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Research Mandates for Technology Transfer:

International Policy Learning

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42

Research mandates for technology transfer: International policy learning.

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CONTENTS

ABSTRACT

In an increasingly knowledge-based economy the generation and use of scientific knowledge in the innovation efforts of enterprises are seen as one important dimension that determines the performance of a National Innovation System. Hence, science and technology policy has in recent years devoted much attention to fostering Industry-Science Relations (ISRs), and in several countries policy initiatives in this realm have been launched. The intensity and quality of knowledge transfer between the science and industry sector thus play an increasing role in determining the returns on investment in research, in terms of competitiveness, growth and job creation.

Against this background, the study provides conceptual and empirical information on comparable programmes in a set of selected European countries. Regarding the channel of interaction between science and industry the report focuses on human capital mobility programmes and the public support of academic spin-offs. Despite a general trend towards relaxing regulatory constraints, the low rate of mobility of researchers between public and private sectors remains in many countries a major bottleneck of knowledge transfer. The contribution of spin-offs from publicly funded research to innovation is significant in specific sectors.

However, there is a huge variety of good practice examples when screening most of the existing programmes. In order to learn from these good practices, one has to consider that good practice is always specific to the market and institutional environment, and addresses market failure and barriers stemming from this environment. Policy makers have thus carefully to identify these market failures and barriers, and then select a proper mechanism to tackle them.

As regulations are only one side of the equation interaction depends very much on incentives. Policy has to take this into account when developing subsidy measures. Promotion programmes for specific transfer channels like mobility or research spin-offs should be regarded as one step within an initiative to make inter-sectoral knowledge flows more flexible and effective.

Chapter 1

INTRODUCTION

This is the final report of a project commissioned by IWT-Vlaanderen (Instituut voor de aanmoediging van Innovatie door Wetenschap en Technologie in Vlaanderen). This project is carried out under the leadership of Joanneum Research (Institute of Technology and Regional Policy – InTeReg) in collaboration with ZEW/Mannheim (Centre for European Economic Research) as sub-contractor.

The main aim of this project is to support the IWT in the formulation of new guidelines for its "Research Mandates" Programme, mainly by providing conceptual and empirical information on comparable programmes in a set of selected European countries. This is done mainly by distilling information from the study on 'Benchmarking Industry-Science Relations – the Role of Framework Conditions' for the European Commission (Polt et al. 2001), the European Trendchart on Innovation and on information delivered by national experts.

This report is structured as follows:

- In chapter 1 we discuss the basic rationales behind programmes designed to foster human capital mobility between academia and industry and the promotion of research spin-offs. Beside an overview of some theoretical arguments we give some information on the institutional/regulatory frameworks, which may hinder or stimulate mobility in various countries.

- In chapter 2 we present basic information on relevant programmes in the various selected countries. We try to give a comprehensive overview of the empirical situation of human capital mobility programmes and the public support of academic spin-offs. We listen all the relevant programmes and describe in more detail the most prominent and significant ones.

- The last chapter will, against the background of existing programmes in other countries, provide main conclusions and suggestions for further development of IWT's "Research Mandate" programme.

> 1.1 THE INCREASING ROLE OF SCIENCE-INDUSTRY LINKAGES

A variety of studies (see for example David et al. 1994; Pavitt 1991, 1997; Rosenberg and Nelson 1994; Martin and Salter 1996; Mansfield 1995, 1997) provide an interesting list of economic benefits that result from basic research mainly done at universities. The scientific research process generates economically important outputs other than published findings and theories. Examples are training of individuals and the development of instrumentation that are complements in the conduct of future scientific and industrial research.

These different forms of benefits are, however, interconnected and mutually supporting. For example, the training of skilled graduates not only promotes the development of professional networks but also facilitates the transfer of new information and methodologies into industry. Hence, some contributions will be **direct**, when academic research leads to applicable discoveries, engineering research techniques and instrumentation. Other will be **indirect**, when academic research training; background knowledge and professional networks contribute to business firms' own problem-solving activities. All this can only be analysed in the context of modern innovation theory, which sees innovation as an interactive process, and stresses the complex feedback systems between basic research and industrial R&D (SPRU, 2000).

Industry-Science relations (ISRs) are thus not simply transactions mirroring a clear-cut division of labour in the knowledge production process. Rather, they represent an institutionalised form of learning that provides a specific contribution to the stock of economically useful knowledge. The non-linear knowledge transfer signals deeper ongoing transformation in the respective role and forms of co-operation/competition between curiosity-driven scientific research, mission-oriented public research and profit-driven business R&D. Industry-Science Relations (ISRs) thus should be evaluated not only as a simple transfer process but also on their other capacities (network effects, problem-solving competence, etc.)

As a result, science-industry linkages have grown in importance as a central concern for government policy in recent years. This interest coincides with a number of new developments in the nature of ISRs, such as the emergence of broad alliances between universities and firms, and growing activity in the realm of commercialisation of research results through licensing of intellectual property and spin-off companies. A large part of programmes, actions and measures in most EU-countries are thus captured on fostering industry-science relations (STRATA-ETAN, 2002).

To this end, ISRs must be characterised along three dimensions (Polt et al., 2001):

- nature and relative importance of the channels of interaction;
- their institutional arrangements;
- and their incentive structures, as influenced by government's promotion programmes.

Regarding the channels of interaction the report focuses on (i) labour mobility, in course of this project defined as (temporal) movement from academic researchers/post-doc graduates students to industry and (ii) spin-offs founded by academic researchers. Despite a general trend towards relaxing regulatory constraints, the low rate of mobility of researchers between the private and public sectors remains in many countries a major bottleneck to ISRs. The formation of academic spin-offs has attracted more and more attention by technology policy makers during the last decade. The contribution of spin-offs from publicly funded research to innovation is of course significant, especially in the information technology and, increasingly, the biotechnology/medical technologies sector. However, the number of academic spin-offs remains small compared to the overall business formation process.

> 1.2 THE IMPORTANCE OF HUMAN EMBODIED KNOWLEDGE TRANSFER

A recent report by the OECD (2001a) on human resource mobility provides further empirical support and insight into the role of personnel mobility in the transfer of knowledge at both national and international level. The report emphasises the central role of knowledge and learning capabilities of individuals in the innovation processes of organisations. This provides a clear rationale for the use of personnel mobility to facilitate the transfer of knowledge and technology. At national level, the promotion of mobility as a policy mechanism may contribute to national and industrial competitiveness while both strengthening and exploiting the science base.

Formal mechanisms like research joint ventures or contract research are thus only one (small) part of ISR. The bulk of industry-science relations takes place through informal and indirect channels, which are mostly human-based. Even studies in the US assuming that patents and exclusive licensure of the results of federally sponsored research are the best approach to maximise the social returns to publicly R&D investment emphasise the more open channels for information dissemination to benefit from publicly funded academic research (Mowery et al., 2001).

> *1.2.1 The industry perspective*

Innovation surveys demonstrate that improved access to better trained human resources is by far the main benefit that industry expects from linkages with publicly financed research, and this is not likely to change in the future given the risk of persistent shortages of highly qualified labour.

For Austria Schartinger et al. (2001) exhibit that the main transfer of knowledge between the industrial and the university sector occurs through the mobility of people equipped with scientific knowledge. Asked for the general benefit from universities, a vast majority of the surveyed firms values highly skilled personnel as the main output from universities and considers employment of graduates as an important access to academic knowledge. It follows that the main transfer mechanism of knowledge between the two sectors is through the human factor (Schibany and Schartinger 2001; Schibany et al., 1999). The flow of skilled personnel to industry is the single most important channel for ISRs. Yet recent graduates bring both enthusiasm and critical approaches that stimulate others and raise standards. Moreover, the skills acquired during education are often necessary precursor to the development of more industry-specific skills and knowledge. Even in applied areas of science and engineering, the transfer of students into industry is rarely a smooth process. Often firms have to make large investments in training new graduates. Students are prepared to learn, but they need to be taught industrial practice before firms can draw upon their resources to expand firm technological competencies. Informal networks between faculty and former graduates account for a large – although difficult to measure – share of the total amount of knowledge exchange between industry and public research. New information and communication technologies can only reinforce the role of these social networks in ISRs.

Governments sometimes underestimate these human resource-related linkages. They tend to overlook the fact that access to scarce human resources is always a key objective of industry in considering the merits of any type of linkage, formal or not, with public science. The employment of scientists and engineers is moreover one of the key indicators of innovation. Although most of the countries had substantial level of growth within the last decades, the employment of researchers by enterprises remains rather low (see Table 1).

Table 1 > ***Total number of researchers[1] employed by industry per 1000 labour force***

							Average annual growth rate %			
Countries	**1981**	**Rank**	**1991**	**Rank**	**1997**	**Rank**	**1981-1991**	**1991-1997**	**1981-1997**	**Rank**
US	4.5	1	6.1	1	6.7	1	3.0	1.6	2.5	11
Japan	3.4	2	5.0	2	6.0	2	4.5	2.2	3.6	10
Sweden	2.2	5	3.0	5	4.9	3	2.9	8.9	5.1	8
Norway	1.6	6	3.2	4	4.1	4	7.1	4.3	6.1	5
Finland	1.1	11	2.0	11	3.4	5	6.2	9.0	7.2	3
Ireland	0.5	15	1.6	14	3.3	7	12.8	12.9	12.8	1
Germany[2]	2.7	4	3.6	3	3.3	6	2.7	-2.1	1.3	13
Switzerland[3]	n/a	n/a	2.5	7	3.2	8	n/a	3.7	n/a	n/a
Canada	1.2	10	2.1	10	3.0	9	5.7	6.3	5.9	6
UK	2.9	3	2.8	6	2.9	10	-0.3	0.6	0.1	15
Belgium[2]	1.3	9	2.1	9	2.7	12	5.1	7.1	5.7	7
France	1.5	7	2.2	8	2.7	11	4.8	2.0	3.7	9
Denmark	0.9	12	1.8	12	2.4	13	7.4	5.1	6.5	4
Netherlands[3]	1.5	8	1.6	13	1.8	14	0.7	2.4	1.3	14
Australia	0.5	16	1.5	15	1.6	15	11.2	1.8	7.6	2
Austria[4]	0.9	13	1.2	16	1.4	16	3.1	n/a	n/a	n/a
Italy	0.9	14	1.2	17	1.2	17	3.4	-0.1		12
New Zealand[2]	n/a	n/a	1.0	18	0.9	18	n/a	-1.1	n/a	n/a

Notes:

1. Researchers are professionals engaged in the conception and creation of new knowledge, products, processes, methods and sys-tems and in the management of the projects concerned. Please refer to the Frascati Manual, 1993: 17.
2. For Belgium, Germany and New Zealand, the last year for which information is provided is 1995 (therefore, the growth rates have been calculated by taking 1995 instead of 1997). The data covers West Germany until 1990, and Unified Germany from 1991.
3. For Netherlands and Switzerland the ratios offered are those of 1989 instead of 1991 (growth rates have been calculated accord-ingly).
4. In the case of Austria, where there is no information form 1993 onwards, the data corresponding to 1997 has been estimated by extrapolating the trend of growth obtained in the period 1986-1992 (3.1%).

Source: Main Science and Technology Indicators. OECD Statistics, 1999, 1995 and 1992; SPRU (2000)

> *1.2.2 Public employment trap*

In its benchmarking study, the OECD (2002) states that a low industry funding of R&D (and thus weak private demand for researcher), combined with regulatory barriers and disincentives to mobility, result in a concentration of researchers in the public sector. The risk of such a trap is less in countries where industry funds and performs a greater share of R&D and where wages competition for skills spurs movement from the public sector to industry.

International statistics on the mobility of researchers and scientists are too scarce to allow international comparisons. Moreover, the existing benchmarking studies (OECD 2002; Polt et al. 2001) cover only a limited number of countries, which provide only some indication of the role of mobility and the main obstacles for the improvement.

A comparison with the US for example shows that scientists and engineers change jobs every four years, and even more frequently in the case of software and IT occupations. In Japan, the opposite is true: it is estimated that only 20% of engineers change jobs once in their career and it is likely that job changes between the public and private sectors are even less frequent[1].

1 The Japanese labour market model is quite specific and it can therefore assumed that most of the European countries are somewhere between these two poles.

Although the data situation restricts simple cross-country comparisons, empirical evidence shows that there are significant differences between countries on researcher mobility rates (annual number of researchers moving from one sector to the other per 1,000 researchers in the exiting sector). For those countries where quantitative measures are available Table 2 exhibit rather high mobility rates from Public Sector Research Establishments (PSREs) to the business enterprise sector in Belgium, Germany, Finland, and Sweden compared with other countries. As far as data are available, the majority of this mobility seems to take place among young scientists who often face temporary employment contracts or work on temporary research projects. These temporary employment conditions offered to young scientists are one of the main drivers of the high mobility rate in Germany. In fact, temporary flows between industry and public research organisations - including temporary movement by senior researchers to industry, mutual exchange of researchers, and temporary visits of industry researchers to science - are more common than permanent moves.

In all countries, mobility is stimulated heavily by significant differences in earning and career options. Consequently, the level of mobility in the opposite direction is lower. The main reason for this is the difference between salaries in the business sector compared to those in Higher Education Institutions (HEIs). Thus, HEIs have only limited possibilities to attract experienced human capital from the business sector. This may be an impeding factor for ISR because researchers from the business sector would not only bring with them practical R&D knowledge but also personal business related networks. The latter would enhance the principal potential for ISR because co-operation between HEIs and the business sector often follows such personal networks.

Both benchmarking studies (OECD 2002; Polt et al. 2001) thus emphasise that employment regulations and conditions in the labour market set the overall pre-condition for

Table 2 > ***Mobility of Researchers between Science and Industry1****

Country	From HEIs to industry		From PSREs to industry		From industry to HEIs/PSREs	
	value	period	value	period	value	period
Belgium	~ 3	1995-96	~ 5	1995-96	0.4	1995-96
Germany	~ 5	1997-99	~ 3	1997-99	n.a.	-
Finland	~ 3.5	1994-95	~ 4	1994-95	0.4	1994-95
Sweden	~ 4	1994-95	~ 15	1994-95	0.6	1994-95

* annual average in% of total number of researchers in the delivering sector
Source: Polt et al. (2001)

changing jobs and occupations. Public employment legislation is relevant insofar as a large share of researchers work in higher education and government sectors. Until recently for example, public researchers in Japan and France were explicitly prohibited from undertaking activities with industry due to their civil servant status. Regulations governing temporary mobility not only concern research in other public research institutions but can also allow young researchers or professors to take leave to work in industry.

An important factor that determines mobility from public science to the private business sector is the regulatory framework concerning labour arrangements and laws. In countries with civil service status in HEIs (such as Austria), the incentive to move from academia to the business sector is very low. In addition, the pension system (for example in Germany where there is no possibility to transfer acquired pension funds to the new occupation) may hinder the mobility even further.

Despite the persistence of regulatory barriers, there is a clear trend across OECD countries toward relaxing regulatory constraints on mobility. This takes place either through granting more autonomy to universities (such as in Austria and Finland) or through relaxing rules on public research collaboration with industry.

> *1.2.3 Public promotion programmes*

The policy priority given to personnel mobility varies across EU member states. There exists a range of mobility schemes depending on the overall policy objective and the context of operation. Within the widespread recognition of the importance of mobility as a means of knowledge transfer, there are examples of schemes specifically designed to exploit this. Hence, specific issues can be noticed addressed by mobility instruments, such as skill shortages (e.g. Belgium, Austria, Germany), the needs of SMEs, and the role of personnel mobility in developing scientific and technological collaboration.

The wide variety of existing schemes being implemented across Europe includes all types of public and private sector organisations. There is a clear emphasis on the mobility from universities to industry, particularly in the recruitment of researchers. The majority of mobility schemes thus operates at the level of individual members of research organisations (including firms, universities and public research organisations).

There is a particular concern for SMEs and the use of mobility schemes to improve their innovative performance. In most cases the main aim is to promote the recruitment of university graduates and researchers to improve the technological competence and research capabilities of SMEs. This results additionally in the strengthening of the capacity to carry out scientific and technological cooperation.

Mobility schemes typically target at individual researchers and other personnel, a large number being scientifically and technically qualified personnel, covering graduates, doctoral graduates and post-doctoral researchers or researchers form other public sectors or industrial laboratories. Less qualified and experienced personnel may be targeted as appropriate for training-related mobility schemes, while highly experienced personnel may also be of interest, such as the reverse flow of experienced industrialists into senior university positions (see e.g. some Finnish schemes). A screening of the targets of mobility schemes shows that students (particularly postgraduates) are targets of many measures (see Table 3). Certain schemes use PhD studentships as a means both to develop research skills and for companies to acquire – albeit temporarily – research personnel.

Table 3 > ***Targets of measures***

Students	15
Graduates	7
University Researchers	16
Civil servants	2
Industrial Researchers	9
Industrial Managers	3
SMEs	1
Firms	1

Source: Trendchart

> 1.3 RESEARCH SPIN-OFFS FROM PUBLIC RESEARCH

Universally, research based start-ups from the public science sector (**"research spin-offs"**) have become an increasingly popular form of technology transfer and one of the favoured commercialisation strategies of public research. Research spin-offs denote all those new enterprises that are founded in order to commercialise new research findings from public research. Research spin-offs are most often founded by former researchers from public research institutions and thus represent a certain type of personnel mobility from the public to the private sector. In some cases, there may be an equity investment in the spin-off by the research institution itself. Another type of research spin-off are those based on the licensing of patents from public research institutions, regardless to the involvement of a researcher in the new firm.

A research spin-off in this definition should be distinguished from an **academic start-up**, that is any new firm founded by employees from public research institutions or by students or graduates from universities. From a technology transfer perspective, research spin-offs are those that make a significant contribution to the transfer of new knowledge to commercial use. They face particular challenges as they have to deal with technology and market uncertainty stemming from the introduction of a new product to the market and thus may demand specific support. From a personnel mobility perspective, however, all types of firm formations by researchers and graduates may be regarded as equally important. Academic start-up activity is strongly influenced by the general entrepreneurial climate as well as the incentives for leaving a public research institution and the job opportunities for graduates. Policy initiatives that attempt to foster entrepreneurial activities from public research should be aware of this distinction as the promotion of research spin-offs and academic start-ups often demand different approaches.

Since the 1980s, and especially in the last few years, the number of research spin-offs is perceived to have risen. Given the current "start-up fever" in many countries, governments too have a special interest in this specific type of industry-science linkages because it may be one of the factors that explain differences in performance in new, fast-growing science-based industries, such as biotechnology. In addition, some are tempted to see the spin-off formation rate as a key indicator of the quality of ISRs, prompting public research organisations to place greater priority on this aspect of commercialisation strategy.

Research spin-offs, and often more generally all types of academic start-ups, are seen as "translators and mediators between academic research and industry", or even more pointedly "as indicators of the public sectors ability to develop commercially relevant knowledge, of its entrepreneurial capacity, and of the depth of knowledge transfer between the public and private sector" (OECD 2000). Ideally, research spin-offs represent a form of co-operation embedded in other forms of interaction such as joint R&D, joint publications or researcher mobility.

Due to different definitions, no uniform concept exists of what constitutes a research spin-off or academic start-up and therefore, international comparisons are complicated (OECD 2000). The scattered empirical data suggest that the number of research spin-offs per public institution or per country is generally on rise, although some countries seem to have already experienced a peak in spin-off formation in the late 1980s or early 1990s (OECD 2002). A well-known example is the difference of spin-off formations between US and most European countries. A provisional and crude estimate by the OECD demonstrates that in the 1990s the rate was about three to four times higher in North America than in most other OECD countries, although current dynamic developments are rapidly changing this picture.

However, in a broad view the following specificities concerning the research spin-off formation can be mentioned:

- The total number of research spin-offs is very small. There is only one such spin-off for ap-proximately every 1,500 enterprises founded, whereas every eighth new firm is a corporate spin-off (OECD 2000). With respect to the total number of researchers in science, the spin-off ratio is on average 2 to 4 per 1,000 R&D personnel in HEIs and 2 to 3 per 1,000 R&D personnel at public sector research establishments (PSREs). Their importance as a mechanism for technology transfer is not in question but their limited magnitude in the economy must be kept in perspective. One has to notice, however, that the number of academic start-ups by large exceeds that of research spin-offs. In some service sectors such as information technology, advanced producer services, academic start-ups represent the majority of all new firm formations.

- The creation of a new firm in order to exploit the commercial potential of new research results depends heavily on the type of research carried out in public science institutions, both with respect to the time horizon of research (long-term oriented fundamental versus short-term oriented research which is near to application) and the field of research (i.e. the market for new research findings). Academic start-ups thus tend to be concentrated in certain sectors and technologies - primarily in the life sciences, information and communication technologies, and advanced producer related services such as software, management consulting and technical services. Consequently, start-up activities differ by the type of public science institutions where different kinds of research are carried out. The objectives and resources of a technically oriented contract research organisation, like the German Fraunhofer Society, VTT in Finland, or VIB in Belgium, are different from those of an educational institution like most universities.

When looking at policy-related framework conditions for start-ups from public science, it should be noted that the same economic environment, which generally determines the level of new firm formation in an economy, affects academic start-ups. The financing conditions on capital markets, especially the availability of venture capital, the degree of competition and the openness of markets for new entries, anti-trust law and market regulation influence the creation of new enterprises. If these general framework conditions for firm formation are favourable one might expect a large number of academic start-ups too, while unfavourable market and regulatory environments will result in low start-up figures.

> *1.3.1 Policy measures*

All governments are aware that improving the environment for entrepreneurship will help to foster the generation of public research-based spin-offs. The experiences of some countries suggest that there are different approaches to promote start-ups and that there are specific obstacles to public research-based spin-offs that only government can lower. Although there is no single success model for promotion the already mentioned benchmarking study identified some general good practice principles in facilitating academic start-ups, which can be summarized as follows (see Polt et al. 2001):

- Provide pre-seed capital, i.e. financial support, in stages before a new firm is created.
- Focus managerial and financial support on specific sectors in order to address the specific barriers prevailing in a certain market.
- Follow institution specific approaches in promoting academic start-ups in order to address the specific situation (mission, research orientation, business networks etc.) at an institution.
- The provision of infrastructure such as incubators may support new firm founders by reducing transaction costs but their main function is to raise awareness in public science that starting an enterprise is a career option, and close ties should be kept between start-ups and their parent in-stitution.
- Institutional reforms in public science towards more flexibility and autonomy in research com-mercialisation will raise the willingness of researchers to engage in start-up activities.

Public seed capital

Although in countries where public research organisations are allowed to take equity stakes in companies (e.g. Belgium, the UK, and the USA), this does not seem to be an important source of capital. The access to external financing may thus play an essential role in allowing start-up firms to survive. It is not only the motivation to create start-ups but also to attract pre-seed capital funds. The emergence of seed capital funds is thus an important incentive for entry into start-up activity and a private venture capital market is an important facilitator for start-ups from science. However, special attention should be paid to financing in very early stages ("pre-seed financing") when uncertainty is high, the business ideas not yet well developed, and the size of projects is too small for private venture capital. Here, public seed capital that covers the costs for developing a business plan and carrying out R&D to develop a marketable product or service, is a major element for a comprehensive financing environment.

Incentive structures

The formation of academic spin-off is highly related to the regulations concerning the mobility of academics. Policies have therefore to encourage human mobility and flexibility of public institutions as well if start-ups are to fulfil their mediator role. Hence, the rise in frequency of new firm creation seems to have happened in parallel to the adoption of national, regional, and even institutional policies. Improving the management of public research organisations or regulations governing researchers mobility are important roles of the government in terms of building incentive structures.

One of the most critical factors in the formation rate of spin-offs is the fact that a good scientist needs not be a good entrepreneur (Stankiewics 1994). One of the main barriers to start-ups from science is perceived to be a lack of entrepreneurial climate in universities and a lack of managerial knowledge in the case of researchers. Start-ups from the science sector have to be promoted, in addition to the access to financial funding, via supportive measures like consulting services among others (see the institutional framework below). With the establishment of specialised professorships for entrepreneurship and start-ups, the managerial skills of students and the awareness building initiatives, the level of academic spin-offs created can be raised.

Institutional framework

If start-ups should play an intermediary role between the public and private sector, contacts between researchers from both sectors are essential. In many countries however, public sector employees are restricted in getting involved in private ventures, and this limits the interaction a start-up firm can have with its parent institution. Such restrictions refer to secondary occupations, leave of absence and the right to take ownership in enterprises. Notably, in most countries, full professors have the status of civil servants. In particular, university researchers may acquire tenured positions, i.e. guaranteed lifelong employment at the university may create rather high barriers to becoming an entrepreneur. Since founding an enterprise is related to high risks and the potential gains are by no means sure, the opportunity costs are quite high. Additional supportive measures have to take this into account. Therefore, the main target group should be younger researchers and assistant fellows in public science who should be encouraged and supported in private ventures.

To foster start-ups from public science, the UK and many other countries, followed an "infrastructure based approach". These are based upon regional approaches, combining infrastructure (incubators), consulting and pre-seed financial support. A large number of science parks located at or nearby universities or large public research organisations have been established, forming incubators for start-ups. Not surprisingly, informal contacts and personal and organisational networks are very supportive and stimulating mechanisms. Networking contacts are thus critical for spin-offs and relevant information should be locally available.

Chapter 2

PUBLIC PROMOTION PROGRAMMES – AN OVERVIEW OF SOME SELECTED COUNTRIES

In the following sections we give an overview of programmes aimed at fostering human capital mobility between academia and industry in the countries, which have been selected in a common decision process between InTeReg and IWT. In this project, human capital mobility between academia and industry is defined in a very strict and narrow manner. As mentioned above, only two channels of human capital interactions are considered in this report:

(i) the (temporally restricted) move of researchers/post-doctoral graduates to industry (especially SMEs), and

(ii) the move from researchers at HEIs/PSREs to the enterprise sector by founding a new business venture (academic start-ups), sometimes involving the commercialisation of new research results (research spin-off).

The overview of the various selected countries is structured as following:

First we try to summarize the empirical situation of the two interaction channels mentioned above in a very short manner. Since there are no internationally comparable data this assessment is based mainly on interviews with national experts and the author's own experiences, gained in discussions with scientists from the selected countries and a review of previous studies.
Secondly, we give an overview of promotion programmes, which are designed to foster these types of industry-science relations.
Thirdly, we describe some of these programmes in more detail. The selection of these programmes is based upon at least one of the following criteria: (i) size of allocated resources, (ii) innovativeness of the programme concept, or (iii) significance for the ISR in the country.

> 2.1 AUSTRIA

> *Mobility of researchers*

The mobility of researchers from science to industry is rather low in Austria. This is especially true for HEI. Career paths in the university system are rather linear. University researchers start as university assistants and develop their careers from there. They either get a permanent appointment or drop out of the system. Because of this career path, uni-

Table 4 > ***Programmes aimed to foster Human Capital Mobility between Academia and Industry-Austria***

Name of Programme (responsible authorities)	Public Funding (million € '99)	Main Approach	Type(s) of ISR Mainly Addressed
Scientists for the Economy (BMBWK)	0.04	Lump-sum payment for firms, which employ a university researcher. University researchers are granted temporary leave from their official university tasks and may return to their position afterwards	Researcher mobility
Young Researchers' Programme (FFF)	5.54	Support for research activities of young researchers in joint projects with companies (SMEs), thereby increasing the extent of co-operation between science and industry	personnel mobility, joint R&D projects
Polytechnic Colleges for the Economy (FFF)	0.3	Fostering joint research projects between polytechnic colleges and firms and at increasing the capacities and networks of polytechnic colleges for future research collaborations with firms	Joint projects with graduates

Source: BMBWK (www.bmwk.gv.at)., BMVIT (www.bmvit.gv.at) versities usually do not recruit researchers externally but develop these jobs internally. However, this does not apply for full tenured professors. Mobility restrictions between universities and industry in Austria also arise from the specific culture of the university system and are based on rather pragmatic issues. Many of the university researchers, who make use of the chance to leave university temporarily for external research or teaching purposes, have lifelong employment contracts. Hence, they are eager to be able to return to their jobs after the termination of their external contracts.

Although there exist some programmes specifically targeted towards (temporal) mobility between academia and the business sector, there significance in terms of public funding (and hence, in terms of participants) is rather limited. Table 4 gives an overview of these programmes, their approach and allocated monetary resources.

> *Research spin-offs*

The annual number of all start-ups by researchers from universities may be estimated at about 25 in total. Almost 60% of these are in the producer-related service sector. The producer-related service sector includes a wide variety of activities such as economic, technical and legal consultations, and other services. The share of technology-based start-ups is comparably small and the same applies for PSRE. A main barrier to start-ups from science is perceived in the lack of entrepreneurial climate at universities and a lack in managerial knowledge, especially in the case of researchers from natural sciences and engineering. The most prominent programme to foster academic start-ups established just recently (2002) is the AplusB programme (Academia plus Business), which is described in detail below.

> *The Austrian AplusB (Academia plus Business) programme*

The principal objectives of AplusB go beyond the mere quantitative increase of academic spin-offs and encompass:

- Ensuring a sustainable increase in the number of academic spin-offs;
- Enhancing the quality of these spin-offs (in terms of innovativeness and knowledge/technology intensity);
- Enhancing the likelihood to survive and succeed at the market place;
- Increasing the general potential for spin-offs from academic institutions;
- Enhancing the exploitation of research results by the business sector;
- Supporting technology transfer from academia to the business sector in general.

These objectives define the programme's general orientation and also form the basis of its funding guidelines. To realise these aims the AplusB Centres assist in the preparation of spin-offs from universities, *Fachhochschule* colleges and non-university

Table 5 > ***Programmes aimed to foster academic start-ups - Austria***

Name of Programme (responsible authorities)	Public Funding (million €)	Main Approach	Type(s) of ISR Mainly Addressed
Scientists Establish Firms (BMBWK)	0.31	Lump-sum payment for university researchers, which is disbursed after the formal foundation of a firm	Start-ups
AplusB (TIG, BMVIT)	11.8 (approved up to 09-02)	Support for the creation of incubators, business plans and to accommodate potential founders in newly created centres, support for the organisation of events to raise the awareness towards start-ups	Start-ups

Source: BMVIT, TIG

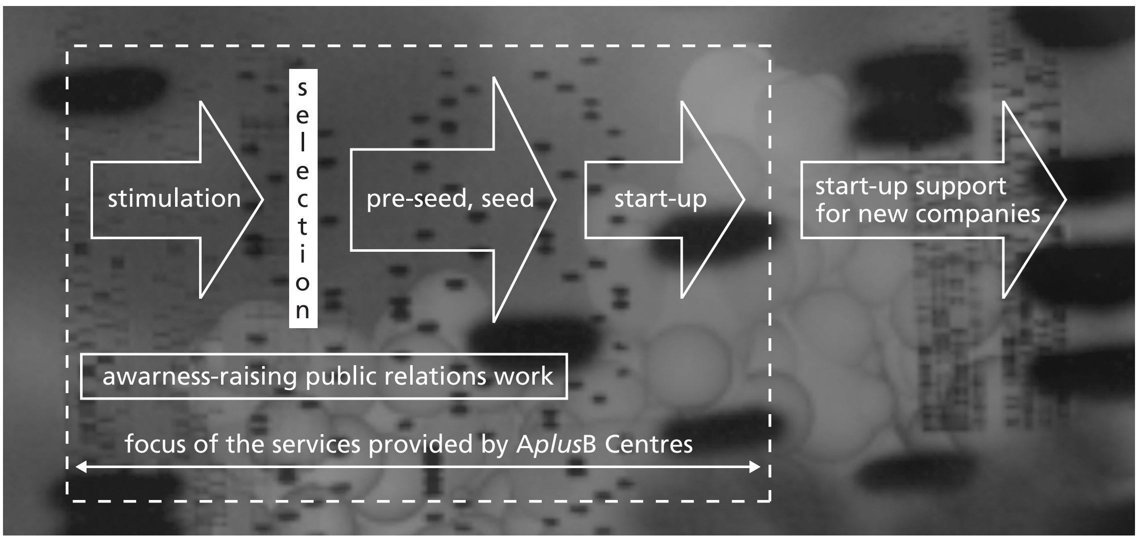
research institutions by providing professional support for scientists in the difficult process of turning a good business idea into a viable business. This involves not only counselling and assistance during the actual start-up phase but also establishing the idea of entrepreneurship more firmly in academic theory and practice. Close links between potential founders and their academic "home base" ensure that the new companies can exploit the know-how developed in academic institutions. Thus AplusB Centres also make a significant contribution to intensifying and reinforcing the co-operation between science and industry in the field of research. AplusB Centres develop a set of different measures aimed to foster the awareness as well as the actual entrepreneurial activities by young (academic) scientists. This includes (see Figure 1):

- awareness-raising, mobilisation and stimulation of start-up activities (e.g. by organising events, information campaigns, special professorships for entrepreneurship, etc.);
- providing counselling, know-how and support (subject-specific tutoring and coaching, management consultancy, further training) for one and a half years;
- providing optimal start-up conditions for the new companies by cooperating with potential investors and with other programmes.

AplusB Centres do have a number of specific characteristics, which are as following:

- **Sponsors/Applicants:** AplusB Centres are jointly sponsored by partnerships between different institutions, which also apply for the subsidy. The minimum number of partners required is two; of these, one must be an academic institution (university, non-university research institution, Fachhochschule colleges) and the other must have verifiable know-how in supporting and monitoring research-intensive company start-ups.
- **Size:** The size of a proposed AplusB Centre depends on the applicants' assessment of the existing potential. However, at least ten concrete start-up projects should be supported by the Centre at any given time.
- **Duration/Financing:** Public funding for AplusB Centres is to be granted for a period of ten years. During the first five years a maximum of 45% of the cost is covered by Federal funds under the AplusB programme; a minimum of 20% is to be financed by the Centre's own resources and 35% by the Federal Province where the Centre is located. For the next five years, a maximum of 25% is to come from the Federal budget, a minimum of 50% from the Centre itself and a minimum of 25% from the budget of the respective Federal Province.

Figure 1 > ***Activities of AplusB Centres***



Source: TIG; www.tig.or.at

- **Target group:** AplusB Centres primarily address scientists on the staff of universities, Fachhochschule colleges and non-university research institutions who have completed degrees at gradual level (doctoral candidates, university assistants, contract researchers, graduates) or at post-graduate level. The target group may be extended to include advanced students, teaching assistants and graduates with professional experience. Awareness-raising and stimulation activities are to address students and professors, too.

Up to now five AplusB Centres are established, or are in the founding process. Some basic characteristics of these centres are given in Table 6. Almost all major universities of Austria take part in this programme by establishing a centre at least in conjunction with another university. The scope and size of the centres vary considerable. Some centres are orientated towards top-down defined scientific/technological areas, whereas some have a very broad focus targeting all potential start-up founders from all disciplines. The planned absolute number of academic start-ups stimulated by the centre varies from 30 up to 70. In total, the successful realisation of these planned figures would mean about 210 academic spin-offs over the next five years generated and/or stimulated by the programme.

> 2.2 BELGIUM

> *Human Capital Mobility*

Personnel mobility from public science to industry is high in Belgium. This high level is stimulated, firstly, by significant differences in salaries and a high demand by industry for well-qualified personnel. Secondly, fluctuation of higher educated science and technology personnel seems to be generally

Table 6 > ***Overview of established AplusB Centres in Austria***

Name of the A+B Centre	Focus	Location (Federal State)	Participating institutions	Start of operation	planned start-ups over the next 5 years	subsidies by the central government 2002-07 (Maximum)
BUILD!	not specific	Carinthia	University of Klagenfurt FH Technikum Carinthia Carinthia Technol. BABEG City of Klagenfurt City of Villach	01-07-02	39	1.7 mio.€
CAST	Life Sciences (after 2005 Informatics; Bio-Informatics)	Tyrol	University of Innsbruck Tiroler Zukunftsstiftung Innovations & Venture Partners Ltd. Management Center Innsbruck	01-07-02	33	2.6 mio.€
IniTS	ICT, Biotechnology; Medical Techniques	Vienna	Technical University of Vienna University of Vienna ZIT	01-10-02	70	3.8 mio.€
Science Park Graz	Natural Sciences; Informatics; Medicine; Engineering Sciences	Styria	Technical University of Graz University of Graz SFG	01-07-02	37	2.1 mio.€
tech2b	ICT; Mechatronic; Applied Mathematics; Engineering Sciences; Chemistry; Biotechnology	Upper Austria	TMG Johannes Kepler University FH Upper Austria LIMAK Chamber of Commerce, Upper Austria	01-10-02	~ 31	1.6 mio.€

Source: TIG, 2002 (www.tig.or.at)

high in Belgium and thus, demand for replacement at enterprises is significant. Thirdly, public promotion programmes in the field of ISR pay special attention to personnel mobility as an effective channel of technology transfer. Finally, a close interaction between industry and science in the field of training and education, and the corresponding development of personal networks between researchers in both sectors, favours personnel mobility too.

The **KIV** measure ("SME Innovation Vlaanderen") explicitly targeted SMEs with limited innovation capacity and which were not engaged in R&D projects. The programme for the **stimulation of innovation in SMEs**, which started in 2001, replaced the KIV measure. Although the KIV-programme was relatively unsuccessful in attracting proposals during the beginning the introduced modifications included the broadening of the scope of the programme (e.g. a more broadly definition of the target group) as well as awareness raising mandates. The starting point of the measure was an innovation project within a SME. A research institution (university, collective research centres) must collaborate with the SME to define the project and to propose a researcher to the company. The research institution must send an application to the IWT. The researcher is then hired by the SME.

FIRST Doctorate offered 20 scholarships annually to PhD students who wanted to develop their PhD in co-operation with industry. The research results had to contain an industrial finality, aiming at developing a new product or process or service. The research proposal had to be initiated by a Walloon university in co-operation with a Walloon research centre or company and had to lead to a PhD. The researcher was asked to spend part of his time in an enterprise or a collective research centre involved in the project. There was an age limit of 36 years for the researcher. Scholarships were granted for a period of 2 years but could be extended by another 2-year period. The Walloon region and the company or research centre that collaborated with the university during the research period paid part of the remuneration of the researcher. The Walloon region covered part of the salary of the researcher (70% when the partner is a SME, 50% for large enterprises). The university paid 10% of the salary and an enterprise/collective research centre financed the rest. It also delivered a grant of 5,000 Euro per year to the university involved. The company or the research institute paid the rest. In turn, the company or research institute obtained the rights over the research results but if it failed to validate these results, the university had the right to take them over.

Table 7 > ***Programmes fostering Human Capital Mobility between Academia and Industry-Belgium***

Programme (executing agency)	**Region**	**Public Funding p.a. (million €)**	**Starting year/Duration**	**Main approach for the researcher**	**Criteria for eligibility**
KIV (IWT)	Flanders	1.2 (~100 projects)	1997-2001	wages subsidies to SMEs for hiring research personnel, financial support to HEIs/PSREs for providing consulting services to SMEs	University degree
FIRST Doctorate (DGTRE)	Wallonia	1.1	1999-2001	support to PhD students for carrying out a doctoral thesis jointly with an enterprise	University degree in industrial engineering for 2 years with a view to obtaining a doctorate
FIRST Europe (DGTRE)	Wallonia	2.8	1999	support to PhD students for carrying out a doctoral thesis jointly with an enterprise, including a research period abroad	
Post-doc grant scheme (IWT)	Flanders	~ 20 scholarships p.a.	19	Financing of post-doc staff of research units	Post-docs

Source: Trendchart, Polt et al. 2001

First Europe is a very similar programme for PhD students but the university researcher has to spend 6 months in the Walloon enterprise and 6 months in the foreign research laboratory. The costs (remuneration of researchers, and travel and subsistence costs) are completely covered by the Walloon region and the European Social Fund. Each year, approximately 30 scholarships are granted.

> ***Research spin-offs***

FIRST Spin-off is a programme to promote the founding of spin-offs by university researchers in Wallonia. It offers 20 scholarships to researchers each year. During the project, they work on the completion of a product, a procedure or a new innovative service concept, carry out an economic and technical feasibility study, and write a business plan for the creation of a spin-off. The researcher must commit to participate in entrepreneurship and management courses during the project. The project normally takes 2 years, and is renewable for 1 or 2 years. At the end of the project, the researcher submits a report stating the scientific and technical results, and indicating the possibilities to start up industrial and commercial activities based on the research. Furthermore, the report contains a business plan, financial plan and an estimation of the market. The researcher is followed by someone who has experience in the creation and management of companies. Financing covers the remuneration and courses of the researcher and is fully covered by the Walloon region. A lump-sum payment of 5.000 Euro is foreseen for the applying research institute. Conforming to the decree of 17 December 1997, research results belong to the university. However, if the researcher decides to start-up a company based on his research within 3 months after the end of the scholarship, the university has to attribute a license to the researcher that:

- is free during the first 5 years after company start-up;
- cannot be shared with third parties without the former approval of university;
- is exclusive on the condition that exploitation of results becomes effective in a time period that is to be determined by the university and the company. If the company fails to exploit the results before expiration of this period, the license becomes non-exclusive.

Even though this FIRST Spin-off programme is probably one of the better programmes in Belgium initiated by government, it has some weaknesses. First of all, the researcher must have a technical background (engineer, exact sciences) in order to apply for a FIRST Spin-off scholarship. This means that they certainly have the technical capabilities to elaborate on the product, procedure or innovative service concept they have been working on, but that they also lack the commercial and financial background needed to write the business plan and to carry out the feasibility study. Entrepreneurship and management courses can teach them some basic principles, but they still lack the business experience, the business contacts needed with suppliers, clients, financiers, and the

Table 8 > ***Programmes aimed to foster academic start-ups - Belgium***

Programme (executing agency)	Region	Public Funding p.a. (million €)	Starting year	Main approach for the researcher	Criteria for eligibility
FIRST Spin-off (DGTRE)	Wallonia	1.1	1999	support for HEIs researchers to establish a new firm	EU Member State University degree from the Belgian French speaking Community Not older than 36
Interface Offices (DGTRE, Flemish government)	Belgium	2.3	1998	support for technology transfer offices in HEIs to strengthen valorisation of research results	- 7 interfaces were financed in Flanders

Source: Polt et al-, 2001

capabilities to build a team of entrepreneurs who have skills different to technical skills. A lot depends on the business person in charge of following up on their progress, the time they want to spend coaching the researcher, and their willingness to open up their network of contacts to the researcher. Some of the experts interviewed in the context of our benchmarking exercise (Polt et al. 2001) particularly those from the industry or VC-environment mentioned that the FIRST programme does not encourage collaboration of people with a technical degree with those with management experience. Although it fulfils the objectives of being a pre-seed capital, it under-estimates the dimension of co-operation.

Both in Wallonia and Flanders, universities are developing their **interface offices**. These offices receive some public support from the regional governments. Although the structuring of most interface services is still in its infancy, there is one good practice to be found in Flanders - Leuven R&D. Interface activities are activities that promote the co-operation between Flemish universities and companies value university research and help to establish spin-off companies by the university. The promotion of co-operation between Flemish universities and companies focuses on the organisation of contacts, search for partners and juridical and financial assistance for the establishment of contracts. Valuation of research results includes educational initiatives concerning validation, active searching for commercial potential results, market research, and protection of IPR and coaching the establishment of a validation plan. The promotion of the establishment of spin-off companies includes business plan coaching, coaching for investments, and financing and management training. By 2001 the Flemish government has put the support of the interface offices on a permanent base with the following changes: (i) interface services have to make a policy plan for at least five years containing the outline of their valorisation policy, (ii) annual report about their activities and the results achieved and (iii) every five years an evaluation.

> 2.3. GERMANY

> *Human Capital Mobility*

Researcher mobility from science to industry is comparably high in Germany. This is especially true for HEIs. One main reason are temporary employment contracts for research assistants. Usually, working contracts are limited to 5 years (both for graduates and researchers already with a PhD). At most institutes in the PSRE sector, a similar practice is employed. Therefore, young researchers in HEIs and PSREs are forced to look for new job options and the industry sector is undoubtedly the most preferred target sector as it offers higher wages and represents the larger potential (as measured in the number of R&D personnel). Furthermore, older R&D personnel (i.e. aged 35 and older) often find it difficult to get a new research assistant job at a HEI. Due to serious wage differences between HEIs and PSREs on the one hand, and industry research on the other, there is little mobility from industry to science. Two exceptions should be mentioned however. First, at Technical Universities, it is quite common to invite top-level industry researchers to take a professorship (whereby industry R&D experience is regarded as a substitute for obligatory habitation). Second, in Polytechnic Colleges, professors must have a minimum of two years work experience in industry, i.e. pure academic careers are not accepted at this type of HEI.

There are several programmes aiming to support mobility from researchers at science to the enterprise sector in Germany. One may distinguish three approaches:

- Subsidies to SMEs for temporary employing researchers from public research organisations in the course of a joint research project, including researchers from abroad. The **ProInno** programme run by the Federal Ministry of Economics and Technology is today the main representative of this approach.
- Subsidies to SMEs for employing graduates or researchers in order to increase the technological level of the innovation activities of the SMEs. Subsidies are typi-

cally restricted to a certain period of time. Such type of programme is often called **"Innovation Assistant"** and is run by several Governments of the Federal States (Länder). In East Germany, there is a special programme that provides grants to SMEs to cover labour costs for R&D personnel (subsidy ratio of 40%). This programme should stimulate R&D activities in SMEs and thus increase their demand for R&D personnel, which will increase the mobility of graduates and researchers to SMEs.

- Building up **regional networks** among innovative SMEs, public research organisations and other relevant actors in a regional innovation system. These networks should focus on certain fields of technology and should stimulate and strengthen co-operation, foster the commercialisation of new research results, increase the critical mass in certain technologies, and promote the mutual exchange of knowledge. There are two large programmes (InnoRegio, Innovative Regional Growth Poles) that solely focus on East Germany and stimulate, among others, the exchange of personnel between public research and SMEs.

> *Researcher Mobility Promotion through ProInno*

The main characteristics of the programme are presented in Box 1. Support for temporary researcher mobility between public research and SMEs is only one out of three approaches in the ProInno programme that aims at encouraging SMEs to enter into R&D activities and to increase the use of external knowledge at R&D performing SMEs with respect to collaborative research. Less than 10% of the total programme volume is used for supporting personnel mobility.

The researcher mobility scheme funds the temporary leave of a researcher from a firm or a research organisation (both public and private) to an SME, or the leave of an SME's researcher to an other firm or research organisation. Mobility has to be associated to a certain R&D project; the time of absence that is being funded is between 3 and 24 months. The programme provides a share of the actual wage of the researcher that is moving temporary to or from an SME (40% in West Germany, 45-50% in East Germany). The funding shares correspond to European competitive law that allows up to 50 % of public

Table 9 > ***Programmes fostering Human Capital Mobility between Academia and Industry-Germany***

Name of Programme (responsible authorities)	Public Funding (million € 2001)	Main Approach	Type(s) of ISR Mainly Addressed
ProInno (BMWi) www.forschungskoop.de	~ 120, <10% for personnel mobility	Subsidies to SMEs for co-operative R&D projects with other enterprises or with HEI/PSRE, including personnel exchange	Joint R&D projects, Personnel Mobility
Innovation Assistant (various Länder programmes)	~ 10	Subsidies to SMEs for temporary employment of researchers	Personnel Mobility
R&D personnel promotion (New Länder only) (BMWi) www.aif-pfo.de	~ 30	Subsidies to SMEs for temporary employment of researchers	Personnel Mobility
InnoRegio (BMBF) www.innoregio.de	~ 40	Subsidies for establishing innovation networks in selected EastGerman regions	Informal Networks, Personnel Mobility
Innovative Regional Growth Poles (BMBF) www.wachstumskerne.de	~ 25	Subsidies for establishing innovation networks in selected East German regions	Informal Networks, Personnel Mobility

Source: Trendchart, Polt et al., 2001

funding for pre-competitive R&D at firms. Wages of researchers are by definition R&D costs, thus the level of funding for researcher mobility complies to EU regulation.

A special feature of the scheme is that it allows for **cross-border mobility** too. SMEs can employ researchers from abroad under the scheme for up to two years. SMEs have to pay a compensation to the researcher's institution abroad (typically the wage the researcher receives at his home institution), and they have to cover transit costs, accommodation in Germany, insurance and a daily allowance (but they need not pay the moving researcher a full wage at German standards). The employed researcher has to have a working contract with the delivering institution abroad for the time of exchange. The scheme provides either a 40 to 50% funding of the compensation paid to the researcher's institution abroad or a lump-sum 1,535 Euro per month. As the wage level especially in Eastern Europe for researcher is significantly lower than this figure, the lump-sum is likely to cover all costs associated with the personnel exchange.

There is no meaningful evaluation that would allow for a proper assessment of the efficiency and effectiveness of the mobility scheme within the ProInno programme. A recent, descriptive evaluation (Prognos 2002) showed that the personnel mobility scheme was only used by a small part of the firms participating in the ProInno programme and its predecessor, FoKo (about 6.5% of all surveyed participants). Furthermore, only a few data are available to the public concerning the activities in this scheme. So far, the following assessment on the working of the personnel mobility scheme within ProInno may be made:

- Only a small percentage of all SMEs participating in ProInno use the mobility scheme. Their share may be estimated to be lower than 10%. In total, the mobility of 510 researchers was funded in the time period June 1999 to July 2002.
- The majority of supported researcher mobility concerned international mobility. 301 out of 510 researchers came from abroad.
- Researchers from abroad come almost entirely from Eastern Europe, especially from Russia (were the wage level for researchers is very low and unemployment among them very high). This points to the fact that the lump-sum of 1,535 Euro per month is a high incentive for SMEs to hire cheap labour from Eastern Europe for their own research activities.
- Among those researchers coming from Germany, most of them work at universities and technical colleges.
- There is little evidence that temporary researcher exchange between SMEs and other firms takes place, nor that researchers from SMEs are sent to other institutions.
- There is no active promotion of the researcher mobility scheme by the programme management. There is also no proactive support by the programme management to help SME and the delivering institutions in setting up the co-operative agreement on which exchange is based.
- It seems that almost all applications for researcher exchange are granted.

Given the total number of R&D performing SMEs in Germany (~20,000), the total number of researchers at public research (~175,000 at FTE, of which nearly 100,000 are in natural sciences and engineering [NSE], see BMBF 2002) and an average annual mobility ratio of public sector researchers in NSE towards industry R&D of 2 to 4% (about half of them moving to SMEs, see Czarnitzki et al. 2000), one may estimate the number of NSE researchers in public research that move to SMEs each year to be between 1,000 and 2,000. Under the ProInno mobility scheme, about 70 of these researchers are supported. Thus, the contribution of the programme to the overall mobility between public sector researchers and SMEs in Germany is rather small.

There are several reasons for the little significance of the scheme:

- Making use of the scheme demands a significant administrative effort both on the side of the SME and the public research organisation (PRO), such as filling out an extensive form with 13 appendixes and a co-operation agreement.

- There are several barriers that hamper the temporal exchange of researchers between SMEs and PROs, such as bureaucratic procedures at the side of the PRO, little incentives for academic researchers to go for some time to an SME (it does not help them in their scientific career), and better earning options for PRO researchers that want to go to the business sector at large enterprises.
- There is little assistance by the programme management in tackling these barriers, despite the international mobility of researchers, which was promoted to SMEs as an instrument to overcome shortage in high-qualified labour that was rather high in the first half of the year 2000, at the top of the new economy hype.

> ***Innovation Assistant Programmes***

Many Federal States in Germany run mobility programmes for graduates and researchers that are most often called "Innovation Assistant". These programmes partially fund the employment of graduates or researchers by SMEs for a certain period of time, mostly between one and two years. The schemes typically fund up to 50% of wage costs of the employed graduate or researcher. An essential condition for funding is that graduates or researchers are working on R&D or innovation projects and that the employment of them increases the R&D and innovation orientation of the firm. Some more details on the various innovation assistant programmes at German Federal States are given in Table 10.

Box 1: ProInno
("*Förderung der Innovationskompetenz mittelständischer Unternehmen*" - Promotion of Innovation Competence in SMEs)

ProInno aims at encouraging SMEs to co-operate in innovation projects with other firms and with public and private research organisations. A main focus of ProInno is to support SMEs in their first step towards more systematic R&D activities and the linking into R&D and innovation networks. Therefore the programme especially addresses the barriers in SMEs without regular R&D activities and outside of networks, but with innovation orientation at least to a certain extent.

ProInno consists of three programme parts:
- "Entry Projects": SMEs with no R&D so far (or no R&D in the last five years) start an R&D project may receive state subsidies. Subsidies may be mainly used for covering R&D personnel expenditures. In addition, funding of marketing activities that build upon the R&D results, and costs of R&D contracts given to research organisations and other firms, may be covered, too. Funding is project-based and may not exceed a total amount of Euro 105.000 (East Germany: 135.000). The maximum level of funding is 35% of reimbursable costs (East Germany 40 to 45%).
- Co-operation Projects: Subsidies are provided for three types of R&D co-operation: (a) collaborative R&D projects between SMEs and SMEs, (b) collaborative R&D projects between SMEs and research organisations, (c) R&D projects by SMEs that include contract research to one or more research organisations. Financial support is restricted to SMEs that enter a new field of technology or that enlarge their competencies, and that will enlarge their co-operation experiences by carrying out the project to be funded. Subsidies are provided both for the SMEs (mainly for costs of R&D personnel) and for research organisations. The maximum level of funding for SMEs is 35% of reimbursable costs (East Germany 40 to 45%). Research organisations may receive a maximum of 45 to 70% (depending on the financing structure of the research organisation) of their R&D costs in collaborative project and 45% of their costs associated with a contract research project. Total funding per project may not exceed Euro 105.000 (for type (c): 120.000), in East Germany generally 135.000.
- Temporary Personnel Exchange: SMEs may receive state subsidies for exchanging R&D personnel in the course of a specific R&D project. Personnel exchange may take place either between an SME and other firms (regardless of size) or between an SME and research organisations. The SME that applies for financial support may receive

funding for either (a) sending its own R&D personnel to other institutions or (b) acquiring R&D personnel from other institutions. In case (b), the delivering institution may also be located abroad. The researchers that are being exchanged need not to hold a German citizenship. Financial support is restricted to SMEs that enter a new field of technology or that enlarge their competencies. Subsidies are provided for 3 to 24 months, covering 40% (East Germany 45 to 50%) of the actually paid gross payment at the delivering SME (case a) or the amount of money paid by the SME to the delivering institution (case b). If personnel exchange involves a delivering institution from abroad, the SME may also alternatively apply for a funding of Euro 1,535 per person and month. The researcher that is send to an SME must have a working contract with the delivering institution (case b) or the SME (case a). Personnel exchange must take place on the base of a co-operation agreement between the SME and the delivering or receiving institution.

Applications for subsidies may be sent at any time to the administrative agency, the *Arbeitsgemeinschaft industrieller Forschungsvereinigungen* (AiF). The AiF examines the application and recommends whether to give state subsidies or not. The final decision is made by the Federal Ministry of Economics and Technology (BMWi). There is no tender nor a competition among applications. Under the ProInno programme, one SME may receive subsidies for up to two different projects.

ProInno was introduced in June 1999. There was a predecessor programme (FoKo: "Forschungskooperation" - Research Co-operation) that started in 1993 and ended in 1998. It had a similar structure, but without the "entry projects" and with a less explicit focus on SMEs (i.e. SMEs included firms up to 500 employees, while in ProInno the SME definition is that of the EU competition law).

From the programme's start until December 2001, a total of 3,482 applications have been allowed, representing 2,050 R&D projects. The total allocated sum of state subsidies for these projects was Euro 317 Mio., the volume of associated R&D projects is about Euro 1 Bio. As projects may run over a period of several years, the annual amount of public money paid to SMEs or research organisations is Euro 180 Mio. only.

The allowed applications show the following distribution by type of project:

- Co-operation project SME - SME: 1,682
- Co-operation project SME - research organisation: 1,077
- R&D project by SME with contract research to research organisation: 200
- Entry project: 264
- Personnel Exchange: 259

A total of 2,650 SMEs received funding under ProInno until the end of 2001. The average size of a firm is 37 employees, the average share of R&D personnel among them is 16%, i.e. 6 persons. This means that the programme has a very strong focus on highly R&D intensive small firms.

There was an **evaluation** of the ProInno programme and its predecessor FoKo published in July 2002. It shows that the SMEs that received funding and answered a questionnaire feel that the programme is a good thing and that the R&D projects produced some positive effects for their firm. Those SMEs also report a high rate of growth in terms of employment, turnover and exports. As neither a control group nor a selection bias was considered, the evaluation results with respect to the performance of the subsidised firms are meaningless, however.

There is a complementary Programme to **ProInno**, called InnoNet (www.vdivde-it.de/innonet) Launched in autumn 1999, it facilitates co-operative R&D among a larger number of research organisations and firms. InnoNet backs pre-competition R&D projects involving at least four firms and two research organisations. The network has to focus on a certain field of technology. Support in this Programme is not restricted to SMEs. Grants are allowed on the base of a competition of proposals for networks. In the first competition (1999/2000), 280 project ideas participated and 18 projects have been selected by a jury for receiving public funding.

Table 10 > ***Innovation Assistant Schemes in Federal States in Germany***

Federal State	Level and duration of funding	Number of innovation assistants (IA) per firm	Conditions for financial support
Berlin	max. annual gross earning of 41.000 € per employee Duration: 12 months Up to 45% of the employee gross	Up to 2 IA at the same time and max. 2 IA per company. Young companies (< 5 years): up to 4 IA	Diploma may not be older than 24 months; just entered the job market, i.e. after diploma not employed in a company for longer than 12 months
Brandenburg	First year: 50%, max. 20.000 € Second year: 40%, max. 10.000 € Consulting / training benefits: 50%, max. 25.000 €	2 IA and each for 24 months. Companies in the early stage (60 months): financial support up to 4 IA (not more than 2 at the same time)	Products/processes which are developed by the IA must be compatible to environment and are expected to be competitive edges; IA must be employed for min. 24 months.
Bremen	Duration: 12 months 40%, at the most 12.000 € per IA	Up to 2 IA and each for 12 months	
Hesse	First year: 50%, max. 20.000 € Second year: 40%, max. 10.000 €	Max. 2 IA per company within three years. Researchers may not be employed for longer than 12 months.	Graduates may not be employed for longer than 12 months; IA must be employed for min. 12 months.
Mecklenburg-Vorpommern	SME: First year: 50% (women: 55%), max. 20.000 € Second year: 30%, max. 10.000 € Other companies: First year: 30% (women 35%) Science etc.: First year: 50% (women 55%)	No limitation. Only graduates.	Must be first employment after diploma; employment in the long run; adequate qualifications are required; the number of personnel must be increased
Lower Saxony	Full employment: 900 € monthly Duration: 12 months	Max. 4 IA at the same time Also scientists.	Multi-financial support requires unlimited employment; verification of employment (6-24 months) in a company is needed
North Rhine Westfalia	Duration: 12 months 50%, max. 12.783,30 € annually (women: 60%, max. 15.338,76 € annually)	1 IA per company. Also graduates whose diploma isn't older than three years and who didn't work more than one year in a company.	IA must be employed for min. 12 months; prevailing R&D activities
Rhineland-Palatine	960 € at a gross salary of 2.200 € to 2.600 € 1.130 € at a gross salary of 2.600 € to 3.000 € 1.310 € at a gross salary of more than 3.000€	In 24 months max. 1 IA Also researchers (new directives)	Required discipline may not be represented in the company yet; Duration: 24 months

Saarland	Allowance for up to 12 months, percentage of funding not known	Max. 2 IA in two years. Also researchers.	IA must be employed for min. 12 months; new knowledge for company
Saxony	Max. BAT-O months 1-6: up to 75% months 7-12: up to 60% months 13-18: up to 50% months 19-24: up to 40%	2IA at the same time for max. 24 months	IA must be employed for min. 12 months; new knowledge for company
Saxony-Anhalt	Duration: 12 months 40%, max. 12.000 €	Within 5 years 2 IA for 12 months.	Diploma may not be older than three years; IA must be employed for min. 12 months and must carry out R&D activities
Thuringia	Up to 50% of the annual gross salary First year: max. 20.000 € Second year: max. 10.000 €	No limitation. Also scientists.	Unlimited employment; IA must carry out R&D activities

The Federal States of Baden-Württemberg, Bavaria, Hamburg and Schleswig-Holstein do not run Innovation Assistant programmes
Source: ZEW

Innovation Assistant programmes are rather small in scale. Varying by Federal State, the amount of public spending for this type of scheme is does not exceed 2 Mio. Euro (Lower Saxony), the total annual sum of public money spent in all Innovation Assistant programmes is estimated to be about 10 Mio. Euro. The number of graduates and researchers involved does not exceed 200 per year and Federal State. In almost all programmes, funding concentrates on the employment of graduates rather than researchers.

Interestingly, some Federal States do not run such a programme. These are Baden-Württemberg and Bavaria. Hamburg has cancelled its innovation assistant programme after the introduction of ProInno in 1999, and Schleswig-Holstein recently discontinued its scheme. In Hesse, there is such a programme, but it is almost not used by the enterprises. The Government of Baden-Württemberg argued in December 2001, that such a programme is not necessary as graduates move to SMEs without public funding. In Hesse, the programme management reports that the application procedure is too complex, thus firms use programmes that directly support R&D activities, and they finance additional staff out of this money.

> *Research spin-offs*

Within all the different channels of ISR, spin-offs are today indeed a priority among the government's activities to promote ISR. A recent study showed that the level both of research spin-offs and academic start-ups from HEIs and PSREs is remarkable (see Egeln et al. 2002). Between 1996 and 2000, about 2,600 research spin-offs have been founded each year in knowledge and R&D intensive sectors alone. The total annual number of academic start-ups in these sectors (that represent about 25% of all start-ups in Germany) is 45,000. Annually, about 2,500 university professors and 7,800 other researchers at public research organisations are founders of a new enterprise. About 1.2% of all researchers in public research organisations leave their institution each year to participate in the founding of a new enterprise. This involves that about 15% of all leaving researchers start their own business. The number of research spin-offs as well as academic start-ups has risen in 1999 and 2000, along with a general increase in start-up activities in Germany in knowledge and R&D intensive sectors in these two years.

The study furthermore shows that the vast majority of research spin-offs is in the service sector, while only 10% are founded in R&D intensive manufacturing. HEIs show higher spin-off intensities than most PSREs. The most prominent barriers that research spin-offs had to deal with in the process of firm formation are lack in financial sources, lack in qualified personnel, and regulatory obstacles. Only a small fraction mentioned a lack in management capabilities or in market knowledge.

While the start-up activity from academia is high, there are many public initiatives to foster entrepreneurial thinking and activities at public research in Germany. The government applies different approaches to promote research spin-offs and academic start-ups:

- Improving the entrepreneurial climate at universities by raising the awareness for entrepreneurship and the propensity to establish one's own business. There are a number of measures on an institutional level, including the establishment of professorships for entrepreneurship and network approaches. The most significant programme is **EXIST**, funded by the Federal Government. Some German *Länder* Governments also run promotion programmes for academic start-ups, including direct grants to firm founders (e.g. North Rhine Westfalia, Baden-Württemberg).
- At PSREs, a new programme for the promotion of spin-offs started in 2001, called **EEF-Fonds** (Easening the Establishment of start-ups at Research organisations).
- Research spin-offs as well as all other technology-oriented start-ups may make use of public **venture capital programmes** such as BTU, tbg or FUTOUR (East Germany). There is a new Early Stage BTU-Programme that is especially relevant to research spin-offs.
- **Infrastructure provision** for start-ups and spin-offs (Technology and Incubator Centres) is another major public activity. Most of these centres have been established in the 1980s and early 1990s, and some of them are associated to universities. Incubators are often run by local authorities. Today, only a few new incubators are established anymore.

Table 11 > ***Programmes aimed to foster academic start-ups - Germany***

Name of Programme (responsible authorities)	**Public Funding (million € 1999)**	**Main Approach**
EXIST, EXIST-Transfer (BMBF), various Länder-programmes www.exist.de	~ 30	Networking and pre-seed financing for HEI-based start-ups in certain regions
EEF-Fonds (BMBF) www.eef-fonds.de	n.a.	Pre-seed financing for research spin-offs from PSREs through offering grants to PSREs in order to substitute researchers that prepare the start-ups of a spin-off
Venture Capital programmes: BTU, BTU-Early Stage, FUTOUR, tbg- and KfW-programmes for high tech start-ups (BMWI) www.tbgbonn.de	~ 500 to 1,000 (VC investment)	Equity investment (matching investment to a private lead investor), low-interest re-financing loans and guarantee schemes for investors, equity investment, and grants for VC for high-tech start-ups
BioChance, BioProfile/BioRegio (BMBF) www.bioregio.com	~ 15	Subsidies to research-based start-ups in biotechnology for carrying out R&D projects; infrastructure provision for and subsidies to start-ups in biotechnology in certain regions
Multimedia Start-up Competition (BMWi) www.gruenderwettbewerb.de	~ 1	Grants for start-ups in multimedia that introduce new products and services to the market, support is restricted to a few start-ups that are selected through a competition

Source: Trendchart, Polt et al., 2001

- There are some **technology specific programmes** to promote research spin-offs, e.g. in biotechnology (BioChance, BioRegio/BioProfile) and multimedia.

For all types of start-ups, the Federal and the Länder Governments offer grants and low-interest loans to individual founders. The most important Federal programmes are the DtA start-up schemes. These programmes are used by academic spin-offs as well, although they are not targeted on the specific needs of this type of start-up.

The **EXIST programme** may be viewed as the most interesting public promotion programme for start-ups by researchers from public research organisations in Germany (see Box 2). Its main focus is on providing a network of stimulation and support to potential entrepreneurs. Direct financial support is only a one, small element in the strategy to improve the entrepreneurial climate at universities. Major activities concern awareness initiatives, integrating entrepreneurship in curricula, and offering start-ups access to already existing supportive infrastructures and institutions. In the programme's first round, five regional networks (Dresden, Jena, Wuppertal, Stuttgart, Karlsruhe) have received funding. In the second round, called EXIST-Transfer, support for another 10 networks is provided. The EXIST programme partly served as a model for the Austrian AplusB programme.

Box 2: EXIST: Promotion Programme for University-based Start-ups

The German EXIST-programme is an example of a start-up promotion from universities using a regional network approach and supporting only a selected number of networks which serve as "best practice" examples. Through the identification of critical success factors, university start-up initiatives in other regions can use the supported projects as models. Furthermore, the "best practice" examples should stimulate competition among HEI in providing framework conditions conducive to start-ups.

The EXIST programme has four main objectives:
- to establish a culture of entrepreneurship in teaching, research and administration at HEI,
- to increase the knowledge spillover into economic value added
- to foster the transfer of business ideas and entrepreneurial potentials at HEI and PSRE into real business activities
- to increase the number of technology-based enterprises and innovative services, combined with the corresponding labour market effects.

The EXIST programme started in December 1997 with the launching of a competition. The aim of the competition was to find the best concepts for achieving the objectives mentioned above by building a network of relevant regional institutions (university, public research organisations, technology transfer, firms, public authorities etc.). To qualify participation, at least three different partners from a region had to work together, including at least one higher education institution. A total of 109 proposals for regional networks were brought to a jury which selected 12 most promising proposals. In many case of rejected proposals, the participation in the competition was enough to start the process of networking, improving framework conditions and drawing increased attention to new firm formation as a professional option for graduates. Thus, the programme affected university start-ups even in the pre-promotion stage and without spending any public money. This effect was proved by an analysis of 47 regions.

In a second round of competition, five proposals were awarded prizes as the best regions (Wuppertal, Karlsruhe, Stuttgart, Ilmenau-Jena, Dresden). These five regions started in December 1998 with the realisation of their network concepts. The approaches, starting conditions and main emphasis of the five regional networks differ widely and reflect the heterogeneity in public higher education and in regional economic structures. Each approach builds on the specific potential in the region and covers very different numbers of participating institutions (from 15 to 60). All networks have central contact agencies which give advice, help establishing contacts between network members and distribute information.

The EXIST programme gives financial support for different purposes: First, the network itself is sponsored by the EXIST funds. Second, scientific support and an on-going evaluation is financed within the programme. Third, country-wide publicity on activities and success within the five networks is a major mechanism for stimulating similar start-up initiatives in other regions. Forth, direct individual support to new firm founders is provided by the sub-programme EXIST-Seed.

EXIST-Seed provides support in the very early phase of new firm creation, i.e. the formulating of business ideas and the development of enterprise concepts. The target group are students, graduates and young academic staff, either individuals or teams up to three persons. Financial support is available for start-up activities in the phase before a full business plan has been developed, i.e. the focus is on encouraging the successful translation of a business idea into a business plan. Financial support covers the entrepreneurs' livelihood, the funding of consulting services, expenses incurred prior to the setting-up of a business and expenses for filing patents. A prerequisite is that the university provides a mentor and a workplace and guarantees that the entrepreneur may use the university's infrastructure. Furthermore, the entrepreneur must be assisted by the regional EXIST network. Funding may be granted for up to one year and up to 20,452 Euro per annum for students, and 38,347 for academic staff (including lump sum). After six months, the progress of the project is assessed by the mentor and the administrating agency of the Programme.

In 2000, a new sub-programme called EXIST-HighTEPP (High Technology Entrepreneurship Post Graduate Programme) started. It shall improve the entrepreneurial oriented education at HEI and aims at increasing the academic potential in the field of management of start-ups, and at offering high-quality education for managers of young, technology-oriented enterprises. The sub-programme runs at three universities (Jena, Bamberg, Regensburg) and focuses on biotechnology and information technology. A major approach is that both managers and natural scientists get experiences in the other fields, hence fostering interdisciplinary learning. The sub-programme also includes practice at companies.

Further supraregional measures are being developed by EXIST and will be open to other networks and regional initiatives, such as incentives for professors to support university-based start-ups, training for lecturers and consultants who give advice to start-up companies, setting up and testing model structures in industrial property rights and a "virtual academy for company founders" for the target group of new media. These measures are always centred on model projects (also outside the five EXIST-networks). The results and lessons learned by the model projects are made available country-wide.

The public funding for EXIST was about Euro 7.5 mill. per year in the first years (1998-1999). In 2000, funding was doubled to about Euro 15 mill. annually. The on-going evaluation of the EXIST programme shows that there is a strong demand for start-up related qualification and further education measures in each of the five regions. In some regions, new curricula were introduced especially dealing with new firm foundation. A network analysis in the five regions came to the result that in most regions new network connections among the participating actors and institutions had been built up. Until the end of 2001, more than 250 start-ups received support in the five EXIST regions. An especially high level of success is reported from the Karlsruhe region (KEIM) and Stuttgart region (PUSH).

In 2001, a new tender for regional start-up networks in university regions was called. It is named EXIST-Transfer and supports another 10 regional networks. These networks should build up on the experience of the five "best practice" models. In summer 2002, the 10 networks have been selected. They will together receive 10 Mio. Euro for the period 2002 to 2004.

Source: www.exist.de

The **EEF-Fonds** is another interesting example for stimulating research spin-offs. The programme was established in 2001 as a model project that uses experiences made in spin-off promotion in one large German research centre, the Research Centre Karlsruhe. First, PSREs may receive funding for labour costs of R&D personnel for one year in order to substitute a researcher who establishes a new business that commercialises new research findings. The founder remains formally committed to the research organisation. Second, funding is also available for external consulting, qualification, market analysis and patenting costs associated with starting-up the business. The EEF-Fonds may be used by the following research organisations: the Fraunhofer-Society, the Helmholtz-Association of German Research Centres, the Max-Planck-Society, and the Leibniz-Society.

Applications have to be submitted by the research institutes (via their technology transfer office) at which researchers who plan to establish a start-up are currently working. The application has to consist of a business plan. Researchers intending to establish a start-up are expected to contact the technology transfer office at their institute in order to compile all documents needed. Furthermore, there must be a declaration of support by the research organisations. Applications are evaluated by an expert group consisting of members of the four public sector research organisations addressed by the programme. The expert group accompanies the start-up and evaluates its success at a later stage.

Financial support is provided for (a) labour costs of researchers who establish their own business (3,400 Euro per month and researcher for up to 12 month). Teams of up to 3 persons may be supported. (b) costs for external consulting and qualification measures in favour of the entrepreneurial researchers are funded by up to 3,200 Euro as a lump-sum. (c) costs for market analysis, patenting & licensing, scientific analysis etc. may be covered up to 50% of total costs and up to a maximum amount of 15,400 Euro.

> 2.4. FINLAND

> *Human Capital Mobility*

Research personnel mobility from science to industry is comparably high in Finland, showing an overall increase during the 1990s. According to a survey in 1995, 3.4% of HE graduates who had worked at an HEI in 1994, moved to the business enterprise sector in 1995. At PSREs, the mobility ratio of HE graduates was 3.8%. However, only 14% of all HEI employees with a HE degree who moved away from a HEI occupation to an other sector, entered the business enterprise sector, while the vast majority moved inside the HEI sector or to other public services. At PSRE, 26% of all outwardly mobile HE graduates went into business enterprises. The level of personnel mobility is likely to be higher today, as 1994/95 was still a period of economic recession with a rather low demand for highly qualified labour in the labour market. During 1998, nearly one in four highly educated employee's changes jobs (compared to 17% in 1992). The mobility of educated research personnel was slightly higher, being clearly highest in the IT sector.

The high level of personal mobility between industry and science in Finland rests on three major elements: (1) long-term oriented and stable relations between enterprises or industrial sectors and universities in graduates mobility; (2) close co-operation in graduate education between universities and industry (e.g. joint supervision of doctoral and master's theses including placements); and (3) the existence of co-ordinating structures for considering industry needs and changes in industry demand, in university education programmes. Additionally, many doctoral and master's theses have been funded by industry in Finland. The mobility of researchers from science to industry and vice versa is mainly based on personal contacts (often as a result of joint research). While the level of mobility from public science to industry is high, mobility in the other direction is impeded by grave differences in salaries. In this field, national experts note the lack of effective pro-

Table 12 > ***Programmes fostering Human Capital Mobility between Academia and Industry-Finland***

Name of Programme (responsible authorities)	**Public Funding per Year (million €)**	**Main Approach**	**Type(s) of Interaction Mainly Addressed**
Cluster Programmes (several sectoral ministries, Tekes, SA)	~ 30	funding co-operative projects and networks of innovation actors in sectoral fields (research- producer-supplier-user chains)	networking, contract and collaborative research, mobility
Researcher Mobility Programmes (Tekes)	n.a., low	subsidies or tax relief to researchers moving abroad or coming from abroad	international researcher mobility
Centres of Expertise (Ministry of the Interior)	~ 20	building up regional networks in certain fields of technology involving enterprises, universities, municipalities and intermediaries	networking, start-ups, informal contacts, collaborative research, training & education
Research Training for Employed Persons	n.a.	compensation to enterprises in order to enable post-graduate training for researchers in business enterprises	training & education, mobility

Source: Trendchart, Polt et al., 2001

grammes for the promotion of two-way mobility. In HEIs, human capital planning and mechanisms on research mobility are currently under active development (alumni networks, recruiting offices, encouraging entrepreneurship etc.). International mobility of researchers is regarded as crucial for a small country like Finland.

Programmes for researcher mobility are rather rare in Finland. The Academy of Finland (SA) provides appropriations for the employment of post-doctoral researchers and for researcher training positions but this programme mainly focuses on universities and graduate schools. Tekes pays certain costs of researchers working abroad in R&D projects but also may bear costs of researchers who are coming to work in Finland in R&D projects. For several years, Finland has had a tax relief for top foreign experts moving to Finland, i.e. they are taxed at a fixed rat of 30%.

> *Research spin-offs*

Although no comprehensive data is available on technology-oriented start-ups by researchers from public science in Finland, the existing information indicates a rather high level of start-up activity. In the HEI sector, data from the National Centre of Expertise Programme suggests that there were about 70 high-tech spin-offs per year in the period 1995 to 1998, but it is not clear how many of them had been real university-based start-ups (i.e. creation of a new firm by a university employee, the firm activity being based on new research results or the knowledge and competence acquired through university research). If one assumes that at least every second start-up fulfils the criteria of a university spin-off, the start-up ratio per 1,000 researchers at HEI would be about 2 to 3.

A high level of start-up activity is also reported by Aaltonen (1998) who found that 11% of university researchers had been engaged in spin-off activities but engagement included, for example, giving advice to start-ups. VTT reports 5 to 7 start-ups by their R&D personnel per year, i.e. 2 start-ups per 1,000 researchers. As start-up activities in other PSREs are rare, the average start-up intensity in PSREs in Finland may be about 1.

The **TULI** programme has been modified before starting a new programme period in 2002. The main goal of the programme is to promote new, technology—based businesses coming from applied research in Finland. Tekes has hired the Finnish Science Park Association (TEKEL) to co-ordinate the

Table 13 > ***Programmes aimed to foster academic start-ups - Finland***

Name of Programme (responsible authorities)	Public Funding per Year (million €)	Duration (starting date)	Main Approach	Type(s) of Interaction Mainly Addressed
TULI (Tekes),	~ 1.65	1993-	promotion of start-ups from science by providing a supportive infrastructure which actively looks for spin-off ideas	start-ups

Source. Trendchart, Polt et al. 2001

programme. There is a full-time project manager hired for each regional project and independent consultants are used for developing the potential new business concepts identified in the project. Typically, local technology transfer companies propose a TULI project to Tekes for funding. The level of research activity in the region is the main criteria in the decision making process.

The Technical Research Centre of Finland (VTT) evaluated the scheme in 1996. The result of the evaluation was that the scheme has benefited from the exploitation of results from R&D projects. It has also been found beneficial from the entrepreneur candidate's point-of-view. The evaluation showed that some 400 ideas had been studied of which 100 were developed in some way and finally 13 new products were carried into manufacture.

> 2.5. UNITED KINGDOM

> *Human Capital Mobility*

There is no representative data on the mobility of researchers between industry and science in the UK. Based on expert assessments, it may be assumed that the mobility of researchers from HEIs to industry is rather high, given the significant wage difference and the absence of major legal barriers. This may be slightly different with respect to PSREs where a significant number of researchers are civil servants, and pension arrangements may hamper mobility. Mutual personnel mobility between industry and science is strongly encouraged by several public promotion programmes.

The **Teaching Company Scheme** (TCS) was founded in 1975 and has been regarded as one of the greatest successes of UK HEI-industry links. The TCS was initiated by the DTI and aims to develop active partnerships between HEIs and industry in the field of education. The scheme sets up partnerships between firms and HEIs through the formation of teaching company programmes. Firms take on graduates, known as TCS associates, to work full time on specific projects jointly supervised by the HEI and the company.

Projects are intended to be closely linked to the interests of the firm and should be aimed at achieving a substantial and comprehensive change in the firm, for example in management and production techniques. Partnerships are exclusively between HEIs and firms within the region as the associates must travel regularly between the two organisations. The scheme has five formal objectives, namely to:

- raise the level of industrial performance by effective use of academic resources;
- improve manufacturing and industrial methods by the effective use of advanced technology;
- trainable graduates for careers in industry;
- develop and retrain existing company and academic staff;
- provide academic staff with broad and direct experience of industry, to benefit research and enhance the relevance of teaching.

A typical programme lasts for two years. The graduates have a science and engineering background and are recruited jointly by the partners. The associates spend 90% of their

Table 14 > ***Programmes fostering Human Capital Mobility between Academia and Industry - UK***

Name of Programme	Public Funding (million € in 1999 or estimates)	Year of Intro-duction	Main Approach	Type(s) of Interaction Mainly Addressed
Faraday Partnerships	~ 6	1999	establishing intermediary infra-structure for technology transfer in certain fields of technology	collaborative research, start-ups, personnel mobility, training & education
Teaching Company Scheme (TCS)	~ 36	1975	subsidies to enterprises for employing highly qualified graduates on specific projects	personnel mobility
Science Enterprise Challenge	~ 13	1999	establishing "centres of enter-prise" at up to 8 universities	training & education, technology transfer
Higher Education Reach-Out to Business and the Community (HEROBAC)	~ 31	1998	funding for the establishment of centres of expertise in HEIs, ISR-oriented training for HEI staff, "one stop shops" for business partners.	contract research, networking, personnel mobility
Collaborative Awards in Science & Engineering (CASE)	n.a.	n.a.	grants to students for carrying out doctoral research addressing industrial problems and jointly supervised by HEIs and firms	training & education

Source:Trendchart, Polt et al., 2001

time working in the company on specific projects and are paid at industrial rates. The remaining 10% of their time is spent within the HEI undergoing training. Until 1981, the TCS was financed totally out of public funds, but since then firms have provided up to one-third of the cost of new programmes and at least 50% of the cost of renewed programmes. The programmes range in size from one associate over two years to 14 associates in a three-year programme, which is then renewed. A quinquennial review during 1996 found that 70% of associates are offered employment in participating companies at the completion of a TCS programme. Well over 2,000 TCS partnerships have been created since it was first established.

One example of the new TCS centres is that of Cardiff University, the University of Glamorgan and North East Wales Institute who are partners in the TCS centre in Wales (one of 40 programmes in the Principality). An SME participating in the scheme for the first time only needs to pay 30% of the direct costs (compared to a larger firm, which normally pays 60% of costs). Although it is still too early to provide an adequate assessment of TCS Centres, early evidence indicates that it has been successful in making HEIs more aware of the education and teaching needs of SMEs (Howells et al. 1998).

The **Co-operative Awards in Science and Engineering** (CASE) scheme is used to fund research students, who are jointly supervised by academics and external sponsors who may come from industry or from public sector bodies. The CASE scheme is largely financed by the UK Research Councils, with some industrial finance for the student and the academic department. The awards aim to encourage industrially relevant research projects by PhD students in HEIs. Standard awards are allocated to HEIs, typically by a quota allocation to a department.

In 1994, the CASE programme was extended to cover Industrial CASE. This extension was set up under a three-year trial period.

Table 15 > ***Programmes aimed to foster academic start-ups - UK***

Name of Programme	Public Funding (million € in 1999 or estimates)	Year of Intro-duction	Main Approach	Type(s) of Interaction Mainly Addressed
University Challenge Fund	~ 94	1999	support to universities or consortia of universities to set up local "seed" funds supporting early stage commercialisation	start-ups, IPR, prototypes

Source:Trendchart, Polt et al., 2001

Industrial CASE operates in exactly the same way as CASE, except that the Research Councils allocate the awards to industrial companies to support projects in HEIs, which they select. Thus with Industrial CASE, studentships are allocated directly to firms so that they can take the initiative in defining the research project and selecting the academic partner. Under a 1996 review of the pilot scheme, the Industrial CASE programme received strong support. Aside from the normal Industrial CASE mechanism, a small number of awards under a continuing pilot scheme are made available to SMEs through regional technology centres regional technology centres. This initiative also appears to have worked well and has extended the reach of the scheme to firms who would not normally have participated in CASE (Howells et al. 1998).

> *Research spin-offs*

The UK has a growing number of spin-off businesses that have been set up by universities to commercialise a particular research potential. In 1998, around half of the universities had set up wholly, or partially, owned companies, to exploit research results (Howells et al. 1998). A total of 223 such holding companies were identified. The majority of these firms are working in the biotechnology, life sciences and medicine, with engineering in second place. HEIs and, to a lesser extent, PSREs, have been closely linked with the emergence and development of science parks in the UK. Some of them are closely linked to universities and aim, amongst others things,

- to capture more satisfactorily, IPR leaking out of the university;
- attracting companies who may then become customers for the universities' research;
- and providing facilities for start-ups by graduates and former university staff (incubators).

However, there are also science parks with few or no ties with universities. The number of firms in UK science parks was 1,414 in 1997 and has increased since 1991 by 40%. Case studies suggest that about one in six of these firms are HEI start-ups. Some universities run research field specific incubators, such as the University of Manchester. At PSREs, spin-off activities seem to be lower, although some institutions, such as DERA, have recently proposed changes to contractual relationships with their employees to ease start-up activities by researchers.

> 2.6. NETHERLANDS

> *Researcher Mobility*

In the Netherlands' innovation policy personal mobility between academia and the business sector is rapidly becoming a high priority issue. Mobility of knowledge workers is an important part of technology transfer. The government has recognised this in the Science budget and the budget of the Ministry of Economic Affairs for 2003. One of the main problems in the Netherlands is a quantitative shortage of technically skilled personnel. Therefore actions are predominantly aimed at extending the supply of technical human resources. In the recent past the shortages of ICT-personnel have led to coordinated action of government, educational

Table 16 > ***Programmes fostering Human Capital Mobility between Academia and Industry - Netherlands***

Name of Programme (responsible authorities)	Public Funding (million € '99)	Duration	Main Approach	
KIM	5 mill. €	1994-2001	Wage-cost subsidy for SME which are hiring graduates ("knowledge carriers") for innovation projects	Graduates
Knowledge Transfer Entrepreneurs SMEs	6 mill. € (2001)	2001 -	Subsidy for the temporarily employment of a knowledge carrier	

Source: Trendchart

institutes and the employers' organisations. This goes in line with one of the success factors in the Dutch economy in the past, i.e. its ability and willingness to adopt new technologies or industrial processes.

The goal of the **KIM** schedule was to enlarge the innovative capacity of SMEs. Companies can be subsidised for hiring a recently graduated "knowledge carrier". The graduate implements a previously drafted innovation plan, directed at organisational-, market-, product- and/or process innovation. Knowledge carriers are graduates at Master level. By employing knowledge carriers, innovations should take place for which otherwise funding or time would not be available. Companies with a maximum of 100 employees can apply. They must hire the knowledge carrier for at least 32 hours on a weekly basis for a period of at least one year. A 'productive asset' of the KIM schedule was the help given to SMEs by the Syntens first line counsel organisation. Syntens is a government-funded organisation with 13 regional offices in the Netherlands, established to promote innovation in SMEs.

The KIM measure was replaced 2001 by the **Knowledge Transfer Entrepreneurs SMEs** aiming to stimulate SMEs in the adoption of technologies that already exist but are new to the company. Entrepreneurs can apply for a subsidy to have a strategy or feasibility study undertaken, or the employment of a knowledge carrier in order to elaborate innovation plans in the area of organisation, market, product and/or process. Knowledge carriers are persons with a diploma from technical college or who have completed a university, post-college or post-doctoral education. The knowledge carrier must be employed for at least 32 hours per week and for at least one year. The subsidy for the employment of a knowledge carrier is maximum 10.000 €.

> ***Research spin-offs***

In the Netherlands policy to promote academic spin-off used to have low priority, but there is now a growing importance for academic spin-offs within the topic of science-industry relations. The innovation policy of stimulating academic start-ups started in the fields of life sciences and ICT, but will now be lifted up to a general level.

The **BioPartner** programme aims to increase the number of start-ups in the area of Life Sciences. More generally, the policy objective is to achieve a structural improvement in the climate for new entrepreneurship in Life Sciences in the Netherlands in the long run. The scheme also tries to bring about a more favourable mindset towards entrepreneurship in universities.

The **Twinning Centers** programme was implemented to provide office space, managerial support and innovation finance to NTBFs in the ICT sector. Major concern was insufficient new start-ups, particularly university spin-offs, in the area of ICT. Support approach is combination of financial support (risk capital) and resources (management guidance, networking etc.).

The Ministry of Economic Affairs has established a subsidy scheme for techno-spin offs: the **Technostartersscheme** (Subsidieregeling Infrastructuur Technostarters) with a budget

Table 17 > ***Programmes aimed to foster academic start-ups - Netherlands***

Name of Programme (responsible authorities)	Public Funding (million € '99)	Main Approach	Type(s) of ISR Mainly Addressed
BioPartner	9 mill. € per year	Comprehensive Programme based upon 5 action lines: Networking, First Stage Grants, Incubator Centres, and Venture Fonds	Start ups in Life Sciences
Twinning Centers	9 – 13 per year	Two incubator centers for start ups offering infrastructure; financial and organisational support	Start ups in ICT
Subsidy Scheme Infrastructure Technostarters	41 mill. € (2002-2003)	Provision of infrastructure for technology based start-ups at PROs (first stage grants, incubators, advice, equipment, …)	Technology based start-ups

Source: Trendchart

for 2002/2003 of € 41 mill. This scheme is not restricted to a specific sector. The purpose is to improve the focus of universities and research institutes on the transfer of knowledge by encouraging them to offer a high level of infrastructure and support to technology-based start-ups. The scheme will grant subsidies for the development (or expansion) of facilities like first stage finance, coaching and advice for (potential) start-ups. Apart from these special schemes, mobility of knowledge workers and academic spin offs is also embedded in the subsidy schemes for innovation related research programmes: the Innovation Oriented research Programs (IOP's, yearly budget € 14,6 mill., currently 9 programs, ranging from Man Machine Interaction to Genomics) and the 4 Leading Technological Institutes, containing public-private partnership on scientific and technological research, with a yearly budget of € 20 mill.

Techno-start ups and Incubators are spearheads of Dutch innovation policy. The coming White Paper on Innovation (scheduled in the beginning of 2003) aims to integrate the diverse initiatives in this field. The Government is also aiming to intensify and integrate the policies on the shortages of highly skilled scientific and technical personnel.

CONCLUSIONS AND RECOMMENDATIONS

One of the main problems concerning ISR, which can hardly be addressed by market forces alone, is to bridge (not close) the cultural gap between the world of science and the business world. However, it should be stressed that there are different ways to establish such a bridge and none of the measures to foster industry-science relations (ISRs) should be used exclusive. The issue is about having the best portfolio of measures, which is highly context dependent. As a result 'good practice' is even more context dependent.

This leads directly to the advantages and limitations of the benchmarking approach: On the one hand, this approach facilitates learning from others. On the other hand, the changing role of public support of ISR-related measures is still based on a lot of uncertainties, which induced an ongoing policy debate in relation with public support. The two measures, which were examined in this report in more detail, are good examples in this respect.

Researcher mobility heavily depends on the regulatory framework at public research organisations and the resulting barriers and incentives. One typical of such a framework is the salary system and employment regulation at public research. National promotion programmes for researcher exchange and mobility address these barriers and incentives. Concerning the establishment of new firms there does not exist a commonly accepted definition of research spin-offs, which complicates discussions on policy addressing the issue of public support.

When transferring promotion schemes, one has to bear in mind that the level and direction of researcher mobility and start-up activities by researchers is strongly driven by the economic framework conditions, such as the dynamic in new technologies, size structure of the enterprise sector and economic growth.

> ***Mobility programmes***

As was already mentioned above, personnel mobility and interaction in graduate's education has received attention in some countries as being a major issue in ISR (*"Moving knowledge by moving people"*). There is a clear trend towards relaxing regulatory constraints on mobility, which should foster greater research interaction with industry. Examples include granting more autonomy to universities as in Austria or Finland or relaxing rules on collaboration between public research and enterprises. The way in which regulations are implemented in practice has a great impact on outcomes.

However, regulations are only one side of the equation. Interaction between researchers and industry depends heavily on incentives (see below). Most often the movement of research personnel tends to be a 'one-way street' due to differences in salaries. This can be seen as a kind of market mechanism which works for graduates as well as established and highly educated 'star-scientists'.

Many countries have gone further than deregulation and have launched programmes to address disincentives to human resource-based science-industry interaction. Most public exchange programmes specifically address two general goals:

- to stimulate the transfer of knowledge to SMEs that lack the technical and financial resources to attract skilled graduates; and
- joint graduates education programmes that involve enterprises in the definition of the theme of a thesis and allowing students and graduates to carry out practical R&D work at the enterprise. It is, however, not always easy to ensure a satisfactory match between the skills demanded and the qualification and research interest of graduates.

The exchange programmes for mobility thus cover a spectrum according to the main functional objectives: from industry training and temporary placements for students to the promotion of highly skilled established public researchers working with industry on specific research projects. While the support for the former often takes the from of reimbursement of labour costs, the support for the latter often takes the form of programmes which must be sufficiently funded in order to foster lasting relations between the producers and users of knowledge. Public mobility schemes – in order to have a noticeable effect on the level on mobility - should therefore not be restricted to one category of graduates (post-doc researchers) but should cover all kinds of mobility related transfer mechanisms. Moreover, most of the programmes compared are small in volume and coverage and their effect upon the overall pattern of personnel mobility between industry and science is minor. Hence, the effect of mobility schemes focusing only on post-docs in most countries has been more modest than expected. The low demand of such public support on the side of the industry can partly be ameliorated through awareness measures, i.e. eliminating information deficits and changing attitudes towards science, e.g. by learning from positive experiences other enterprises have already made.

Exchange programmes have to bear in mind incentives and disincentives for researchers to temporary moves to the business sector:

- R&D personnel exchange to SMEs is little attractive to researchers as research activities in the enterprises are only rarely related to academic research. Thus, researchers in general gain little in terms of scientific research when working at SMEs. As practical experience of R&D in firms is not acknowledged in academic career decisions (such as calls for university chairs), this type of investment is of no or little value to researchers that plan to return to academia. For young researchers that look for outside options, working in R&D at an SME may be an opportunity, although large firms will be more attractive as they offer more career options for young researchers. SMEs themselves may face difficulties when integrating a researcher who was socialised in an academic environment. Although the researcher might bring new approaches and methods to R&D in an SME, transaction costs in addition to the labour costs may be considerably high at the side of the SME, too. The situation may be different, however, when it comes to research-intensive SMEs in science-based industries. But even in research-intensive SMEs it is more a matter of changing regulation than of public support.
- R&D personnel exchange to large companies makes much more sense in terms of an academic career and for policy measures that aim at support for moving back and forth between the 'two worlds' of academia and business. The researcher is more likely to find an environment similar to academic research that allows her/him to continue research that is relevant to the scientific community, especially in science-based industries such as biotechnology. The large enterprises typically have sufficient capacities to efficiently integrate academic researchers in their R&D laboratories. Working experience in a corporate R&D lab is also much more acknowledged in the scientific community in those disciplines that work close together with industry. However, it is difficult to see why such type of mobility need public support as there are hardly any information asymmetries and there are no financial obstacles at the side of the large enterprise. There might be bureaucratic burdens of regulatory barriers at public research organisations for such type of temporary mobility which might be tackled simply by changing the respective regulations.

In the case of SMEs, the more promising approach to strengthen their R&D capacities and to foster co-operation with public research organisations is to support co-operation between SMEs and public research in the education of graduates, namely by joint supervising of Master and Doctoral Thesis. Such a scheme may be combined with an option to support the subsequent employment of the graduate in the SME.

> *Academic start-ups and Research spin-offs*

The rationale for the public support of spin-offs from universities or PSREs (Public Sector Research Establishments) is twofold:

- To increase the return on investment in public research by adopting research results within a new established firm and
- to increases the number of new technology based firms (NTBFs).

All governments are aware that improving the environment for entrepreneurship will help to foster the generation of spin-offs from public-based research. Nevertheless, policy makers need to decide whether more targeted promotional programmes are warranted. On the one hand, policy makers have to decide how much they want to invest in a mechanism that favours a specific type of firms rather than new-firm creation as a whole. On the other hand, the success in specific high-tech industries cannot wait for changes in the entrepreneurial climate, especially as these may take a long time. The balance between the two arguments is slightly different, e.g. some policy makers do not like the idea of concentration on academic spin-offs too much, because spin-offs are a very small sub-set of technology-based new firms.

One definition of academic start-ups is new firms founded by employees from public research institutions or by students or graduates from universities. Thus, the promotion of academic start-ups should be viewed in the context of the existing programmes to support any type of new business venture. In the case of well-established promotion programmes for start-ups, the German or Austrian approach (AplusB) to stimulate the entrepreneurial orientation of universities is meaningful. Researchers and graduates are stimulated to consider starting up a business as an opportunity and should be offered (or eased access to) supportive infrastructure. If they decide to enter an entrepreneurial career, they can use the variety of promotion measures that exists for all start-ups.

From a technology transfer perspective, research spin-offs are those that make a significant contribution to the transfer of new knowledge to commercial use. Hence, research spin-offs denote all those new enterprises that are founded in order to commercialise new research findings from public research. In some cases, there may be an equity investment in the spin-off by the research institution itself or are based on the licensing of patents from public research institutions. The promotion of research spin-offs has to take into account the specific challenges of this type of start-up. Here, offering of (secondary) public venture capital, equity investment by research institutions or the licensing of technologies to experienced companies with deep market knowledge are promising approaches. As research spin-offs are most often founded by former researchers from public research institutions they represent a certain type of personnel mobility from the public to the private sector. Supporting schemes have to address the different needs and phases of spin-off creation and development. Policy thus often exhibits a kind of 'integrated approach' coordinating the instruments available: awareness and entrepreneurship promotion actions, consultancy, mobility schemes, venture capital, physical infrastructures (e.g. in terms of office space or access to lab equipment), etc. Thus policy has to find a balanced mix of these interrelated tools.

> *Recommendations*

The learned policy maker will not use the results of this exercise as a toolbox to be applied mechanically to the perceived problems of ISR in his/her country. Rather, policy maker ought to use them as a guide for policy learning and as a means for the establishment of a shared vision among stakeholders, as the basis for future policy actions. The following conclusions and recommendations can be made from the benchmarking exercise:

- Promotion programmes for research mobility should be regarded as one step within an initiative to make intersectoral mobility between public research and the private enterprise sector more flexible.
- SMEs first of all demand well educated personnel. In times of shortage in high-qualified labour, SMEs often experience particular difficulties in acquiring personnel as graduates and researchers prefer working in larger organisations due to higher income levels, future income options and career opportunities. Therefore, SMEs may receive support for hiring graduates for which the implementation of the results of a research project should build the criteria of subsidy.

- Personnel based co-operation between SMEs and research organisations seems to be more effective when resting on graduates than on researchers as the latter have less incentives to move to R&D in SMEs.
- Academic start-up activity is strongly influenced by general entrepreneurial climate as well as incentives for leaving public research institutions. Public promotion of academic start-ups should be linked to existing well-established programmes offering a supportive infrastructure for researchers and graduates.
- Research spin-offs are often faced among other things with high risk, credit-rationing or lack of managerial know-how. Supporting schemes have to take into account either specific consulting measures are necessary or types of market failures exist in terms of financing.

MOBILITY PROGRAMMES AVAILABLE IN THE TREND CHART DATA BASE

In the Trend Chart the Policy Measure 'Mobility of students, research workers and teachers' is defined as follows:

This covers the mobility of students, research workers, engineers or scientists from one country or industrial sector to another, and from education or research to industry, which has the effect of encouraging the transfer of technology and dissemination of know-how.

The following Table 1 lists the programmes available in the Trend Chart database.

Table 18 > ***Mobility of students/researchers/teachers – available in the Trend Chart database***

Country	Title of measure	Web Site
BEL	KIV: KMO Innovation Vlaanderen ("SME Innovation Vlaanderen")	www.iwt.be
	FIRST doctorate enterprise	http://mrw.wallonie.be/dgtre/
	First - Europe	http://mrw.wallonie.be/dgtre/
GER	HSP III - Special Programme for Higher Education Institutions	www.bmbf.de
	Internationally Oriented Studies at Higher Education Institutions	www.bmbf.de
	Grants for R&D in SMEs in Eastern Germany	www.fhms.de
	EXIST - Start-ups from Science	www.exist.de
	ProInno	www.forschungskoop.de
	Green Card: Emergency programme to satisfy personnel demand in the IT sector	www.bundesregierung.de/ dokumente/Artikel/ix_9199.htm
	BioProfile / BioRegio	www.bioregio.com
	KfW-SME-Programme Employment and Qualification	www.kfw.de
	Institutional and Employment-related Reforms at Higher Education Institutions	www.bmbf.de/3992.html
	Direct Research Promotion - New Technologies	www.bmbf.de/618.html
	Facilitating Start-ups from Public Research Organisations (EEF-Fonds)	www.fzk.de www.bmbf.de
UK	CASE - Cooperative Awards in Science and Engineering	www.hefce.ac.uk/Research/ IndLink/research.htm
NDL	KIM Subsidieregeling Kennisdragers in het MKB - Knowledge Carriers in SMEs	www.minez.nl/subs

Source: Trendchart (http://trendchart.cordis.lu)

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VTO-STUDIES:

IWT-STUDIES:

Biography

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WHAT IS THE IWT?

The Institute for the promotion of innovation through science and technology in Flanders (IWT-Vlaanderen) is an autonomous public body, established by the Flemish government in 1991 to support industrial R&D in Flanders. For this IWT has various sources of finance through which financial assistance totalling euro 200 millions is provided annually.
It also provides services to Flemish companies in the area of technology transfer, partner search, preparation of projects under European programmes, etc.

Through these activities and others IWT is developing into a knowledge centre for R&D and innovation in Flanders.

WHAT IS THE IWT-OBSERVATORY?

The IWT-Observatory (Innovation - Science - Technology) is a division of IWT-Vlaanderen which focuses on policy support through policy indicators and policy studies. The IWT-Observatory organises technology surveys and collects indicators on the R&D and innovation activities of companies in Flanders.
The most important task of the IWT-Observatory, however, is the organisation of innovation studies, with support from external research groups, for the purpose of deepening knowledge of the Flemish innovation system, bench-marking against foreign (policy) experience, introduction of new insights from innovation theory, and providing access to data from specialised surveys and databases. Until the end of 1998 the IWT-Observatory was known as the Vlaams Technologie Observatorium (VTO).

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