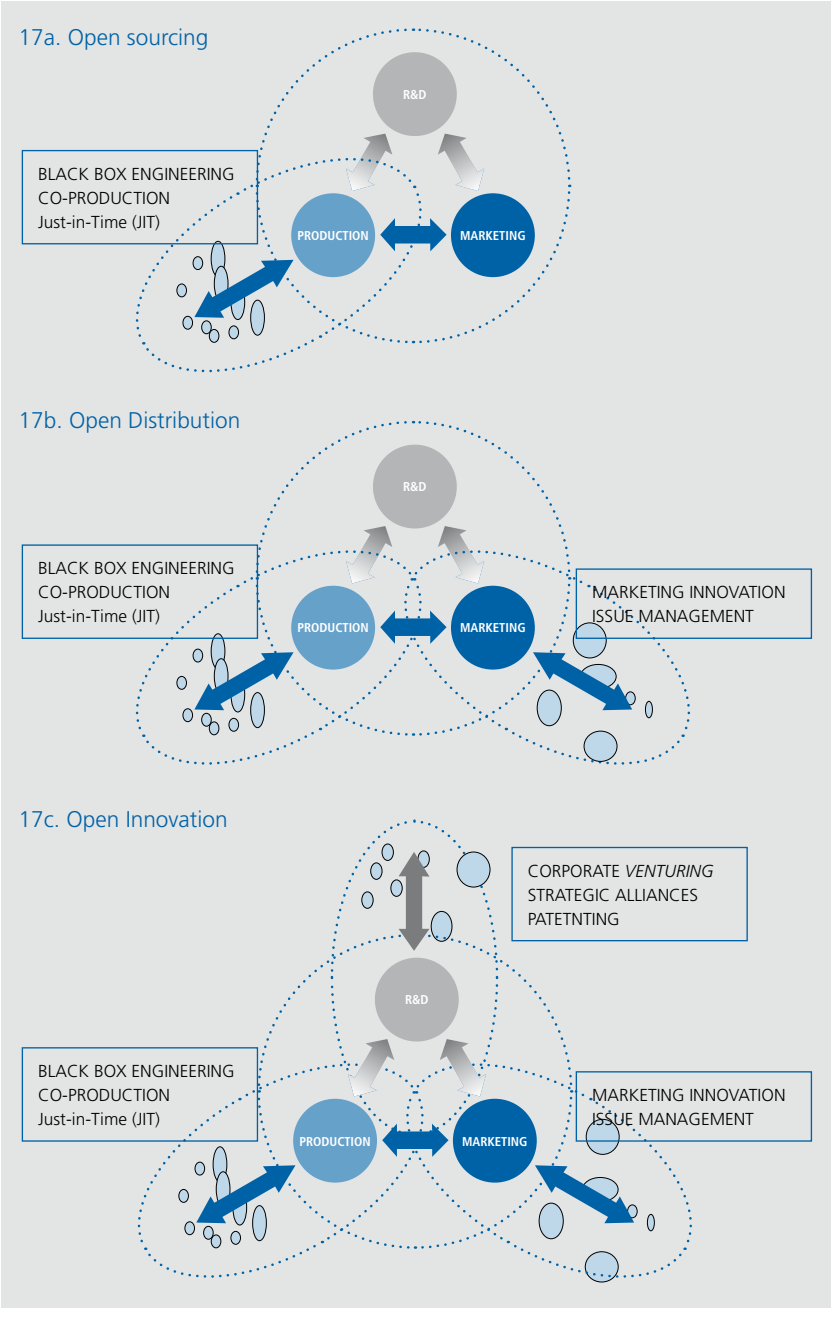
The internal preconditions for 'open' innovation probably require a more iterative model in which all three departments collaborate with each other in real-time (16c). This creates close feedback loops between the departments and facilitates new products that are not only innovative, but also marketable and relatively easy to produce efficiently. 'Design for recycling' is an example of a more iterative model. It is a business model that does not focus only on the production process, but also on the after-sales process and even the after-consumption stage. The competitive advantage that can be reaped by this business model depends strongly on the rules (for instance environmental regulation for recycling) imposed upon business. This iterative process stimulates the R&D department to stress the 'D' function in particular. It is also more difficult to organize in the early stages of product development. It is also more risky, because the choice for a particular solution could proof wrong. Leading Japanese corporations have been experimenting with this model in particular in the Research and invention phase of projects. Competing project teams were set-up consisting of representatives of Research, Manufacturing and Marketing. The invention stage is the least costly for firms, so the 'slack' created by competing teams need not be large. Too many of these competing teams, however, creates the challenge of 'splintering' research divisions and lacking synergies. The strong emphasize on 'D' bears the risk that the firm cannot develop unique and sustainable competitive advantages in products (and the related services).

It is conceivable that iterative teams can be organized across borders within the same company, but it is more likely that this kind of team can most effectively be organized between geographically nearby team members. The biggest challenge of most corporations remains to organize these interdisciplinary teams in the first place. For the United States it was found that most companies do not educate their researchers about the business side of their innovations (Chessbrough, 2003: 44). This problem is often related to the geographic location of the various activities. R&D personal is not located near the people who plan and execute the business strategy. For multinational firms that do have their various departments located nearby, however, interactive and iterative teams are easier to establish.

External challenges: from closed to open…

Figure 17a-c picture the various external challenges that are related to the open innovation paradigm in the broadest sense. The challenge for corporations to establish open links with innovators and knowledge institutions is made more complex because firms at the same time engage in a variety of external relationships. First and foremost (17a) firms have already engaged in outsourcing, vertical de-integration. The idea of 'lean manufacturing' was inspired by the innovative models of just-in-time inventory and 'black box engineering' that were pioneered in Japan. In these business models supplier became 'co-producers' and 'co-innovators' of

Figure 17: Open business models



the end-producers. The sophistication of the supply network defined the competitive position of the end-producer. Firms in the United States and Europe have taken over many of the characteristics of the lean manufacturing idea, but also found out that this created additional risks as well. Lean manufacturing implied also 'vulnerable' manufacturing in which firms became susceptible to production disturbances at their suppliers. To control these external disturbances, open sourcing very often has been associated with local production networks located around key facilities of the core producer. The promise of global sourcing, thus in practice has been very difficult to achieve. Global sourcing became local or regional sourcing (cf. Mol et al, 2005).

As regards distribution arrangements (17b), many manufacturing firms were faced with a merger wave in the retail channel as well as with greater problems in establishing unique (or single-mark) distribution channels. Open distribution has been particularly relevant as an entry strategy in foreign markets, were multinational enterprises cooperated with local distributors rather than acquiring them. The innovative potential in these relationships has slowly been acknowledged, and has led to some marketing innovation. Furthermore, the growing importance of the end-consumer has re-inforced the importance of the 'reputation' as an intangible asset of the firm. Brand reputation can add immense value to a company. Reputation shows great resemblance to the Intellectual property rights: it is difficult to protect and easy to lose. In particular big multinational enterprises that engaged in 'corporate branding' (the name of the company is the brand name) have faced problems with more assertive consumers (cf. van Tulder with van der Zwart, 2006). Open marketing, therefore, requires firms to engage in 'stakeholder dialogues' to develop sophisticated marketing strategies. Marketing becomes 'issue' and 'stakeholder' management.

Finally, the issue of open innovation has already been addressed in section 1. Firms engage in corporate venturing by spinning-off previously internal R&D facilities 17c). The number of strategic alliances aimed at pooling R&D has increased, whereas the external patenting strategy of firms has become an increasingly important part of their intellectual asset management strategy and for many firms represents a substantial source of profits. However, open innovation has brought a number of challenges as well. In case the spin-off (venture) moves into the same market segment as the former parent (either directly or through delivery to competitors) the smart open innovation strategy in fact can turn into a 'market cannibalization' strategy. European firms outsource an average of 18% of their R&D investment (EC, 2006). This figure seems lower than in the case of Japan and/or the United States and some of the developing countries. It requires decentralized management structures of a large number of technology agreements with stakeholders in relevant locations. But their prime networks most of the time remains at home. A considerable number of European firms is still relatively conservative with their internationalization of R&D (almost 40% of a sample of 200 multination-

als did not anticipate any change in their worldwide R&D distribution; EU, 2006). The company's home country in many respects continues to be the most attractive place for locating R&D investments. The literature on strategic alliances furthermore shows that two out of three strategic alliances fail, so an alliance in innovation can be extremely risky. This applies in particular in case the partners are unequal; for instance with joint-ventures in developing countries that have been established because of host regulation, not because of R&D value added. Because of the risk of loosing valuable knowledge, an increasing number of European and American firms have figured out that losing market share in the guest market is less of a problem than losing R&D knowledge and consequently decided not to invest in the third market, whilst keeping their R&D strategy centralized and coordinated. In particular across borders, technology transfer represents a prime strategic asset of multinational enterprises. Consequently, the largest part of the volume of international technology transfer is still company internal. For example 73 percent of all cross-border licensing in the United States in 1998 was between affiliates of the same MNE (Mann, Brokenbougm, 1999; UNCTAD, 2005)

The R&D organizational challenge...

Figure 17c shows the tremendous complexity of the organization of the firm that wants to gain a real competitive edge from open innovation in general. In all areas substantial gains can be made, but the risks increase as well. In every functional area tremendous coordination problems appear; which only increase when one wants to coordinate amongst functional areas with external partners across borders. The latter, however, is also one of the challenges of a viable open innovation strategy. The Locomotive project focused on the three functional areas, from the perspective of the internal R&D organization across borders. Figure 2 shows four types of organization and coordination that can be adopted by multinational enterprises (cf. Fortanier and Van Tulder, 2006).

Type 1 firms have centralized their R&D at the headquarters, and only some development activities at local affiliates. This is the traditional type of multinational and can largely be associated with the 'closed innovation' model, also at an international level. The MNE acts as an 'island' in the host location; decisions are centralized, and very formalized (prescribed rules and procedures, manuals). There are no lateral ties with other R&D deparments, whereas lateral ties with manufacturing and marketing only exist at the local level.

Type 2 firms lean to have a main laboratory at headquarters. Local product development is for local market and product adaptation. The relationship with the home country is centralized, but less formalized than type 1. There are limited lateral ties with other R&D facilities across borders, whilst there is some local ties between the Develoment centres and local manufacturing and marketing, whilst few with manufacturing elsewhere. This type is still largely 'closed'.

Type 3 and type 4 firms approach the more 'open innovation' business model, but from different international organizational perspectives. Type 3 has strong local research activity, but central coordination to ensure all research can be integrated in product development, lateral ties with other R&D is considerable, whereas ties with other functional areas locally exist, but need not be well developed. Type 4 firms represent the most 'open' type of innovation also in the international organization of the firm. Local centres of excellence can exist that perform a leading role in the internal organization of the firm in Research as well as Development. The home country is one of several centres without particular hierarchical function, limited central coordination. Lateral ties with other R&D are strong, intense and egalitarian. The same counts for the lateral relationships with local marketing and production.

Two leading European firms might illustrate the challenges ahead for open innovation: Philips versus Volkswagen (van Tulder et al, 2007). The Dutch consumer electronics firm Philips has perhaps gone furthest of all European manufacturers in its adoption of an 'open innovation' strategy. Its internal R&D organization can be classificed as 'type 4'. Philips is an established multinational enterprise that has had international production and sales activities since many decades. All local R&D centres are very strong and also linked to other business functions. The latter is partly a legacy also of the 'matrix' organization of the company in which the company adopted a 'multi-domestic' strategy to be accepted as a local player in many countries around the world. The most important change Philips has implemented has been the change in its R&D headquarters. The famous Natlab in Einhoven has been restructured into a more supportive function to other R&D functions around the world, than the central laboratory it used to be. Corporate Technology does coordinate R&D activities, but more supportive than hierachical. At the same time, Philips has opened up its headquarters and invited many other firms to locate on an 'open high tech campus'. Spinn-offs, new ventures, big as well as small firms are locating nearby. One of the most important reasons for this strategic turnaround, however, has to be found in relative weakness of Philips since the beginning of the 1990s. Since then the firms has been in almost continuous crisis, sold-off most of its divisions (now new ventures, many of which are very high-tech), more than halved its turnover and employees in order to restore its profitability. The restructuring strategy thus forced the company on the 'open innovation' path. It has been a very logical strategy to adopt, but whether it is sustainable is still not clear. Philips now faces the problem of limited internal coordination and lack of external control. For local partners around the world, however, the strategy has created major changes for new ventures and cooperation.

German car producer Volskwagen on the other hand, represents much more the European average of a big corporation both in terms of its internationalization strategy, its approach to sales and production and towards innovation. Volkswagen developed a 'type 2' strategy. The internationalization strategy of the compa-

ny has been one of aggressive internationalization through acquisitions in particular within Europe. In this strategy local brands have been important, but the most important challenge was to integrate them in the manufacturing strategy of the parent company (joint platforms for instance), which was also related to a particular outsourcing strategy. This did not create much room for local R&D initiatives. Strong vertical ties therefore were established with the central R&D department, leaving basically room open for local adaptation and brand development. Lateral ties with other R&D facilities have been limited, but lateral ties with local manufacturing and sales on the other hand have been strong. The room of manoeuvre for local actors – except for the ones around the German headquarters – remains relatively limited; it develops as a function of the general strategy. Volkswagen's strategy has been relatively successful both in market penetration and innovation. So there is no reason why the firm will have to change its strategy and enter the more risky strategy of open innovation. In many areas Volkswagen has moved away from the old 'closed' paradigm and in the direction of a more balanced approach in which internal coordination has become complemented by external control.

In conclusion

Open innovation as an organizational model, clearly has its drawbacks and risks. It does not provide a panacea for competitive disadvantages in other functional areas. Consequently, the number of firms that have engaged in full-swing open innovation has remained limited in general and in Europe in particular. Consequently, the spread of R&D and innovation over a larger number of players has remained more modest as well. Formal R&D investments are at the same time increasingly concentrated in the private sector, which in turn is dominated by a relatively small number of large firms. 700 companies account for about 80% of private R&D and more than half of the total R&D performed within OECD member states (Dearing, 2006). The challenge for developing local innovation strategies – certainly in the non-core regions of the world – strongly depends on the way they relate to the international R&D strategies of the most important carriers of innovation – i.e. the multinational enterprises. Although there are clear indications that the old paradigm of closed innovation is no longer valid, it is not likely that the (new) paradigm of open innovation will prevail in the nearby future either. This paper showed the considerable challenges that still lie ahead. For new locations such as the Czech Republic it is therefore vital to keep concentrating on the realized strategies of multinational enterprises that are locating in the country, than at the idealized strategies that can be read from the business literature. Taking the dominant strategies of leading European firms into account, it is best to focus on local innovation strategies that cope with relatively hierarchical R&D strategies and adaptative research. The barriers to entry are high, but so are the barriers to exit once local suppliers and research institutes are in the international network.

Conclusions

This textbook examines the contribution of MNEs to R&D and innovation development in host countries, determinants for geographical localisation of R&D and new trends in approaching global R&D activities. The LocoMotive project aimed at providing an analysis of current trends in MNEs with respect to regional influences on their location for R&D. It also rised an opportunity to establish relations between key private sector R&D decision–makers and the project partners from these regions. We hope that the results of the Locomotive project presented both in this textbook as well as at the conference and workshop contributed to better understanding of factors determining complex innovation process.

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The LocoMotive project can be enormously important for the future competitiveness of Europe and the fulfillment of the goals of the Lisbon Agenda. While contributing to a better understanding of motives of multinational companies to invest into R&D abroad and the main location factors, it can also provide a set of recommendations for both the EU and respective national governments on how to improve the attractiveness of Europe and each individual member country for FDI into research and development. Furthermore, these recommendations are not a result of academic discussions but a result of interviews and workshops with managers of corporate R&D units already located in EU member countries, who have practical experience with selecting locations for R&D units, their establishing and routine daily operations. (...) Results of the project clearly show (maybe for the first time) how important role have large multinational companies played in European economy and particularly in countries which have undergone a massive transformation of national economies. The project has also identified a set of steps that the EU and respective member governments could (and should) to improve the environment for investment in research and development. These improvements would create better conditions for both large multinational and small domestic companies.

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