Government initiatives to support the commercialization of research

- an international benchmarking study

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Summary In this report we present government initiatives and support schemes aimed at increasing commercialization from universities and other public research institutions. We compare international support schemes with the Norwegian Forny program and suggest improvements as to organization and measures. The study has benchmarked government initiatives aimed at increasing commercialization in six countries: Canada, Finland. Ireland, the Netherlands, Scotland and Sweden.	**Key words** Kommersialisering FoU Universitet Offentlig støtte **Keywords** Commercialization University spin offs Government support	
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PREFACE

This study was commissioned by the Research Council of Norway to improve their FORNY program. The study has benchmarked government initiatives aimed at increasing commercialization from public research institutions. Six countries have been investigated: Canada, Finland, Ireland, the Netherlands, Scotland, and Sweden.

We have seen it as our main task to provide insights and good ideas about how government programs can stimulate the commercialization of publicly funded research from universities and other public research organizations.

The study has been conducted by a joint research group with participants from the Bodø Graduate School of Business and the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway. The project has been administered by the Nordland Research Institute in Bodø and has been running from October 2005 to February 2006. The case studies in this report have been written by Einar Rasmussen (Canada and Finland), Odd Jarl Borch (Ireland and the Netherlands), Roger Sørheim (Scotland), and Are Gjellan (Sweden).

We would like to thank the staff at the FORNY program secretariat and Bjørn Brastad at Nordland Research Institute for their support during this project. Special thanks go to the interviewees for sharing their thoughts and insights with us, those who commented on the written country descriptions, and particularly to all of those who have helped us to plan and conduct relevant data collection in each country. Among them, the invaluable support from Henrik Tötterman in Finland and Denys Cooper in Canada is greatly acknowledged.

Bodø, Norway
February 2006

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SUMMARY

The interest in the commercialization of research from publicly funded research institutions has increased exponentially in recent years, and the number of government programs and initiatives has followed suit. This study benchmarks the Norwegian FORNY program with other government initiatives to promote the commercialization of research in Canada, Finland, Ireland, the Netherlands, Scotland, and Sweden. The rationale for implementing a new initiative is usually connected to fill a perceived gap in the innovation system. Government initiatives targeted at the commercialization of research is a rather new area in many of the countries, and it seems like type of government support depends on the maturity of the formal and informal infrastructure for commercialization.

Government programs can address commercialization by several means such as: promoting institutional change and build new infrastructure; providing basic infrastructure; promoting learning and development of new initiatives; and supporting specific commercialization projects in areas of market failure. Although, many of the programs in this study are not very clear on their objectives, we found several examples where thorough mappings and evaluations were conducted in order to improve the initiatives. New initiatives are often developed at the regional level or have to be adapted to the local setting in order to be effective. Hence, to experiment with new initiatives seems to be an important role for government programs.

How to get academics and universities more interested in the commercialization of research is a key issue among the agencies in all countries. Few government initiatives are directly targeted at changing the academic culture, but such initiatives are usually connected to the regional and institutional level. The technology transfer offices are seen as a key infrastructure for commercialization of research, and several programs address the lack of specialized competence in this field. An innovative infrastructure for commercialization of research is the Flintbox online platform for access to early stage academic research developed in Canada.

The largest share of resources in government programs are used to support specific commercialization projects, through for instance proof of concept funding. In the phase before investors or industrial partners become involved, the support is usually awarded as a grant to the specific project. Further, some programs provide coaching and training of academic entrepreneurs to make them more capable in commercializing their inventions.

In all countries there is a widespread recognition that a lack of seed capital finance has been a major obstacle in order to develop research-based ideas with growth potential. It seems like not only funding, but also the coordination of public and private funding is a challenge. Some government agencies take an active role in coordinating the seed capital market.

Although the technology transfer offices at university level constitute the major infrastructure for commercialization, it seems clear that highly specialized competence might need a national coordination in order to achieve critical mass.

Some output metrics such as number of patents, licenses, and spin-offs together with the revenue generated are commonly used, but there seems to be frequent dissatisfaction with these metrics. The simple quantitative metrics seems unable to fully capture the impact of the programs. Finally, we have not identified any initiatives in the investigated countries that award financial bonuses based on commercialization output.

Recommendations
Based on the findings in the six countries, we propose the following recommendations for further development of the Norwegian FORNY program:

1. The FORNY program may assess (map) the situation on a regular basis to identify the major gaps that need to be addressed

2. The FORNY program may stimulate increased experimentation with new initiatives

3. The FORNY program may actively encourage the research institutions to see commercialization of research as a strategic activity for the society and the institution

4. The FORNY program may support training of key personnel at the technology transfer offices

5. The FORNY program may support an initiative to use Flintbox as a tool for commercialization of Norwegian research

6. Funding from the FORNY program may be 100% grant based and not dilute ownership in any of the projects supported

7. The FORNY program may support training of researchers in the process of commercializing their inventions

8. The FORNY program may introduce initiatives to facilitate the links between the seed capital market and research-based commercialization projects

9. The FORNY program may promote the development of commercialization units with specialized competence within specific industry sectors

10. The FORNY program may widen the output metrics to better reflect their mission

11. The FORNY program may stop the use of bonus funds as incentive to the commercialization units

1. INTRODUCTION

This is an international benchmarking study of specific measures implemented by government agencies to increase the commercialization of research from publicly funded research institutions. Such measures can be seen as a part of a wider array of government measures to promote innovation in general, such as promoting industrial innovation, entrepreneurship, and innovation. Government efforts to promote innovation also include research policy, IPR policy, and industry policy among others. Government support is also part of a wider range of initiatives at multi-national, regional, and institutional level including a range of both private and public actors [1].

In order to learn from experience and provide examples of best practices, this report looks at how a number of countries and their agencies are working to facilitate the commercialization of research. The role of this project is not to identify gaps or make quantitatively valid assessments of which measures that would be most efficient to fill specific gaps. Rather, the project will provide a number of examples and an analysis of best practise related to different types of government initiatives to promote the commercialization of research. The focus of this study is rather limited; hence we do not take a position in the debate about whether a stronger focus on the commercialization of research will have a negative impact on academic research and the academic community's independent role as knowledge providers.

Our task has been to look at initiatives within the area where the Norwegian FORNY program is operating. This chapter gives a conceptual discussion, a brief account of the Norwegian FORNY program, and the methodology used for this study. Chapter 2 analyses the relevant initiatives found in each country. The findings are discussed in Chapter 3, before 11 recommendations for further development of the FORNY program is presented in Chapter 4. Finally, a comprehensive description of each country and relevant programs are presented in Appendix, Chapter 5 to 10.

1.1 CONCEPTUAL DISCUSSION

All the countries in this study have increased their effort to stimulate innovation during the last decade. Innovation policy has to a large degree overruled the role of the traditional industry and regional policy. The reason for this has been the

challenges that the established primary industries and manufacturing industries are facing due to globalization, and especially the competition in price from low-cost countries. The innovation policy has been strongly linked to increased university education and a strong emphasis on improving the links between academia and the business community. However, it should be noted that the role of academic research varies a lot between sectors. The entire biotechnology industry is built on academic research, while other sectors have limited direct partnership with research institutions.

The gap between research and commercial application has been very well articulated among people working to support commercialization of research and often referred to as the 'valley of death'. This gap can be closed from both sides. To provide a basis for the following discussion, the next sections outline a simplified model of the gap or the 'valley of death' concept and how it can be bridged.

1.1.1 Models for research commercialization support

Figure 1.1 presents a simplified illustration of the gap between academic research and commercial or industrial application of the results, often referred to as the 'valley of death'.

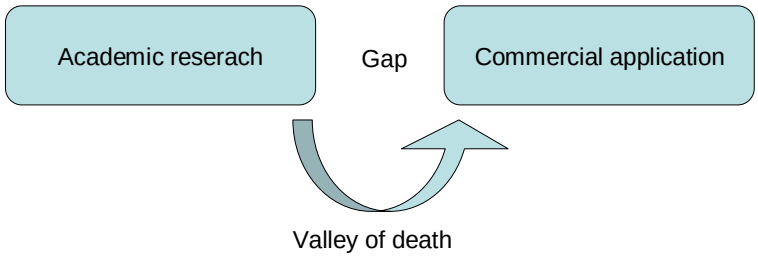

Figure 1.1: The gap between academic research and commercial application

Apparently this gap can be filled from both sides. It seems, however, that both the risks and costs associated with developing research projects towards commercial application is very high, and most actors prefer that other actors take the initial risks and costs. This section outlines four main principles for how to facilitate the transfer of technology from the academic setting to industrial use.

First, the role of academic research can be extended. In this way the university and the researchers takes an active role in developing the inventions and technologies

further in order to make them more interesting to commercial partners as illustrated in Figure 1.2.

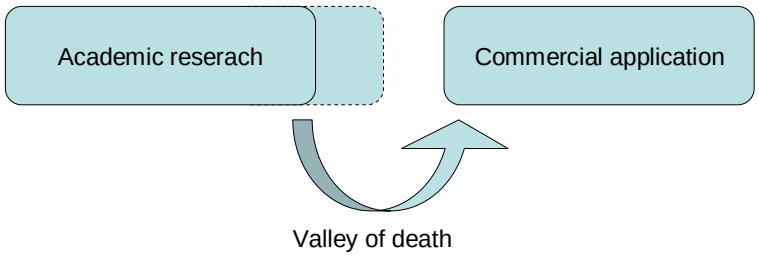

Figure 1.2: Extended university role

The ideas behind terms such as "academic entrepreneurship" and "entrepreneurial universities" are based on this conception of a more active role for universities in commercialization. Legislative changes such as the Bayh-Dole Act in the US in 1980, and the recent changes in Norway and Finland are also made to expand the university's area of operation into the so-called "third mission". Typical government programs aiming to expand academic research towards industry are related to attitudes, awareness, and training to create a culture and competence inside the universities to work with commercialization projects. Further, there are programs targeted at specific projects such as proof-of-concept grants and support of academic entrepreneurs financially through project support and through leave of absence grants. Also informal efforts to legitimize such activity internally in the university are important.

Second, the gap can be narrowed down from the other side by making it more attractive for industry, entrepreneurs, and investors to get involved in the development of early-stage research-based technology from research institutions as illustrated in Figure 1.3.

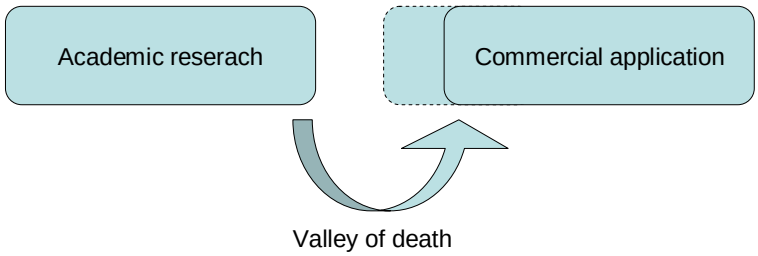

Figure 1.3: Facilitating industry and investor interest

This model often requires the existence of a well-developed industry or investment community. Some of the most prevailing ways for governments to induce interest from commercial partners is by financial incentives such as tax deductions and capital injection in privately managed seed- and venture-capital funds. Another type of support is through grants to commercialization projects requiring additional commitments from a private investor or industry partner.

Third, the gap can be mitigated by more contacts and closer cooperation between academics and prospective users of the technology, as illustrated in Figure 1.4.

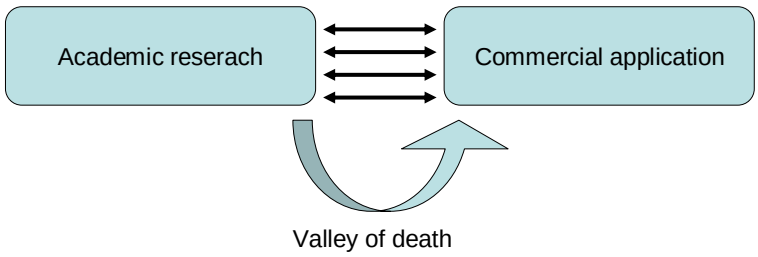

Figure 1.4: Networking and cooperation

Networking and cooperation is likely to enhance the understanding between the different cultures in academia and industry, to match researchers and their technologies with potential users, and to develop working relationships.

Fourth, the gap can be filled by inserting a broker to take care of research-based inventions and technologies and to help in the process of reaching a commercial market as illustrated in Figure 1.5. In its pure form, the broker model implies that the researchers are somewhat separated from the entrepreneurs or companies

commercializing the technology. This way of operation has become less prevalent as the cooperative nature of commercialization and the important role of inventor involvement has become increasingly recognized.

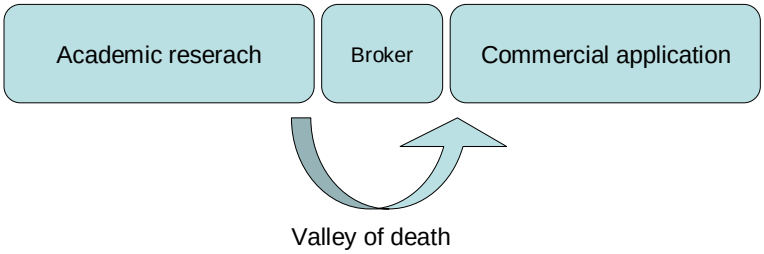

Figure 1.5: The intermediator model

The intermediator model is primarily found when actors outside or in the border area of universities handle the commercialization of an invention on behalf of the researcher. Examples of such operations are found at TTOs, science parks, and private licensing firms. Such organizations are often labeled boundary organizations and are mainly funded by public sources. The model is suited for inventions with a clear market potential where the researcher(s) do not want to be involved in the commercialization process.

A special type of intermediate organization is the industrial liaison and the technology transfer offices (ILO/TTO) set up at universities. The role of ILOs and TTOs is to facilitate contact between academic research and commercial users of research results. It seems, however, that an ILO can operate under two main principles; either as an intermediate organization (Figure 1.5) or as a part of activities at the university (Figure 1.2).

1.1.2 The role and rationale of government initiatives

As outlined above, there are several models for how the government can facilitate the commercialization of research. In practice, a combination of all these roles is necessary to bridge the gap. The public support system can be seen as an eco-system where the interaction between several programs and initiatives are more important than any single initiative. It is important that there is a continuous discussion of the types of roles that public funding initiatives can play in promoting commercialization of research, and the interplay between them. These areas may be divided in four.

Promote institutional change and build new infrastructure
First, initiatives can promote institutional changes with the long-term view to create structures and build competence which are more capable of commercializing research. This can be done by inducing changes in the culture and attitudes, by networking and training, and by establishing organizational structures such as TTOs. Such initiatives are seen as important in all countries in this study.

Provide basic infrastructure
Second, government support programs can provide permanent basic funding for maintaining a relevant infrastructure for technology transfer. Examples exist in all the countries where for instance the TTOs or comparable actors are dependent on some government funds to secure their basic operation. The aim of many government initiatives are, however, to make themselves redundant and not become a basic funding of infrastructure.

Promote learning and development of new initiatives
Third, the government can take a role as innovator by fuelling experimentation, launching new initiatives, and disseminate knowledge about best practice. Commercialization is an area of high complexity and uncertainty, and experimentation is necessary to find solutions to the specific challenges of specific contexts. Government programs can take the initial risk and cost and create new and better routines and arrangements for the commercialization of research. The lessons learned from such investments can benefit many actors.

Support projects in areas of market failure
Fourth, government initiatives can overcome market failure by stimulating the supply and demand side for research-based technologies (mitigate market failure). This is usually done by providing resources directly to specific projects. A critical issue when addressing market failure through project support is the decision about what projects to support. In early phases, such as proof-of-concept, the decisions are usually made by an evaluation committee. In later phases, programs tend to rely on private actors by requiring that private capital has been invested in order to be eligible for receiving public funds.

1.2 THE NORWEGIAN SETTING AND THE FORNY PROGRAM

Compared with the other Nordic countries, Norway has a low level of industry R&D expenditure. The low amount of R&D in industry and the lack of new value creating industries have been one of the basic arguments for a change in the government's innovation policy. The new innovation policy measures have, in particular, been channelled to technology development areas, new knowledge-

based entrepreneurship, and risk capital for new and fast growing ventures. It has been seen to be crucial to create competitive advantages through more knowledge-intensive products and participate in the growth of new industries.

A rather low R&D activity in the private sector in Norway is balanced by a high volume of public sector research through universities and research institutes, financed directly through the ministries or through the Research Council of Norway (RCN). The challenge has been to create a new entrepreneurial culture within these universities and to create innovation systems with a strong relation between the research environment and the industries. A white paper from the Ministry of Education and Research in 2002 (Ot. prp, nr 67 2001-2002) states that:

- commercialization is to be a third important goal for universities as an obligation to spread the results from research
- universities should encourage entrepreneurship
- universities should have a support system to facilitate the patenting and commercial exploitation of research findings

In 2003, Norway made a legislative change where researchers no longer hold title to their inventions. The universities now own the intellectual property rights (IPR), and technology transfer offices (TTOs) have been established in order to commercialize and manage the IPR.

The most important government agencies within innovation and industry development are the Research Council of Norway and Innovation Norway. The RCN finances both basic research and applied R&D and is the main funding partner for research activities at the universities, research institutes, and industry. A third important actor within the innovation arena is SIVA, an organization that is supporting a network of research parks and incubators to provide competence support and a milieu for entrepreneurs and other R&D intensive ventures.

1.2.1 Overview of the FORNY program

FORNY is a joint program between the Research Council of Norway and Innovation Norway. It was established as a program in 2000, but has existed as a project since 1995. The program is financed by the Ministry of Trade and Industry, the Ministry of Local Government and Regional Development, the Ministry of Education and Research, and from 2006 also the Ministry of Fisheries and Coastal Affairs and the Ministry of Agriculture and Food.

The goal of the FORNY program is to increase wealth creation in Norway by commercializing research-based business ideas with considerable market potential. Hence, FORNY is a strictly targeted program with explicit objectives. This makes it different from many of the other Norwegian business support schemes which have a broader set of objectives and less clear performance goals. The program is aimed at universities, research institutes, and university hospitals. The support is to be channelled towards knowledge-intensive ventures with a high profit potential.

In order to achieve its main objectives, the FORNY program will:

- Contribute to change attitudes and behaviour in the research institutions in order to make the search for commercialization opportunities an integrated and prioritized part of the research activity.
- Contribute to the establishment of professional organizations and systems for the commercialization of research at the research institutions.
- Contribute to make competent and relevant commercialization assistance available
- Contribute to research-based industry development across the country.
- Contribute to increased cooperation and learning among research institutions, entrepreneurs, investors, industry, and the government authorities.

Instead of targeting the researchers directly, the FORNY program works through the research institutions, the technology transfer offices of these institutions, and commercialization units such as innovation companies and science parks. The cooperating innovation companies called commercialization units have played an important role in the program. These are companies specialized in supporting entrepreneurs from research into business. Their assistance includes the evaluation of an idea and its commercialization prospects, implementation strategy with regard to IP, adding competence, providing commercial networks, and access to financing. Developing a founding team of entrepreneurs and support in working out business plans are also important tasks. The commercialization units are awarded commercialization funds and are free to decide what projects to support.

FORNY generally provides 50% of the total funding for each project. The commercialization unit has to provide the rest, often negotiating by a pay-back from the new company after commercialization. The FORNY program provided financial support to 48 institutions in 2005, including 15 commercialization units, 7 universities/academic colleges, 18 R&D institutes, 5 university hospitals, and 13 technical colleges.

In addition with the close ties to the delegated research institutions and commercialization units, the FORNY program has close coordination with other government agencies. In particular Innovation Norway which takes over where the FORNY program completes its task, i.e. after the commercialization process is over and the venture is entering the growth phase. Also, these ventures can apply for support from the SkatteFUNN; the R&D tax deduction scheme in RCN.

1.2.2 Description of specific initiatives

The FORNY program has several initiatives aimed to increase the commercialization of research from Norwegian R&D institutions.

Idea generation and development of infrastructure

The research institutions (universities, university colleges, and research institutes) can apply for infrastructure funds in order to include commercialization as a part of their strategies, to increase the awareness and knowledge about patenting and commercialization, and to simulate the search for commercialization possibilities in the research activity. The FORNY funding can cover up to 50% of the total costs. The FORNY program can also support the establishment of TTOs at the universities, cooperation between TTOs and other commercialization units, alignment of policies and rules at research institutions, and part-funding of patenting costs.

Commercialization funds

The commercialization units and IPR owners are awarded commercialization funds as a lump-sum grant. These funds can be used locally to cover up to 50% of the costs of specific commercialization projects up to licensing or firm establishment. The FORNY funds can not be used for product development.

Proof of concept funds

From 2002, the MEDKAP program for industry development from medical research was included in the FORNY program. These funds are now available as proof of concept funds through the FORNY program but are now also available for other advanced technologies. NOK 30 million are available for 2006.

Leave of absence grant

From 2006, FORNY can support researchers who are working on commercializing an idea through the leave of absence grant. This grant covers the cost of the employer for making 20-100% of a researcher's position available to work on a commercialization project. NOK 8 million are available in 2006.

Incentive funds
Incentive funds (bonus) are awarded to the commercialization units on an annual basis depending on the performance measured on a number of criteria.

1.2.3 Resources and performance

The FORNY programs budget has increased over time. The annual grants during the period 1995-1999 were € 3.8 million rising to € 11.3 million during 2003-2005 to € 15 million in 2006. In total, during the ten year period 1995-2004 the program received € 61 million (NOK 490 million). The commercialization units have during the last years received about 1/3 of the total sum. During the period 1995-2004 the FORNY program has been involved in 125 licenses and 231 new firms. 160 of these businesses delivered annual accounts to the register authority in 2004.

In the established firms, this has generated a net value creation during the period 1995-2004 of € 40 million (salary + company profit). The total income in 2004 from all the present firms is about € 60 million; 40% of the total income is generated by one ICT firm; Opera Software ASA. Most of the firms are small, with only a few high-growth companies. One-third of the companies had a turnover of more than € 125 000. The total number of employees in the 160 companies was 524 in 2004, making an average of 3 jobs per firm. 33% of the companies have no employees. One-third of the companies were within the ICT sector and 15% within medicine/technology and biotechnology.

The more qualitative benefits of the FORNY program has been regarded as quick and non-bureaucratic decision-making through the commercialization units [2]. One challenge is to have enough research money to bring the research results through the verification stage. Other challenges are to contribute to the development of the broader innovation system, achieve closer links to investors financing the next phases of venture development, and improve market adaptation to achieve a stronger market pull effect to balance the technology push dominance within the projects. Too many of the ventures remains in the commercialization units too long, not finding the investors and industrial partners that may help them to develop the project further.

1.3 METHODOLOGY

The empirical data used in this study covers government programs in six countries: Canada, Finland, Ireland, the Netherlands, Scotland, and Sweden. All these countries have a well developed university sector where the major source of funding for university research is basic funding and grants from the government.

Information was obtained from a literature review and interviews with well-informed people in each country. A large number of policy reports in the form of statistical information, benchmarking studies, case studies, and program evaluations provided extensive background information about innovation policy and government programs in each country. Further, we obtained updated brochures, descriptions, and criteria about the specific programs. Finally, we conducted semi-structured interviews with well-informed people in each country such as policy makers, program managers, policy researchers, university administrators, and program users. Four of the countries were visited by two researchers; Canada, Finland, Ireland, and Scotland. In total we interviewed about 90 people in 70 face-to-face and 20 telephone interviews. The case description about each country has been verified by key people in the respective countries. The data have been analyzed by the research team in cooperation with practitioners.

2. COUNTRY ANALYSIS

The countries to be studied in this project were selected to have some comparable characteristics with Norway. In particular we have tried to find countries with similarities in population size, economy, educational system, geography, living standards and industry structure. In addition, some of the countries have some specific characteristics comparable to Norway such as; long distances and need for good infrastructure (especially Canada, but also Finland, Sweden and partially Scotland), a business sector consisting of mainly SMEs. Table 2.1 summarizes some key facts about the countries in this study.

	Norway	**Canada**	**Finland**	**Ireland**	**The Netherlands**	**Scotland**	**Sweden**
Population (mill)	4.6	32.8	5.2	4.0	16.4	5.1	9.0
Area (thousand sq km)	324	9093	338	70	41	79	450
GDP per capita (thousand USD)	42	33	30	34	30	31 (UK)	30
Unemployment rate	4.2%	6.8%	7.9%	4.2%	6.7%	5.4%	6%
Currency rate (approximate)	1 € = 8 NOK	1 € = 1.6 CAD	€	€	€	1 € = 0.7£	1 € = 11 SEK
GERD/GDP[1] 2002	1.67	1.96	3.44	1.12	1.80	1.87 (UK)	3.98 (2003)
Percentage of GERD funded by government	39.8	29.8	25.5	25.5	35.8	29.1 (UK)	21.0
University IP ownership	Yes, from 2003	Varies between universities	From 2006[2]	Yes	Yes	Yes	No

Table 2.1: Country information.

[1] Gross Expenditure on Research and Development in percentage of Gross Domestic Product
[2] Researchers still own the IP from pure basic research

It should be noted that none of the countries studied have a set of initiatives fully comparable to the FORNY program. As described in the country presentations (Chapter 5-10), the innovation support is often directed towards university - industry collaboration, while relatively few measures are available for research-based ideas without an industrial partner. Hence, the FORNY program appear as fairly well developed compared to the initiatives in the other countries. An exception is Canada, which clearly stands out as the country having the broadest set of initiatives to promote the commercialization of research. Still, there is a lot to learn from single initiatives in all the countries in this study. The next sections summarize the main findings related to the FORNY operation from the six countries. A comprehensive case description of each country is found in Appendix, Chapter 5-10.

2.1 CANADA

The first striking observation when looking at the Canada case is the overwhelming number of initiatives for commercialization of research. This makes fruitful ground for investigating such initiatives. A better coordination of the initiatives is sometimes called for, but it might be that several initiatives at several levels are more flexible and able to identify and fill gaps faster and more efficient than large centralized units would. A complex structure makes marketing of the initiatives important. At the universities, however, the ILOs and TTOs play a central role as coordinators of the different funding sources. The debate in many countries has emphasized IP ownership as a key to succeed with university technology transfer. The Canadian universities have different approaches to IP ownership, but the quantitative results from their commercialization activities seems not to be affected by IP policy (see Box 5.1).

The limited ability of the traditional quantitative measures to grasp the outcome of commercialization activity is increasingly recognized. Hence, alternatives such as case studies are used in combination with more structured evaluation approaches such as RMAF (See Box 5.5). In the next sections the Canadian experience is related to the FORNY initiatives.

2.1.1 Infrastructure

In total, the Canadian efforts to commercialize research have passed the pioneering period and have developed into a more operational phase where these activities are generally seen as an important part of research and innovation activity. As the commercialization and technology transfer infrastructure in Canada has matured, both government programs and university ILOs takes a broader view on

technology transfer than just patenting and licensing. For government agencies, the benefit for Canada and Canadians are central, while the universities increasingly view technology transfer as a strategic part of their activity.

Although many of the larger Canadian universities have a well established ILO or TTO infrastructure, this is not the case at many of the smaller universities and colleges. The NSERC College and Community Innovation Pilot Program aims to include colleges in innovation work, but this program have a wider mission than promoting commercialization of research. There are also plans to expand the Idea to Innovation program to include faculty at Colleges in the future. These initiatives are comparable to FORNYs efforts towards university colleges in Norway.

Further, there seems to be a general agreement in Canada that there is a lack of competent people in the research institutions to handle commercialization projects. Hence, the Intellectual Property Mobilization Program has focused their funds more towards training initiatives in recent years. Also within the health research, there are several initiatives to fund training of TTO personnel and managers of commercialization projects. Another trend in several of the Canadian programs is that they fund networking between institutions or even require that a consortium is made to be eligible for receiving funds.

The diversity of approaches and a willingness among some of the public actors to experiment with new initiatives also give rise to some truly innovative instruments. The Flintbox tool makes it possible to streamline and expand technology transfer to a wider audience, with increased possibilities for research to make social impact and commercial success (see Box 5.3).

2.1.2 Project support

It seems like a large share of the project related work funded through the FORNYs commercialization funds are taken care of at the TTO level in Canada. For specific support, both the proof of principle programs described in the case descriptions consists of two phases, where the second phase are intended to support the commercialization project either as a spin-off or in cooperation with an industry partner. When as spin-off is established or an industrial partner involved, there are a number of more general schemes to support technology development and entrepreneurship in Canada. The most important here is IRAP in combination with tax deduction schemes. Support for entrepreneurship is generally handled at province level.

In Canada there are specific initiatives to develop research of uncertain value to be of interest to investors and companies both within health (CIHR POP) and within science and engineering (NSERC I2I). Both programs are comparable to FORNYs proof of principle scheme.

2.2 FINLAND

There is a large number of policy measures for innovation in Finland, but only a few rather young initiatives are targeted at commercialization or technology transfer in the stage before an industrial partner are involved. Traditionally, initiatives for commercialization seem to have been directed at technological development involving collaboration with an industrial partner. Tekes have had a strong collaboration approach in their funding schemes which usually forces top-down university - industry collaboration. Hence, few schemes have been open to research findings before an industrial partner was involved or in the pre-start-up phase. The TULI program is the first initiative designed to project where the cooperation with industry is not established or has failed.

Another feature of the Finnish innovation support system is the apparent competition between the national level innovation organizations (sometimes labeled as the 6-pack). It seems like the different organizations strategically adapt to current policies in order to secure their own position among the public organizations. This might explain that both Finpro and Tekes have a network of international offices. Another example is the recent extension of public seed capital where Tekes, FII, Sitra, and Finnvera all established early stage funding schemes nearly at the same time. It is also interesting to observe that the idea development phase in research organizations is supported by actors such as Tekes (TULI and Venture Cup) FFI (Innovation Managers), Sitra (INTRO and LIKSA), and recently the Academy of Finland have had pilot programs to increase the commercial awareness among university researchers. In addition, some programs are managed by the Science Parks, the universities' own innovation services, and internal efforts such as VTT Venture. Although it is claimed that one of the strengths of the Finnish system is the close networking between the different actors, the complicated system with many actors easily confuses the users of the different initiatives. According to our informants, even innovation support professionals are not always familiar with all available instruments. Hence, it might be difficult for an inventor to find all relevant sources, and would in the worst case lead to a lot of work for small funds.

Evaluations are taken rather serious in Finland, and all organizations are evaluated periodically. The Impact Analysis division at Tekes is considered as an important

operation. Unfortunately, many evaluations of Finnish initiatives are published in Finnish. A large number of international benchmark studies are, however, available in English, for instance through the Tekes Technology Review series. In the next sections the Finnish experience is related to the FORNY initiatives.

2.2.1 Infrastructure

A clear pattern is that both the competence and the culture for commercialization of research at the Finnish universities are not very strong. The collaboration with companies has worked well, but little is invested in competence on licensing and creating spin-offs. To build an infrastructure at Finnish universities has not been prioritized until recently and still the efforts are modest and not very well coordinated. The Ministry of Trade and Industry is responsible for commercialization, but they have no direct influence on the universities. In promoting the commercialisation of academic research, increased coherence and networking between the relevant organisations (Tekes, Sitra, and the Academy of Finland) has been identified as an area for further development [3].

According to our interviewees there is, however, a shift towards a more proactive attitude among university managers to increase commercialization of research. The attitude is increasingly getting more positive among university faculty, but still many professors are reluctant to mix business and academic activities. According to one informant it is not easy for scientists to spend much time on commercialization projects. Although the third mission has not had a strong impact on university life, the VTT researchers have a strong connection to industry. Hence, the results of the new VTT Venture initiative would be interesting to follow.

We have identified two national initiatives in early phase of idea development, the FFI Innovation managers and Venture Cup. These programs are locally operated, but have a network at national level. This structure seems to work well, and it is considered as important to build credibility at the local level.

2.2.2 Project support

We have identified one initiative in early phase of idea development, the TULI program. Along with the FFI Innovation managers and Venture Cup, TULI are also locally operated, but have a network at national level. The TULI program is generally perceived a quite successful and it seems that TULI has got a high awareness given the modest funding involved. Although, there are few programs from the university side, there seems to be ample funds available for further business development after a spin-off firm has been established.

We were not able to identify any proof of principle scheme in Finland that was directly comparable to FORNYs scheme. It seems, however, that there are several programs available for further research and development work in the case where an industrial partner is involved or after a spin-off has been established.

2.3 IRELAND

Ireland has been a success story as to macro economic policy planning, especially succeeding in achieving considerable foreign direct investments from the multinational companies, among others within the ICT sector (for example Microsoft and Dell). To follow up this success, the next step has been to develop their strongholds within specific industries through intensive R&D efforts. During the last six years there have been increased efforts towards technology oriented R&D, with a five time raise in research funding over a six year period up to 2006. The new policy is very much based on cluster thinking especially within ICT and biotechnology. This emphasis has consequences for the organization and the tools implemented at the university level, with increased emphasis on high potential research areas. Enterprise Ireland (EI) plays a central role, controlling most of the relevant support schemes for commercialization and high-tech firm development, also including seed funds.

Enterprise Ireland is active at university level, supervising the commercialization process and providing coordinative links between universities and industry. Through the specialized Client teams, Enterprise Ireland has representatives at the universities to facilitate spin-offs and patents commercialization, contributing with their industry networks and specialized science and industry competence (see Box 7.1).

The strong coordination efforts are followed up at university level. The integrated Research and Innovation Centres are both coordinating R&D applications, applications for commercialization, and supporting technology transfer. Within the larger universities, they represent a central part of the university structure, with funding from the university, a faculty committee, and a dean or vice-president for innovation and R&D. These offices have their own national meetings and a broad network, contributing both to their own university policy and to policy development at national level.

2.3.1 Infrastructure

The main responsibility for the infrastructure is placed at the universities and the TTOs and innovation centers. At national level, however, Ireland has through the EI Enterprise Platform Program a support scheme for education of spin-off entrepreneurs in the later phase of commercialization.

Efforts towards building an entrepreneurial culture is a regular task for the TTOs. These offices are paid by the universities, but are facing capacity problems and are looking for ways to fund more personnel. The TTOs are giving lectures and arranging seminars at department level. Also, they are providing entrepreneurship education programs for potential entrepreneurs. The TTO and Innovation services are an integrated part of the university structure, and some of them have their own board were department heads are members. The FORNY program may emphasize decentralization of TTO information and support efforts at university department and institute level in their infrastructure support.

An important infrastructure scheme is the EI personnel specialized in a specific industry cluster. Additional capacity at TTO level is available through the specialized EI Client Teams. These are partly working within EI, and are part of the time located at a specific university. They are supporting the project throughout the commercialization process. They provide links to support schemes in the EI. FORNY may learn from the national client teams of Ireland providing specialized competence at national level, a platform for cooperative efforts between universities, and networking between the national level, the commercialization unit level, and towards the industry. FORNY may look at the role of the university in financing the TTOs, and make the TTOs independent from income from the commercialization projects.

2.3.2 Project support

The project support within the Commercialization Fund of EI has a quite similar level of support as the FORNY commercialization funds. In Ireland, it is divided in three parts. The first one is what they call “Proof of concept”, an early phase project funding, providing support up to € 90 000 for 1-1 ½ year, The second phase is the Technology development phase up to € 350 000, and finally the Business Development Phase paying 50% of the costs up to € 38 000. The difference lies in the administration of the support, where Enterprise Ireland follows the projects and evaluates them at different phases with a new application round for every phase. The CORD grant adds to the project funding, and provides support for projects in the firm foundation phase. There is also an additional fund for promising projects with additional € 50 000. Thus, the EI program has some

flexibility built in as to additional funding. For the projects reaching this stage, the Enterprise Ireland staff will have considerable knowledge about the potential of the project.

The scholarship program is linked to the commercialization efforts and is combined with the Entrepreneurship education program with a salary amounting to € 6600 over one year. This support may be combined with the CORD+ arrangement where the most promising projects received additional funding to be able to develop their idea further before commercialization. The most promising researchers or other project managers are here followed up with competence and network support in the final phase towards commercialization.

2.4 THE NETHERLANDS

The quality of scientific research in the Netherlands is of high international standard. What has been seen as problematic is the weak interaction between the knowledge infrastructure and the private business sector. Compared with Norway, the Netherlands has been late in implementing programs for commercialization of research at national level. During the last five years, however, a new innovation policy has been planned and implemented, and new financial tools are launched from the Ministry of Economic Affairs and Ministry of Education, Culture and Science.

The Dutch innovation system includes a relatively fragmented national innovation support program, with ten major instruments, all under the Ministry of Economic Affairs. There are a large number of executive agencies and other organizations such as the Netherlands Organisation for Scientific Research (NWO) and private companies which deliver the programs on national level. The argument for this is that a portfolio of organizational forms creates flexibility in choosing delivery organizations for different types of support programs.

The largest commercialization program is administered through a new organization called Technopartner aiming to improve the high-tech start-up climate. Another program is provided by the STW Technology Foundation. The Netherlands also has an organization for innovation similar to Innovation Norway, SenterNovem, but did not choose to involve them in the organization of this type of tools.

When it comes to implementation at university level, we find an interesting organizational feature within the Technopartner program. The SKE Knowledge Exploitation subsidy arrangement (see Box 8.1) is implemented by regional consortiums consisting of at least one university or research institute and private

interests. Based on a five year development plan, they achieve funding for a broad set of activities.

2.4.1 Infrastructure

The largest technological universities have high ambitions to serve as entrepreneurial universities. They have well developed entrepreneurship training programs, incubator facilities for new firms, and also strong links to R&D-intensive companies. However, we find limited efforts towards changing the culture of the universities as to commercialization and spin-offs. As a response to the critique of the system, the universities and larger research institutes are now strengthening their technology transfer functions, developing decentralized TTO officers at each department or institute. This may increase the direct links between the researchers and the supporting staff. Also, within the Technopartner consortiums, there are tools for screening and scouting for researchers with a research idea with commercial potential. These functions may strengthen the focus towards commercialization among university faculty, and provide direct links towards industry partners or funding institutions.

2.4.2 Project support

The small business innovation research program (SBIR) is available to researchers at universities that want to create a spin-off from a research institution. The grant can be used for product-market analysis, for development of a prototype, for development of personal skills, and for protection of intellectual property. The budget of the Technology Foundation STW has increased over the years. At present the budget is € 43 million per year.

2.5 SCOTLAND

The basic rationale related to governmental support of commercialization of research from Scottish universities and research institutes is related to the fact that Scotland has a strong science base while their industry base is less developed. There is a belief that it is possible to strengthen the industry base by stimulating the commercialization of research from Scottish universities. There is a dedicated focus in supporting the industrialization of research within life science, energy, and tech-media. There are basically two organizations that provide funding and support to commercialization of ideas from the main universities; namely Scottish Executive and Scottish Enterprise. The Scottish Executive has a dual role by taking a lead role in policy formulation and development, and at the same time administering a number of schemes designed to enhance innovation in Scottish

businesses. Scottish Enterprise is the main economic development agency for Scotland, funded by Scottish Executive. One of Scottish Enterprise's main priorities is the commercialization of academic ideas into good business opportunities.

2.5.1 Infrastructure

In Scotland there is a strong recognition that stimulating entrepreneurship within universities and research institutions is very different from stimulating entrepreneurship in general. These projects and entrepreneurs nurtured through separate programmes in order to generate future high-growth companies.

Both top-down and bottom-up approaches are used in order to form a more streamlined pipeline for commercialization projects from research institutions. However, Harrison and Don [4] points out that even if much is already being done in terms of stimulating exploitation of Scotland's science base (through support for commercialisation through SMART and SPUR awards, the Proof of Concept and Enterprise Fellowships programmes, and the Intermediate Technology Institutes), there is still scope for more effective coordination of these various schemes and for a more robust focus on the business development models appropriate for the creation of world class high-growth companies. Further, The Scottish Health Innovation initiative illustrates that it is possible stimulate and facilitate commercialization from the public health sector (Box 9.1)

2.5.2 Project support

The proof of concept scheme has many similarities with proof of concept scheme expanded in by FORNY from 2006. However, the Scottish Enterprise Scheme seems to be more focused on commercial issues in addition to technology development. One could argue that the Scottish scheme can be viewed as an extended program compared with FORNY, meaning that the Scottish program to a greater extent includes activities related to what FORNY calls commercialization funds. However, the whole grant goes to the project, this in contrast to the project funding in the FORNY program where the commercialization actors get a lump sum in order support projects.

We do not find a scheme directly comparable with the leave of absence scheme in FORNY. However, one of the bottom-up initiatives, Enterprise Fellowship programme, has some similarities. The researcher gets a grant in order to prepare their business case after the proof of concept phase. This includes a 12 months salary support as well as business training in order to take the idea forward with

access to networks of mentors, business experts, and professional advisors. The program has impressive outcomes (see Table 9.1).

2.6 SWEDEN

Sweden has long traditions with focus on R&D and collaboration between university and industry. On the other side, there are few national programs for the commercialization of R&D. The Innovation Bridge Foundation established as seven independent foundations have addressed this issue since the mid 1990s. The Innovation Bridge, which reorganized from seven independent foundations into one company with seven daughter companies, is taking the shape of a national initiative. The effect will probably be more learning and best practice exchange between the regions and also a coordinated communication with the government and international organizations like the EU.

Despite the lack of national innovation programs aimed at the R&D sector, there seems to be a history of high activity level at universities and colleges. The results from Venture Cup and Chalmers School of Entrepreneurship are impressive and both programs have strong regional partners (see 10.3.3 and Box 10.2).

2.6.1 Infrastructure

At the university level the holding companies were established in the mid 1990s. To some extend the holding companies have taken the role to build commercial competence at the universities, but with little economic resources, the holding companies have had limited effect. The Swedish Nyckelaktörsprogrammet is aiming at building commercial infrastructure. But since the program is established in 2006 there is no track record in the program yet.

2.6.2 Project support

At regional level, the Innovation Bridge has funding for commercializing technology, while at the national level the VINN NU initiative is most comparable with FORNY. As VINN NU is organized as a competition, it could be complementary to the FORNY measures.

In Norway, the FORNY program is one large initiative for commercializing R&D that both fund activities at Technology Transfer Offices and spin-off companies, while there are more regional funding sources in Sweden. It is hard to measure output in Sweden, as there are no Technology Transfer Offices to track spin-off companies, their revenue, license income etc. But it is also difficult to measure the

total amount of funding for spin-off companies in Sweden compared with Norway, as there are a lot of regional and local sources both places. Hence, the lack of national funding for commercializing R&D does not mean that there are no funding available for spin-off companies and there are many example of high quality spin-off companies coming from Swedish universities.

3. DISCUSSION

Based on the six country study (see: Chapter 5-10), this chapter discusses best practice in government measures to commercialize research emanating from universities and research institutes. Some of our main impressions are summarized in Table 3.1.

	Norway	**Canada**	**Finland**	**Ireland**	**The Nether-lands**	**Scotland**	**Sweden**
Main focus in commerci-alization	Create research-based new industry	Create research-based new industry	University –industry collabor-ation	Excellence in selected areas	Create entrepre-neurial universities	Excellence in selected areas	University –industry collabor-ation
Main level of support operation	Regional	Multi-level	Regional	Central	Regional	Central, but sup-port to univ. initiatives	Regional
Early phase seed funding	Medium	Well developed	Many recent initiatives	Medium	Medium	High, good coordinat-ion	Medium, new regional initiatives
Focus on evaluation	Medium, FORNY keep statistics	High focus, but varies between programs	Medium, regular program evaluations	Medium	Evaluations used for policy making	High focus, some comprehens ive plans	Mostly done at regional level
Focus on building infra-structure	High	High	Low, but increasing	Medium	High, especially university level	Medium	High, but from regional level
Focus on proof of concept funds	Medium, increasing	High, but vary between institutions	Industry partner usually needed	High	Medium	High	Low, some at regional level
Focus on commerci alization project funds	High	High, from many sources	Industry partner usually needed	High, especially directly to selected projects	Medium	High, especially directly to selected projects	Regional level
Programs training TTO level expertise	Low, but regional initiatives	High	Low	Medium	Medium	Medium, also for academics	Low

Table 3.1: Characteristics of the government efforts to support commercialization of research

3.1 RESOURCES AND PRIORITIES

Government initiatives targeted at the commercialization of research is a rather new area in many of the countries, and it seems like the need for government support changes as commercialization activities mature and a better formal and informal infrastructure is developed. Hence, government initiatives with success in a country or institution with a long track record and a well developed infrastructure for commercialization may not be suited in a context where the activity and infrastructure is lacking. As an example, we see that in Canada, which is the country with the longest track record and experience with commercialization initiatives (like age of TTOs), the need for more people with competence in technology transfer is more clearly expressed than in any of the other countries. It might be that the complexity of the technology transfer field and the need for specialized competence is becoming clearer only after some degree of local experience.

An interesting observation is that countries with weak cooperation between industry and research institutions tend to establish more comprehensive programs to facilitate commercialization in form of spin-offs or licenses. Research institutions in for example the Netherlands, Finland, and Sweden commercialize much of their research through collaboration with industry. In designated areas these countries seem to have industries with an absorptive capacity to capitalize on the basic and applied research undertaken at universities and research institutes. These countries also emphasize meeting places like science parks on the university campus. Hence, the introduction of more extensive efforts in order to commercialize research “directly” from research institutions may not be successful because researchers oriented towards commercialization already use their capacity in research-industry collaboration. Further, governmental representatives in Canada, Ireland, and Scotland explicitly focused upon commercialization of research as an important strategy to strengthen the indigenous industrial base. In Canada, Ireland and Scotland there is a strong intent to strengthen basic and applied research in certain areas and capitalize on this investment by facilitating spin-offs and licensing. This is recognition that most indigenous companies within these countries are not in a position to take commercial benefit of the excellence in research.

In some countries the new policies have been focused towards specific knowledge-intensive industries in the fields where the countries have an international competitive advantage. Countries such as Ireland and Scotland have made quite strong priorities concerning the areas they should have world-class research. This

has led to an emphasis on specific industry clusters, influencing the innovation support system to prioritize much of the commercialization support towards the same areas. To prioritize in this way might be easier for countries like Ireland, where much of the indigenous research capacity has been built in the last decade. Still, the need for highly specialized competence within specific areas makes sector-based initiatives relevant in all countries. The new TTOs set up in the Netherlands are connected to university faculties. In Scotland, experts are frequently used to analyze the market imperfections in different areas and in different growth phases of the commercialization projects.

3.2 SEED FUNDING

In all six countries covered in this study there is a widespread recognition that a lack of seed capital finance has been a major obstacle in order to develop research-based ideas with growth potential. Moreover, the type of approaches and the degree of governmental commitment in order to introduce new tools to reduce this perceived "equity gap" varies. The major trend is the move from a passive to a more proactive approach in order to support these research-based spin-offs. An example of "passive" approach is typical in the form of supporting fund-in-fund initiatives. Even if these initiatives have increased the amount of venture capital available they have not been to great benefit for firms in the seed capital phase. This has resulted in a focus on the development of schemes supporting the companies more directly with some kind seed capital. This could be both soft loans and direct equity investments. Another interesting element is that most of the schemes introduced have a "gearing" approach, meaning that the funding from these schemes are matched by the entrepreneurs themselves, banks, investors, development partners etc. There seems, however, to be a lack of holistic thinking when introducing seed capital schemes. On the one hand, such schemes have limited links to other support activities like proof of concept schemes, development of commercial skills etc. On the other hand, cooperation with professional venture capitalists is limited. In line with this, there is a concern that there is not enough attention to the competence dimension when setting up these schemes (related both to selection of investments and the supportive role after the investment is done).

An interesting example in this study is Scotland. In 2003 they started with annual mapping of the seed capital situation in Scotland aiming to identify areas where governmental intervention is needed. This gave a basic foundation for the introduction of new and the adjustment of existing tools. This is a contrast to the Norwegian situation where late night "horse-trading" in the Norwegian parliament formed the basis for the introduction of new seed capital funds. Furthermore, developments in Scotland also reveal best practice when it comes to links between

governmental support programs (like proof of concept) and “business angels” syndicates. We find the formation of joint ventures in order to explicitly found research-based ideas. The governmental bodies Scottish Executive/Scottish Enterprise and the Braveheart business angel syndicate have developed several equity schemes. This is a joint venture between the business angel syndicate, the Bank of Scotland, several Scottish Universities and the governmental bodies. The projects and proposals are filtered by the University Commercialization Department for "investor readiness" before being passed on to the Braveheart business angel syndicate. The Braveheart Group undertake a detailed review of the financial projections and meet with the company founders before a short summary paper is passed out to the partners in Bank of Scotland. The initial investment is then made; usually in conjunction other governmental support and the company proceeds from there. However, this must be seen in the light of the fact that Scotland has a vibrant and quite transparent “business angel” market compared to the other countries mapped in this study.

Another interesting initiative is the development of the “Innovation Bridge” in Sweden which will include a seed-capital element. This is also a kind of gearing instrument where regional initiatives match their funds with funding from the “Innovation Bridge”. In this way they support a number of regional initiatives set up to support the commercialization of research. There are also examples where research institutions have their own seed and venture funds, such as Chalmers and Karolinska. Further descriptions of seed funding initiatives are found in the country descriptions in Chapter 5-10.

Overall, in order reduce the capital gap experienced by science-based spin-offs in Norway, one step could be to introduce a flexible soft loan and equity tool. One argument against this is the introduction of new seed capital funds in the main university cities in Norway, but the reader must bear in mind that these funds will be (if raised) privately owned funds and history tells us that these funds usually undertake investments in somewhat more established firms.

3.3 METRICS AND EVALUATION

All the countries studied are increasing both their administrative and financial efforts to increase the commercialization of research. Considerable funds are allocated to such efforts, and it could be expected that the organizations responsible for this type of schemes will monitor the effects closely. Nevertheless, few countries provide detailed national statistics on the number of spin-offs and other output from the commercialization of research.

Exact comparisons of the various initiatives in the countries studied would be doubtful as the different areas of operation, other initiatives in place, and different contexts makes each program unique. It makes limited sense to compare the quantitative output from one program in one country with another program in another country because of different ways to meter, differences in industry structure, highly diverse composition of initiatives, and differences in scope. Also, the output numbers are not directly comparable due to the variation in definitions used for the statistical material. Further, it is even more difficult to relate the output metrics to any specific programs or initiative as the additionality is not clear-cut. The output may have occurred even if the program did not exist. Most often, several initiatives are involved in supporting each commercialization project and isolating single measure effects is thus a challenging task.

Canada is the country in this study with the most comprehensive statistics on commercialization from universities. Studies indicate that the portfolio of spin-offs from universities and hospitals is around 900, increasing by almost 100 each year. The number of gazelles (19%) and IPOs (93) among the spin-offs are, however, remarkably high. Canadian universities perform similarly compared to US counterparts in most indicators, but according to one study they have 2.5 times the number of spin-offs and slightly less licensing revenue per dollar of research spending than US universities.

As the focus on spin-offs in Finland has been low and the universities have not owned the IP there is a lack of statistics in this area. During a 15 year period (1986-2000), one study identified 530 US patents having Finnish university researchers as inventors. Compared to the about 2000 patents held by Canadian universities around the year 2000, this indicates that Finnish scientists produce a reasonably high number of patentable inventions.

In the Netherlands, the government estimated in 2004 that around 105 spin-offs were established from universities and research institutes each year. With 29 research institutions in the Netherlands the average was approx 6.4 per university per 1000 employees within the research institutions the spin-off rate where 1.69. During the nineties, the universities applied for 223 patents, less than 2 % of the total number of patents. 10% of the company patents were expected to be realized in partnership with universities.

The UNICO-NUBS survey [5] provides an overview of university commercialization activities in the UK, but specific numbers from Scotland are not available. The survey found 175 new spinout companies from UK universities in 2001 and that 19 institutions created more than 6 spinouts. Further, 1402 invention

disclosures were received and 276 patents granted during 2001. Evaluations of the Scottish initiatives reveal the findings in Table 9.1.

Due to the decentralized commercialization structure in Sweden, there are few national statistics on commercialization performance. Although Swedish universities do not own the IP from research, the university holding companies report that they have contributed to the establishment of 300 companies over approximately 10 years. The number is probably very different between institutions, and a university like Chalmers claims to have a track record of 225 spin-offs in less than 30 years.

The culture of reporting results is more developed for instance in Canada than in Norway. Especially the projects and operations have to report the status. In Canada, societal benefits and societal economic return are often mentioned as more important than net revenues for the university. The program operators often use case studies to show benefits for instance related to health or provision of technology to Canadian industry. This trend is also evident in the US-based AUTM survey activity, where finding proper metrics for the commercialization of research is a current topic.

The most developed approach we found to meter and evaluate programs was at NSERC in Canada (Box 5.5). This provides a design for how managers can plan, measure, evaluate, and report on results from a government program. A central element in the RMAF is a logic model showing how activities are intended to achieve planned outcomes. A key seems to be that the job to evaluate a program starts already in the planning phase and much of the data collection is carried out during the program operation; not in retrospect. It might be difficult to find data about the projects supported, and one solution might be to require that all projects receiving grants have to report key data in the following years and to report both soft and hard facts about their impact on society. Data that are collected continuously are much more reliable than data collected in retrospect. In practice, however, we see that many programs are not clear about their exact role. Also the ITI in Scotland have extensive plans on metrics which includes human capital, physical capital, intellectual capital, financial capital, market capital, and social capital.

Nevertheless, the evaluation reports and the information letters show that FORNY is among the best to calculate the effects of the program. Such evaluations may, however, be expanded to include a broader set of objectives and schemes. More long-term goals could be added and also goals that do not only reflect the direct financial revenue generated, but also the benefit created for the Norwegian society

and Norwegians. This kind of metrics should be supplemented by more qualitative information about the impact of the different FORNY initiatives.

3.4 LESSONS LEARNED

The interest in the commercialization of research as a tool for economic development has increased exponentially in recent years, and the number of initiatives and government programs has followed suit. Commercialization of research is a young field, hence, most of the initiatives are rather new and few have been thoroughly evaluated. Among the older initiatives, most have undergone significant changes during the last few years, and there seems to be a lot of experimentation going on. The rationale for implementing a new measure is usually connected to fill a perceived gap in the innovation system. New initiatives and measures are, however, rarely based on quantitative assessments of specific needs and how these could be addressed. Rather, new initiatives are often built on successful examples from other countries, regions, or institutions.

Most countries have put significant efforts into developing an innovation policy with influence on other areas like regional policy, industrial policy and education and research policy. In the countries included in our study we find, however, a varying degree of systematic analyses mapping the market imperfections and efforts towards finding the right level of the different types of support schemes. Typical gaps identified in other countries are lack of competent people, lack of internationalization, lack of funding for in early stages, lack of venture capital, and lack of culture and infrastructure in the universities. Some agencies, such as Tekes in Finland, spend considerable resources on benchmarking and evaluation studies in order to reveal best practice from relevant sources. Assessments of these and other points could more clearly identify in what areas the FORNY program's initiatives would be most effective.

An experimental approach was especially visible in Canada, where new pilots were common in order to test the viability of concepts to see if they could be launched as a general initiative. One example is the Canadian Flintbox (Box 5.3) initiative that was invented at UBC in Vancouver, but is now used across Canada and has also been adapted by a number of US universities. Another example is the Chalmers School of Entrepreneurship (see Box 10.2) that after some years of successful operation has inspired similar initiatives in Trondheim and Helsinki. To experiment with new initiatives is both risky and costly, but it is necessary in order to learn and to find new and better models that could be applied across many institutions. Hence, the responsibility for supporting new experiments should be at national level, as the risk might be too high for single organizations.

3.4.1 Programs to change culture and build infrastructure

How to get academics and universities more involved in the commercialization of research is a key issue among agencies and people working to promote commercialization. In this category we identified programs to change the attitudes and culture within universities to be more supportive to commercialization and spin-off activity, programs to build competence in the commercialization and business development at the universities, and programs to build an effective infrastructure in the form of commercialization support units and facilities such as TTOs and incubators.

The awareness and focus on commercialization varies a lot, not only between countries but also between universities and research groups. Hence, the appropriate measures will vary depending on the maturity of the commercialization topic at each institution. Furthermore, there is a debate where some argue that the shelves and drawers of professors contain an untapped source of new inventions just waiting to be commercialized, while others say this is nonsense. In the latter case, there is no need to stimulate researchers to disclose new ideas, but more fundamental changes have to take place in order to create commercial concepts from research. Many studies have, however, shown the importance of researcher involvement in the commercialization process.

A wider range of structural changes than just funding support programs may be needed to change the culture at universities. A challenge in all the countries studied is that two different government levels are responsible for academic research (e.g. ministry of education) and for industry development (e.g. ministry of industry). For instance in Canada and Finland, it seems that the latter are much more occupied with promoting commercialization than the former, and some of the efforts might benefit from a better coordination between these levels.

Although there is no doubt that academics are increasingly becoming more positive about the commercialization of research, few recipes or best practice to stimulate this change can be found. As efforts to change culture mainly have to be implemented at the institutional level, there are few government programs aimed directly at researchers on these issues. This is often a more internal affair at universities, and perhaps not prioritized very high in all institutions. There are large differences between institutions when it comes to awareness about commercialization and the available infrastructure. In Canada we see that initiatives are broadened to cover colleges as well as universities (Section 5.3.2).

While the larger universities already have the infrastructure in place, this is not the case with many of the smaller institutions.

In Ireland there was a strong emphasis on the national importance of the role of the universities and the government programs and the positive externalities of the support. In the Netherlands, there is a strong emphasis on the role of the university in fulfilling national and regional needs. Technology transfer is seen a strategic tool for universities in order to increase their impact on society. As seen in the Canada case the TTO role is currently evolving more towards being a part of the university activity. In Norway and Finland commercialization activities are in some cases outsourced to separate commercialization units, while in countries like Canada, Ireland, and Scotland activities are organized within the universities with close links to the university administration. An even closer integration with the research activities is attempted in the Netherlands, where TTOs are about to be set up at faculty level and linked more directly to the research groups.

Business plan competitions such as the Venture Cup in Sweden and Finland are initiatives which seem to make a lot of media coverage and a high volume of participants. Hence, compared to the relatively modest amount of resources employed, the outcome is impressive. Although the share of research-based ideas involved is relatively low, a number of researchers are actively pursuing their ideas in public, with possible learning, networking, and role model effects. In Finland, the Venture Cup is seen as an important part of a system where the innovation managers and the TULI-program use the Venture Cup as an arena to develop projects. In the Netherlands, the decentralized structure of the technology transfer activities may facilitate cultural change. Here also, the technological universities in particular are profiling themselves strongly as entrepreneurial universities encouraging staff to contribute in the third mission. In Ireland, strong efforts are made to meet with the researchers at institutes and present role model examples of entrepreneurs.

It is, however, important that the research institutions themselves are committed to the commercialization task. In some of the government agencies, especially in Canada, there were worries that the universities had a too narrow focus on achieving quantitative output goals. TTOs in Canada, Scotland, Ireland, Finland have a broader mission, including writing applications, contact with industry partners etc. An interesting observation is that the revenue from some TTOs in Ireland and Scotland goes back to the university, and not the TTO. In this way the TTO does not get too focused on the financial measures. In addition, it is easier to gain legitimacy for the TTO and commercialization activity if the revenue from this activity is shown to the academics by means of directly funding research.

The lack of competent people in the area of technology transfer and commercialization of research is frequently expressed. This competence is not easily available and may be facilitated through the development of a portfolio of experienced consultants supporting the projects. FORNY may learn here from the Finnish TULI scheme (see Box 6.1). Although it should be expected that countries with a longer track record, such as Canada and Scotland, have more expertise, the focus on training programs seems to be even stronger in these countries. In Canada for instance, networks, partnerships (regionally and with IRAP), and training programs (hands-on internships) are common. Some of these initiatives are funded by programs that are similar to FORNY, such as the IPM and I2I. There is a strong focus on developing talent and it is very often stated that technology transfer also includes the transfer of people. Specialized training programs for all those involved in the commercialization process may prove beneficial. This includes consultants, the researchers themselves, and the TTO officers.

3.4.2 Programs to support specific commercialization projects

The main focus in the "valley of death" discussion has been the insufficient supply of financial incentives in the first phases of commercialization. In most countries, it is acknowledged that there are a funding gap between the research-based inventions made within the universities and commercial concepts that are of interest to industry and private capital. The investors and the industry often feel that the risks are too high for supporting the development of a research idea. The first phase of this funding gap is primarily addressed with grant-based programs, while programs in later stages usually demand private co-funding and sometimes equity in the projects. It seems, however, that projects where no company or investor has shown interest will be cut off from programs requiring cost sharing. Often there are other general programs that provide significant add-on funding to the commercialization initiatives. In Norway, most of the FORNY supported spin-offs receive significant support from Innovation Norway, for instance through the incubator grant scheme. In Canada, IRAP supports a significant share of spin-offs, and in combination with tax deductions these funds can add up to 70% of the total project costs.

In the countries studied, most of the funding to specific projects is administered by the projects themselves, keeping the administrative costs to a minimum. The common approach is that the whole grant goes to the project, no overhead to university and technology transfer offices, and that the researchers are project managers for the funding. The role of the university TTOs is to provide competence support for the applications in order to increase quality before they are

assessed in the funding organization at national level. The projects, thus, have to be recommended by the university TTO and followed up according to milestone plans.

Developing the right team for commercialization is also a challenging task. In many cases, the researcher does not want to become an entrepreneur. In other cases, (s)he may not be the best person to run the firm or the later part of the commercialization process. In line with this, evidence has not supported the myth that university researchers do not make good entrepreneurs and should be replaced by more experienced entrepreneurs. A study of Canadian spin-offs shows that for 12 of the 20 largest fast-growing firms (gazelles), the original inventor is still the leader [6]. Hence, avoiding professor entrepreneurs as a general rule is not a good idea.

An innovative Swedish initiative is the Chalmers School of Entrepreneurship (Box 10.2), where talented students are trained and actually take the role as entrepreneurs in research-based spin-off firms. This model is now being implemented in Finland by the Helsinki School of Creative Entrepreneurship and exists in Norway at the NTNU School of Entrepreneurship. As the students take the role as entrepreneurs, it seems likely that many of the inventions would not have been commercialized without this initiative. FORNY may also receive inspiration also from Scotland and Ireland, where entrepreneurship and management training is given together with support from an assigned mentor and introduction to a broad network of investors (Box 7.2 and Section 9.2.2). This training may be seen in connection with the proof of principle funding and with the “leave of absence” scheme recently introduced by the FORNY program.

3.4.3 The organization of government initiatives

The organization of government support varies according to the culture, degree of newness of the programs, and other country characteristics. Both government and research institutions in all six countries recognize that stimulating entrepreneurship within academia seems to be quite different from stimulating entrepreneurship in general. Rather than being a responsibility for actors outside the university, governments are actively encouraging universities to include commercialization as a part of their mission.

Some countries like Canada and Finland have a number of autonomous actors who are initiating programs, while other countries like Ireland and Scotland have a more well-structured system. Countries like Sweden and the Netherlands rely heavily on regionally based initiatives, while in other countries the programs are governed

centrally. The countries with a clear national ambition and cluster orientation, such as Ireland and Scotland, have more centralized organizations. These countries have specialized efforts towards a limited number of industries. Moreover, we also observe that this makes their universities even more focused on achieving research and commercialization excellence within a few main areas. With a more centralized organization the universities are followed closely; sometimes with government representatives on campus securing the interests and coordination between the commercialization units.

Many of the initiatives found in this study are new. This might be because it is more popular among the government agencies to start a new initiative than supporting an existing one. We see a tendency that the different public actors are eager to contribute in 'popular' areas, while it is less interesting to fund ongoing activity.

The empirical findings from this report suggest that more specialized efforts are beneficial in order to create networks among scientific fields, between universities, and towards specific industries. Networking between regional actors at a national level is seen as important. One possible strategy to promote networking by government programs is through enforced networks such as Canadian IRAP consultants, the Finnish innovation managers, and the Irish commercialization teams. Here, the staff is employed directly at the government level, but are operating within the research institutions. Another strategy is to accept only consortia or networks as eligible applicants for commercialization infrastructure grants, as seen within the Canadian innovation pilot and the NSERC College and Community Innovation Program. We also see that government programs are supporting regional network organizations such as Westlink in Canada.

To maintain a good coordination and connection between different government programs is a topic in all countries, but all are struggling to find good solutions. Although this report considers programs specially targeted at research-based innovations, these projects frequently benefit from more general initiatives such as grants, loans, and equity schemes for start-ups; incubators and training for entrepreneurs; and grants and tax deductions for R&D. In this respect, the Norwegian system with rather few actors and the FORNY program which is coordinated with both the Research Council of Norway and Innovation Norway seems to represent good practice. One of the reasons making FORNY well connected with the other actors might be that the FORNY program has been in operation for more than a decade and have become a well known initiative.

4. RECOMMENDATIONS

In this chapter we provide 11 recommendations for further development of the FORNY program. These recommendations have emerged from what we have seen as best practice in the six investigated countries. Our recommendations are not intended to be conclusive, but rather be input to a further discussion about the development of the FORNY program. Hence, some of our recommendations will require further investigations before they can be implemented.

- **Recommendation 1: The FORNY program may assess (map) the situation on a regular basis to identify the major gaps that need to be addressed**

In order to identify the objectives of the FORNY program, regular assessments aiming to identify the main gaps could be conducted. Initiatives taken to address perceived market failures assume that the government is well informed about the nature of the market failure and that good measures to mitigate the failures are available. A broad knowledge platform is of crucial importance to provide competent advice to the national government and to efficiently coordinate the different governmental actors within the field. In order to stimulate a thorough discussion of the FORNY operation in general and for specific initiatives; FORNY could consider using expert evaluators in the same way as the Scottish seed capital monitoring. The information from more thorough assessments of the situation in Norway could also be useful input to develop the national objectives and priorities within research and innovation efforts, and provide guidelines both to the central government and to divisions in the Research Council and Innovation Norway.

- **Recommendation 2: The FORNY program may stimulate increased experimentation with new initiatives**

The constant changes in setting and the working conditions together with the complexity of the field make it necessary to experiment and to assess the effects on a regular basis. This study indicates that the introduction of new tools is in many cases related to national and regional efforts from enthusiasts within governmental organizations, and it seems difficult to copy successful initiatives from one location to another without local adoption. Hence, the FORNY program should encourage and fund experimental proposals from different actors on the terms that the lessons learned can be available and shared with other actors and regions. Government programs in Canada often encourage innovative proposals to their schemes and

innovative initiatives such as Flintbox (Box 5.3) and Chalmers School of Entrepreneurship (Box 10.2) are often initiated locally.

- **Recommendation 3: The FORNY program may actively encourage the research institutions to see commercialization of research as a strategic activity for the society and the institution**

A key to succeed is that the universities and research institutions are aware of the strategic importance of commercialization activities, and their national role for value creation and benefits for the university as a whole. In order to create a good infrastructure for commercialization the FORNY program may help the universities to see technology transfer activity as a part of their strategic core activity. FORNY has a key role in increasing the awareness of and competence about commercialization of research at university management level. It is of special importance to secure a nuanced view that includes both benefits and possible negative consequences from commercialization initiatives.

- **Recommendation 4: The FORNY program may support training of key personnel at the technology transfer offices**

The major infrastructure for commercialization of research is the industrial liaison and technology transfer offices (ILO and TTO) at universities and research institutes. It seems, however, that it takes many years to establish a good TTO infrastructure with qualified personnel. To work with commercialization of research at project level is generally recognized as a separate field in need for its own specialized competence related to areas like; IPR, facilitating licensing agreements, early stage finance, business models, and internationalization. As the TTO infrastructure in Norway is very new, the level of experience is limited and very few people are trained in using the different tools for university-industry technology transfer. There seems to be a need for highly specialized competence within specific technology areas, and such competence might be difficult to build without targeted initiatives by the FORNY program. The operation of such a program could be in cooperation between a Norwegian university and leading universities in Europe or North America. Training programs should be of a high international standard and preferably include internships. FORNY may here find inspiration from Canada where there is a strong focus on building commercialization talents including several programs.

- **Recommendation 5: The FORNY program may support an initiative to use Flintbox as a tool for commercialization of Norwegian research**

Distribution of information about research results from all the research institutions is a challenging task. There is a market imperfection due to lack of demand-side information at the company side. Ideas about creating a web-based marketing platform for university technology have been discussed in Norway and also in the US. Such initiatives have had limited success so far. FORNY may learn from Canada (Box 5.3), where the Flintbox concept has managed to create additional value by broadening the focus compared to traditional TTO practice, and by including online tools for licensing. In addition, the value of databases like Flintbox increases with the number of users. Hence, new institutions starting to use Flintbox will probably be able to benefit from the investments made by the earlier users. Training and use have to be addressed thoroughly to make Flintbox an efficient a tool for technology transfer. Key individuals or champions are probably crucial for successful implementation, and it is important that universities see Flintbox as a strategic tool for marketing, industry contact, and technology transfer. It might be an idea to make incentives to use Flintbox by including postings and transfers in the universities budget model and by making Internet postings a mandatory activity in projects funded by the research council.

- **Recommendation 6: Funding from the FORNY program may be 100% grant based and not dilute ownership in any of the projects supported**

A critical question at commercialization project level is the degree of independence and full financial control over the project from the initiators. Except for the owners of IPR, we have not found any government programs or operators of these programs that take ownership in the projects that are supported, such as in Norway. The projects supported by FORNY funds are in a very early phase where any dilution may reduce the attractiveness of the project towards commercial partners. The willingness to take risk is a central feature of initiatives like the FORNY program. Hence, the success rate for supported projects may not be too high.

- **Recommendation 7: The FORNY program may support training of researchers in the process of commercializing their inventions**

Although some researchers are very capable of commercializing their technologies, the majority seem to benefit from some coaching and training. The FORNY program may create special schemes with high quality training of researchers working on commercialization projects. Such training initiatives may be connected to the existing proof of concept and leave of absence schemes.

- **Recommendation 8: The FORNY program may introduce initiatives to facilitate the links between the seed capital market and research-based commercialization projects**

It is important that the commercialization project is followed up during the founding process and in its first years of growth. FORNY is the government agency with the highest insight into the challenges research-based ideas meet. FORNY, together with Innovation Norway, should therefore take the responsibility for introducing schemes reducing market perceived imperfections, i.e. contribute to the increase of risk capital available for research-based commercializations. FORNY and Innovation Norway may learn from Scottish Enterprise initiatives in this respect.

Together with Innovation Norway FORNY may undertake an annual mapping of the seed capital market situation for science-based companies in Norway. To reduce system failure FORNY participate in the establishment and operation of industry specific "business angel" syndicates. Within these arrangements, FORNY may develop arenas where FORNY-supported projects are presented and evaluated by especially invited investors (seed capital and venture capital investors as well as "business angel" investors). As to new financial schemes FORNY may initiate the launching of an "Equity Scheme". This in order to increase investment from "business angel" syndicates (gearing), seed capital funds, corporate investors etc. Second, together with Innovation Norway, FORNY may launch and operate a flexible soft loan/equity instrument. This could be organized as a "convertible loan[3]" scheme.

- **Recommendation 9: The FORNY program may promote the development of commercialization units with specialized competence within specific industry sectors**

[3] Convertible loan is a type of "quasi" equity. This type of loan may be converted into common stock based on a conversion price. The debt holder must pay interest as long as the debt is not converted.

The complexity of the high-tech industries and scientific fields involved makes it necessary for a greater degree of specialization to develop matching competence. Highly specialized competence might need a national coordination in order to achieve critical mass. Although the FORNY operation has been technologically neutral, the FORNY program could prioritize the development of infrastructure and expertise in targeted technology areas. This implies that there may be a higher degree of specialized competence at both national and regional level. In Ireland this is achieved by developing expert teams at national levels with strong industry networks and links to the university TTOs.

Instead of facilitating regional competition among commercialization units, FORNY can develop commercialization units with "industry excellence" in selected fields or industries. One way to achieve this is through competitive schemes where commercialization units are encouraged, in cooperation with national or international partners, to present a viable concept and plan to become an actor with industry excellence within specific industries. The basic idea in this suggestion is to keep the current distributed commercialization model and facilitate the specialization and collaboration of existing commercialization units. The task is, however, challenging as the importance of the regional setting for most commercialization projects makes it important that the cooperation between specialized units and the local unit works well in practice. An area where special competence can be built is the research hospital sector. FORNY may learn from the scheme for commercialization of research from Scottish hospitals (Box 9.1).

- **Recommendation 10: The FORNY program may widen the output metrics to better reflect their mission**

It seems that all programs to promote commercialization of research are struggling to find proper ways to meter and evaluate the outcome and impact of their operation. Although some metrics such as number of patents, licenses, and spin-offs together with the revenue generated are commonly used, there seems to be frequent dissatisfaction with these metrics. The simple quantitative metrics are unable to fully capture the impact of the programs, but are used in absence of good alternatives. Inspired by NSERC in Canada, FORNY may consider making an annual booklet with one page describing each FORNY spin-off. This might have a greater impact than only statistics and numbers.

- **Recommendation 11: The FORNY program may stop the use of bonus funds as incentive to the commercialization units**

We have not identified any initiatives in the investigated countries that are similar to the bonus funds from FORNY. Bonus awards can be an efficient incentive in areas where the goal or output from an activity is clear and unambiguous and easy to measure. This is definitely not the case with technology transfer and commercialization of research. The bonus system in the FORNY program appears to be problematic to handle in several ways. It is especially problematic that the bonus funds do not benefit the projects or research groups. The system is also problematic because it can create distorted incentives where decisions are made not necessary to benefit a specific project, but also to obtain a bonus. In addition, the commercialization units have two other strong incentives through their ownership in the projects and through the adjustment of future grants from the FORNY program depending on the prior track record.

5. APPENDIX: CASE DESCRIPTIONS

6. CANADA

Canada is a federation of 10 provinces and 3 territories spread over a vast area and rich on natural resources. The population is close to 33 millions on an area somewhat larger than the US. The Canadian economy is largely based on natural resources within the forest, mineral, and energy sectors. About 4/5 of the Canadian export are to the US, and subcontracting to larger US companies such as the car industry is substantial. As with most countries, the company structure is Canada is dominated by small and middle-sized companies, but there are fewer medium sized firms as a percentage than in the US.

6.1 OVERVIEW OF THE CANADIAN R&D SYSTEM

Canada has a relatively modest level of R&D expenditure due to low investments in the private sector. Public R&D expenditure is, however, among the highest in the world. About one third of all R&D activity is performed by Canada's close to 100 universities and university colleges (most by the top 20), roughly 12% by government institutes, and just above half by Canadian industry. In 2003, 73% of Canadian R&D was performed in the provinces of Ontario and Quebec.

Canada has no Ministry of Education, as all educational activities at the universities are financed from its local province. A major source of funding for research activities at the universities, however, is federal resources. Federal expenditure on R&D is about $ 5.7 billion for the year 2005-2006 distributed on a large number of departments and agencies. About two billions are channelled through the following three federal government funding agencies (included the amount of funding available):

1. Canadian Institutes of Health Research (CIHR) that is funded from and reports to the Ministry of Health. www.cihr-irsc.gc.ca ($ 699 million 2005/2006)
2. Natural Science and Engineering Research of Canada (NSERC) that is funded from and reports to Ministry of Industry. www.nserc.gc.ca ($ 865 million 2005/2006)

3. Social Science and Humanities Research Council of Canada (SSHRC) that is funded from and reports to the Ministry of Industry. www.sshrc.ca ($ 292 million 2005/2006)

In addition to the Universities, Canada's National Research Council (NRC) is a research institute with more than 4 000 employees and spending of $ 732 million dollars (www.nrc-cnrc.gc.ca). About 14% of the total budget is revenues from external sources while the rest is funding from Department of Industry in Canada. Other major agencies are the Canada Foundation for Innovation (funding research infrastructure, $ 561 million), and specialized research institutes in agriculture, atomic energy, space, environment, fisheries, genome, health, natural resources, and social sciences. Most of these institutions have put commercialization of research high on the agenda.

6.1.1 Commercialization policy

From the mid-nineties the issue of productivity and innovation became a current policy topic in Canada [7]. In February 2002, after an extensive consultation process, the federal government launched its innovation strategy which aims to move Canada to the front ranks of the world's most innovative countries. A part of this strategy was to double the university research performance and triple commercialization performance by 2010. This initiative has led to a significant increase in public funding of university research and a strong commitment of funds to improve commercialization of research.

Many different actors are responsible for initiatives to promote commercialization of research in Canada. This is somewhat dependant on the structure of the R&D system. Because the Canadian universities are owned by the provinces, most federal grants are awarded to the individual researcher. It is also important to note that the university policies for IP ownership varies, as some universities own the IPR while at other universities the inventor remain title to the IPR (see Box 5.1). Compared with the universities, the federally owned research labs, where the NRC has a prominent role, have their own set of measures for commercialization.

Box 5.1: Intellectual property ownership at Canadian universities

Canadian universities have a diversity of approaches to IP-ownership (university or inventor), IP-strategies, and organization of their technology transfer activity. For instance, in Vancouver the University of British Columbia owns the IP, while at

Simon Fraser University the IP is owned by the university faculty. Both universities are considered as relatively successful in their commercialization efforts. Among the 20 largest universities, the IP is owned by the creator (academics) in 8 cases, in another 8 cases the IP is university owned, and the remaining four has joint ownership or case-by-case negotiations. A comparison of the two groups of eight universities on number of licenses, patents, license income, and spin-offs show essentially no difference at all [8]. There is a continuing discussion about what approach is better, and universities rebelled against a suggested IP change in 2001. The variation in policy is reported to create some frustration among industry companies and investors who have to deal with different policies.

Although commercialization of research is high on the policy makers' agenda, some of our informants question the existence of an overall innovation policy in Canada. A large number of actors make the picture very complex, and sometimes the coordination between different agencies and levels are weak. Relatively autonomous provinces with a strong regional focus result in a variety of different provincial strategies, funding sources, and network organization to promote regional development. Moreover, as education is the responsibility of the provinces, and much of the research is federally funded, these levels might have different views on the role of the university.

Another issue is to agree on the desired outcome of increased commercialization, or more precisely how to measure the effect. Many programs explicitly states that the goal is improved well being for Canadians. For instance, the CIHR define the role of commercialization as to benefit Canadians through "improved health, more effective services and products, and a strengthened health care system" [9]. The predominant use of simple indicators such as patents, licenses, spin-offs, and revenue might be very limited in capturing the real benefits of research commercialization. Many informants expressed concern that too narrow a focus on short term indicators could be misinterpreted and do more harm than good in order to achieve the potential for social and economic benefits from research. The need for better metrics in order to capture a broader set of outcomes from commercialization was also frequently mentioned.

6.2 OVERVIEW OF ACTORS AND COMMERCIALIZATION INITIATIVES

This section presents the main actors in Canada responsible for initiatives to increase commercialization of research. Due to this study's objective, the main focus is on national public initiatives, although the role of provincial, regional, and private initiatives should not be underestimated. The number of programs at federal and provincial level to support commercialization of research is vast; one survey identified 178 initiatives having $ 3.2 billion expenditure a year [10].

6.2.1 Organizations and programs at federal level

Initiatives to support commercialization of Canadian research could be divided in three. First, the federal research institutes such as NRC make their own internal priorities in supporting commercialization. Second, there are a number of targeted schemes from CIHR, NSERC, and SSHRC towards commercialization at universities. Third, general agencies such as the Industrial Research Assistance Program (NRC-IRAP) and the Business Development Bank of Canada (BDC) give considerable support to research-based spin-off firms. For instance, about half the Canadian university spin-offs has got IRAP funds, and 23 of 35 investments by BDC's Technology Seed Investments involved spin-offs from universities or federal labs.

6.2.2 Organizations and programs at provincial level

In order to understand how commercialization of research is facilitated at the national level, it is important to be aware of the differences between the provinces. Some of the provinces are quite active in implementing research and innovation policies and programs that are supportive of the federal initiatives [7]. It is, however, clear that the commitment to the national innovation strategy varies, and not all provinces have the same commitment to the innovation strategy as the federal government. In addition to the provincial initiatives, Industry Canada has large offices in the provinces and there are also four regional agents for economic development; Western Economic Diversification Canada, FedNor (Northern Ontario), Atlantic Canada Opportunities Agency (ACOA), Canada Economic Development for Quebec Regions (DEC). These agencies often have programs to stimulate entrepreneurship and innovation at universities, the creation of high-tech ventures, and commercialization of research. They are also usually involved in programs that provide grants, loans, and equity funding for business development. Further, there are numerous examples of regional and provincial network organizations involved in innovation and commercialization activities.

6.2.3 University TTOs and ILOs

At the university level, all the major research universities have an office for technology transfer (TTO) or industrial liaison (ILO) which acts as coordinator of commercialization activity. Their tasks, organization, and size are highly differing and the number of technology transfer employees varies from as few as one up to 30 employees on some campuses; the national average is 3,8 [11]. One of the most successful operations, the ILO at University of British Colombia is described in Box 5.2.

An important task for the university TTOs and ILOs is intellectual property (IP) management. In 2003 Canadian universities spent $36.4 million on IP management, with an average distribution of institutional base funding (29%), institutional one-time allocations (10%), IP commercialization revenues (e.g., licensing, cashed-in equity) (36%), and external sources (25%) [12]. It is often referred to a '10-year barrier' to achieve significant revenue from licensing activity and this may affect Canadian statistics as half technology transfer programs are younger than 11 years according to the AUTM-survey.

Table 5.1 provides some numbers on the commercialization activity at Canadian universities and hospitals in 1999, 2001, and 2003 [11, 12].

Activity	1999	2001	2003
Universities and affiliated hospitals managing IP	63	77	87
Inventions disclosed	893	1105	1133
Inventions protected	549	682	
Patents held	1915	2133	3047
Patents issued	349	381	
New patent applications	656	932	1252
Active licenses	1165	1424	1756
New licenses	232	354	422
Licenses royalty revenue ($ thousands)	$ 21 100	$ 47 584	~55
Dividend & Equity ($ thousands)	$ 54 560	$ 45 120	~52
Number of spin-offs (accumulated)	471	680	876
Spin-off revenues ($ millions)	n/a	$ 2580	
Employment in spin-offs	n/a	19 243	

Table 5.1: Output from commercialization activity at Canadian universities and hospitals

Box 5.2: The University of British Columbia University-Industry Liaison Office

The UBC UILO has been in operation for about 20 years and is known as one of the most successful operations if this kind in Canada. With a total staff of 40, the UILO core activities are within sponsored research and technology transfer. In 2004/2005 the UILO administered $ 364 million of sponsored research to almost 6000 projects, received 143 invention disclosures, filed 276 patents, completed 32 licensing agreements, and created 2 spin-offs (reaching a total of 117 to date). The licensing revenue was $ 15.9 million and the equity portfolio stood at $ 4.8 million.

The technology transfer operation at UBC is considered to be much broader than merely patenting and licensing. The financial goal was important in the early days of TTO activity, but a lot has been learned, and in Canada as in the US the trend is moving towards a broader set of objectives than just financial. According to the Managing Director, people in Canada agree with the lines of argumentation that there are a broad number of benefits from ILO activity where financial are not the most important, but fewer people articulate this logic. He points out the importance of getting the criteria and order of the ILO operation right. At UBC they have spent 10 years asking if ILO were business or service, but now get more and more support that ILO is a service activity.

The benefits and outputs from the activity in ranked order are: academic, economic, social, and financial. Academic benefits can be through attracting better and more entrepreneurial faculty and students. Economic and social are achieved to the benefit of Canada and Canadians.

The UBC IP policy is very flexible. UBC do not always maintain their right to own the IP, but can sign it off (especially within IT). It is considered to be important to use a wide array of work methods to find the right solution for each project and to not be bureaucratic. Among the staff of 40 there are 8 PhDs, 5 MBAs, 10 MScs, 2 lawyers, and 2 accountants. The academic level is fairly high, but many are recent graduates. According to the Managing Director, he would prefer that new staff members stayed for at least 4 years, as it takes 2-3 years to get a new employee to be confident in using the different tools and to be creative instead of bureaucratic. Further, he claims that it is very important to support the decisions of the staff, in order to make them comfortable in taking risks and use a variety of approaches when making a deal. Another experience is that industry experience can sometimes

be counterproductive due to difficulties to understand the academic community.

A new initiative at the UILO is the entrepreneur in residence funded by IRAP. This person has prior experience as entrepreneur, "business angel", and has a PhD. He is asked to create infrastructure through education, networking, business plan competition, and to work on capacity-based spin-offs, and relation to VCs. Capacity based spin-offs are based on people rather than IP, and have not been addressed by the ILO before now. Another initiative put high on the agenda is to get a broader use of Flintbox (see box 5.3).

6.2.4 University hospitals

Although many of the CIHR initiatives include hospitals, none of the major initiatives for commercialization are targeted exclusively to research at university hospitals. The reason for this is apparently that most hospitals have a university connection, and the university hospital researchers have a university position. Hence, federal funding for research at university hospitals is only awarded through the university connection. Likewise, the university hospitals are often a partner in the university's TTO, although some have their own TTO.

6.2.5 Seed and venture funding

In 2004, Canada's venture capital industry had $ 20.8 billion under management [13]. Out of $ 1.7 billion invested in 2004, just over half were in firms at an early stage of development. A major development in recent years has been the evolution of balanced and specialty funds with an in-house capacity for investing in seed and start-up deals, including groups such as BDC Venture Capital Group, Brightspark Ventures, Celtic House Venture Partners, Genesys Capital Partners, GrowthWorks, Innovatech, Skypoint Capital Corporation, T2C2 Capital, and Ventures West Management.

Business Development Bank of Canada (BDC) is a government owned institution offering financial services, consulting services, subordinate financing and venture capital. The BDC Venture Capital was established in 1975 as the first national source of venture capital and is still a major player with $ 600 million invested in 200 portfolio companies and $ 125 million in 14 VC funds. BDC's role is to be a complementary lender in the market and take more risk. Hence, they are always looking for gaps to fill. Currently the gaps are claimed to be in pre-seed and in C-round VC funding. The BDC Technology Seed Investments (TSI) initiative was set

up in 2002 with a $ 100 million mandate. Of 35 TSI investments, 23 are made in university or Federal lab spin-offs.

6.3 DESCRIPTION OF SPECIFIC INITIATIVES

As described above, the number of initiatives is vast. This section will describe the most important initiatives at federal level related to the building of capabilities and commercialization culture at the research institutions and initiatives to support the licensing and spin-off process. The most important federal support schemes used by research-based spin-offs in early phase are also included. In addition, a few particularly interesting initiatives based outside the federal level are highlighted to illustrate best practice.

6.3.1 NSERC–CIHR–SSHRC -Intellectual Property Mobilization Program

(www.nserc.gc.ca/professors_e.asp?nav=profnav&lbi=b6)

The Intellectual Property Mobilization (IPM) program is a joint effort of the three federal agencies for funding of university research NSERC, CIHR, and SSHRC. The program was initially started by NSERC in the 90s based on discussions with some of the larger universities to support their TTO activity. Currently, the program only contributes to a small share of the TTO budget, but is considered as particularly important for some of the smaller TTOs. Grants are awarded on a three year basis; a total of $ 19 millions are awarded for the years 2005-2008. It is, however, not possible for the same university to receive funding twice from the IPM program.

The objective of the IPM program is to accelerate the transfer of knowledge and technology residing in Canadian universities, hospitals and colleges for the benefit of Canada. IPM grants are intended to further strengthen the ability of these institutions to manage their intellectual property, attract potential users and promote the professional development of intellectual property personnel through a network approach. Innovative approaches are encouraged, and collaboration projects preferred. The IPM Program has two different kinds of awards.

Group Awards

These awards will provide funding for groups of institutions (universities, hospitals, colleges) to undertake cooperative activities and broaden existing capabilities. A “group” consists of several eligible institutions, which may be organized in more formal networks or consortia. The lead institution in the group must be a university or research hospital. The typical award is between $ 100 000

and $ 400 000 per annum. Funds may be used for, but are not limited to administrative costs in support of group meetings and activities, salary (shared with institutions) of regional technology transfer expert servicing the needs of member institutions, travel expenses for representatives of member institutions to attend meetings of the group. For example, smaller amount of funds could be used for proof-of-concept (less than $ 15 000 per project) or to buy the Flintbox tool (see Box 5.3).

Awards for Internship Programs in Technology Transfer

Based on the reported needs from a survey among universities, the latest round of the IPM program focused more on support of networking and training initiatives. Current networking initiatives in some regions have been role models for the IPM program, as the cooperation taking place in the networks seems to raise the level of expertise in technology transfer. The Westlink Internship training initiative (http://www.westlink.ca/internship_program.php), which previously got start-up funding from NSERC, CIHR, and regional sources, can in some aspects be considered a role model for the IPM internship award.

An “internship program in technology transfer” refers to a joint comprehensive program undertaken by a consortium of several universities, colleges and/or hospitals, possibly in collaboration with non-academic organizations, to train personnel in the essential aspects of technology transfer and commercialization. The training should be broad but thorough and include hands-on experience with appropriate mentoring in the institutions involved and in organizations such as small- and medium-sized enterprises, government departments, venture capital firms and/or other suitable organizations in Canada and abroad. Typical awards are between $ 100 000 and $ 300 000 per annum.

Eligible expenses could include salaries and benefits of staff to develop and manage internship programs, contributions to the salaries and benefits of trainees (up to half of total cost), development and production of training materials and organization of and attendance at workshops and courses.

Box 5.3: Flintbox (www.flintbox.com)

As a response to the limited ability of traditional TTO operation to effectively handle non-patentable technologies, Flintbox were developed at the UBC UILO in 2001 [14]. Flintbox is an online platform for marketing and licensing the outcomes of research. It allows organizations to describe and publish research projects online

and associate products of this research for online license, purchase, and download. Through a single account, end users can access multiple networks of research, available in a common format through the Flintbox application. Flintbox was developed at, and continues to be managed by UBC Research Enterprises, a wholly owned subsidiary of the University of British Columbia.

Currently, more than 20 Canadian universities have published new technologies on the Flintbox Network. Flintbox has had one million visits, 2000 accounts created, 398 research projects published, and over 3200 licenses issued since September 2003. In addition to Flintbox, the iBridge Network is the American implementation of Flintbox (www.innovationbridge.com). The iBridge™ Network is a pilot program of the Kauffman Innovation Network, currently used by the following US institutions: Cornell University, University of Arizona, University of Chicago, University of Kansas, University of North Carolina at Chapel Hill, Washington University in St. Louis, and Wisconsin Alumni Research Foundation. The following three examples describe how Flintbox can be used in practice.

A BC Cancer Agency researcher and his team developed software to assemble and view genomic and comparative genomic information in a 3D environment. The software is responsible for successfully sequencing the genome of the SARS associated corona virus. The objective was to get the software into the hands of research colleagues at other research institutes on a non-commercial basis. Sockeye was posted on Flintbox August 8, 2003. Two years later there have been 2040 views of the technology description, and 1405 licenses issued.

University of Western Ontario researchers developed a survey instrument for measuring employee commitment. Their objective was to handle requests for both commercial and non-commercial use; license the survey to interested companies (for a fee) and research collaborators (free for evaluation only). Since the TCM Employee Survey was posted on Flintbox the survey has received 7764 views and 489 non commercial and 37 commercial licenses.

A researcher at the University of British Columbia developed a purified mouse monoclonal antibody. Their objective was to streamline the licensing and distribution of this antibody. The company Biovest was contracted to undertake production, and Flintbox is used to administer ordering and payment. The RHO-1D4 Antibody technology was posted on Flintbox January 2004. In less than two years there have been 604 views of the technology description and 40 consummated “click-wrap” licenses generating over $ 50 000 in revenue.

Flintbox is a practical solution for distributing early stage research under license. The main applications are in transfer of biomaterial and in dissemination of digital works. Streamlined licensing activities can easily be automated using Flintbox as a tool which provides the procurement (licensing, payment and ordering) and delivery systems for a variety of materials (from software to cell lines). A researcher using Flintbox can manage the content and the licensing process, and Flintbox provides detailed statistics regarding access and licensing activity of each research project posted. In this way the demand for the technology can be identified, relationships built (Flintbox has licensees from over 70 countries), and early stage research can grow into products with commercial value.

Flintbox can be a very strategic tool for universities in disseminating research as it facilitates early-stage and high-volume technology transfer in areas where the traditional TTOs have limited capacity. The experience so far is that universities are good to adopt Flintbox, but not too good to use it. Most postings on Flintbox are descriptions of research projects rather than inventions or patents. One challenge in implementing Flintbox is that some TTOs may be reactive and continue to use their routine processes. Even if a technology is posted and a licensee is found, the transaction may not be executed by using Flintbox.

6.3.2 NSERC College and Community Innovation Pilot Program

(www.nserc.gc.ca/about/initiatives/college_desc_e.htm)

As a part of their innovation mandate, Natural Science and Engineering Research of Canada (NSERC) launched the College and Community Innovation Program in 2004. The objective is to increase the capacity of colleges to support innovation at the community and/or regional level. The program design and funding are intended to stimulate new partnerships and increased entrepreneurship and to assist the colleges to take risks and be nimble in developing new ways of working with local businesses and industries to spur innovation and economic growth.

Six initiatives got a base grant of $100 000 a year. Funding for years two and three will be contingent on successful progress in achieving the goals outlined in the proposal. In year two of the grant, up to an additional $ 100 000 will be available based upon the college's ability to leverage an equivalent amount from sources outside the college. In year three, the base remains at $ 100 000, and the maximum amount to be leveraged increases to $ 200 000.

The pilot program will provide grants to colleges on a competitive basis to initiate or increase activities to support innovation in one specific area where the college has recognized expertise and that meets local community needs. The program is intended to be flexible and to accommodate a variety of activities and address the needs of a range of institutions (small/large; rural/urban); however, all proposals must involve students.

Funds may be used for, but are not limited to providing release time from teaching to faculty members to allow them to work on innovation programs and projects, supporting student involvement in projects, developing facilities, outreach to local business and industry, including SMEs, in the targeted area, developing technology transfer expertise, developing a technology evaluation program, testing or benchmarking for certification so that the technology meets industry standards and/or specifications, demonstrating the efficacy of the technology for marketing purposes, and meeting government regulations,

In addition, other activities to support innovation are supported, such as developing new or enhanced products and processes, building and testing prototypes, carrying out non-routine testing or field studies, conducting market and product feasibility assessments, bringing new knowledge to market, establishing pilot facilities, technology development centers and demonstration sites and building awareness of new and best practice technologies.

6.3.3 CIHR Proof of Principle Program (POP)

(www.cihr-irsc.gc.ca/e/25487.html)

The CIHR (Canadian Institutes of Health Research) Proof of Principle Program (POP) was established in 2001 due to a perceived gap that research-based companies often were spun-off too early. The aim of POP is to develop research of uncertain commercial utility to be of interest to companies and potential investors. POP funds additional targeted research, market research, investment and business development activities. These activities serve to validate, better define and add value to the intellectual property, particularly proof-of-principle research and prototype development. The POP program award funds in two phases.

Phase I

Grants will fund proof of principle research projects of up to 12 months duration designed to advance discoveries/inventions towards commercializable technologies, with a view to attract new investment and create new science-based businesses. POP Phase I fits project where 1) the IP has been subjected to an initial technology assessment, 2) where it is already worked out what the novel invention

is, 3) what is needed to be protected (or is protected), 4) what will be the product/process/service, and 5) what will be commercialized. Up to $ 150 000 is available per application.

Phase II
Grants will fund proof of principle research projects up to 12 months duration at the co-investment stage undertaking follow-on proof of principle activities in partnership with a non-academic investor. This funding opportunity is aimed at providing a platform to better enable the academic institution/researcher to move the discovery/invention further down the innovation pipeline. POP Phase II fits project where 1) the principle of the IP has already been proven and 2) the applicants have acquired interest from companies willing to invest in the new technology. The proposal should be for further confirmatory testing of the IP. Up to $ 750 000 is available per application. An investor must match CIHR funds at a 2:1 ratio.

POP has three calls a year, and about 40% of the applications get funded. The grants are awarded to the individual researcher, but CIHR requires a letter of intent which is signed by the university TTO. In practice, the TTO's are involved in writing the application, and it seems clear that some of the largest TTOs produce the best applications. For instance, 70% of the applications from UBC get funded. Since the inception, POP have a total spending of $ 19.6 million on 163 phase I and 9 phase II projects. In 2005 the budget is $ 4.7 million.

6.3.4 Other initiatives by the (CIHR)
Canadian Institutes of Health Research (CIHR) have a commercialization and innovation strategy having the following vision: "Canada will become a world leader in the translation of health research into benefits for the health and economic prosperity of all Canadians". CIHR has a budget of about $ 11 million a year and nine different programs for commercialization of health research from universities and research hospitals. Programs and competitions are held depending on the perceived need. New programs are typically developed with end-user focus groups (VC, entrepreneurial professors, business schools, TTO, etc.) where gaps and programming needs are identified. Gaps identified include insufficient management skills in spin-off firms and not enough staff with appropriate expertise in technology transfer offices. The Science to Business (S^2B) program and the Commercialization Management Grant program are set up to educate and apprentice people who can fill these roles. The S^2B program enables recent health research PhDs to pursue a health stream MBA to develop a cadre of science-trained entrepreneurs. The Commercialization Management Grant program strengthens

Canada's research translation sector by enabling TTOs and ILOs of universities and research hospitals to recruit up to two recent MBA graduates to work at the institute to accelerate the technology transfer/commercialization of IP residing in academia from CIHR-funded grants. In addition to the formal schemes, the CIHR maintains a network with other innovation actors. IRAP is considered an important instrument, and collaborative discussions are held.

6.3.5 NSERC Idea to Innovation (I2I) Program

(www.nserc.gc.ca/professors_e.asp?nav=profnav&lbi=b4)

The Idea to Innovation (I2I) program was created by NSERC in cooperation with the TTOs and put into operation in 2004. Several other programs support commercialization projects in cooperation between researchers and companies, but the I2I program aims to fill a gap where the researchers have an idea, but no company support. The I2I aims to support the researchers to develop the idea in order get a company interested or to create a spin-off themselves. The objective of the I2I program is to accelerate the pre-competitive development of promising technology and promote its transfer to Canadian companies. The program supports research and development projects with recognized technology transfer potential by providing assistance to university researchers in the early stages of technology validation and market connection.

Eligible research and development activities include (but are not limited to): 1) refining and implementing designs, 2) verifying application, 3) conducting field studies, 4) preparing demonstrations, 5) demonstrating proof-of-concept, 6) building engineering prototypes, and 7) performing beta trials. Eligible technology transfer activities include (but are not limited to): 1) market studies, 2) consulting fees (for business plan, market survey), 3) patenting expenses (with limitations) and 4) expenses associated with creating a partnership (travel).

In order to be tailored to the university spin-off process the I2I program can provide funding in two phases. Phase I is in the proof-of-concept stage and have funding available for up to 12 months, at a maximum of $ 125 000, and is non-renewable. Phase II is called Technology Enhancement and are designed to provide scientific or engineering evidence establishing the technical feasibility and market definition of the technology, process, or product.

Phase II consist of a two funding opportunities. For the creation of a spin-off company, the Early Stage Investment Partner can support up to two-thirds of the costs of the project with the early stage investment entity providing the balance in cash. Funding should not exceed an average of $ 125 000 per year. For further

cooperation with an existing company, the Partnership with a Canadian Company is available. Projects are expected to be completed within two years and funding requested should not exceed $ 350 000 for the duration of the project. NSERC may fund up to half the cost of the project with the company providing the other half through a combination of cash and in-kind contributions.

The I2I program budget has increased to $ 8.3 million in 2005, but is expected to increase up to about $ 11 million in the future. The applications are evaluated four times a year by a committee dominated by people from the business sector. In average 35 applications are received for each evaluation and about 45% of these get funded. Although, it is the academics that apply for funding and administer the awarded grants, the applications have to be signed by the university TTO. It is expected that the TTOs will only sign on projects they believe has a real potential. Furthermore, the program secretary is often contacted by the applicants to discuss the project before the final application is submitted. There are plans to expand the I2I program to also include faculty at colleges in the future.

In general, NSERC are open to fund new ideas and initiatives from the regional level and many of the programs are based on experience and dialogue with the operators. An example on how government programs such as POP and I2I can be implemented in practice is given in Box 5.4, where the University of British Columbia Prototype Development Program is described.

Box 5.4: University of British Columbia Prototype Development Program (www.uilo.ubc.ca)

The Prototype Development Program (PDP) at the University of British Columbia (UBC) is regarded a one of the most successful commercialization initiatives in Canada. The University-Industry Liaison Office (UILO) created the PDP in 1989 to address the technology funding gap between academic inventions and commercially viable technology. The PDP is intended to facilitate the development and commercialization of early stage inventions with scarce resources by providing the management and funding necessary to validate and realize the commercial potential of the technology [15].

Between 1988 and 2005 the UILO received 1,835 invention disclosures, of which 138 (7.5%) received PDP support. A total of $ 4.7 million was invested in prototype development type projects at UBC, of which $ 0.9 million was funded directly from the UILO's PDP budget. As a result of these activities [15]:

- ✓ 57 of the funded projects were licensed or assigned to a commercial partner; 40 of these projects are undergoing active commercialization.
- ✓ The funding has stimulated innovation at UBC and directly resulted in the disclosure of 99 new inventions to the UILO.
- ✓ The UILO facilitated the formation of 34 new spin-off companies based around technologies that received investment from the PDP.
- ✓ These 34 spin-off companies rose over $ 436 million in private equity financing and a further investment of $ 24.7 million from government sources.
- ✓ As of March 2005, 19 of these companies were still active. UBC had an equity position worth almost $ 3 million in these surviving companies.
- ✓ UBC has received approximately $ 2.25 million in royalty revenue from the commercialization of PDP funded technology.
- ✓ The UILO, in partnership with UBC researchers, has proven remarkably successful at attracting funding from the new CIHR Proof of Principle and NSERC Idea to Innovation programs. The UBC success record in each stands at about 70% vs. national averages of 40% (PoP) and 50% (I2I).

The funding sources for the PDP have changed throughout the program's existence. In recent years the POP and I2I programs have been a significant source. These funds are claimed to fill a gap. Internal funds, primarily granted from the province, are also significant. More important, however, is the flexibility allowed with the internal funds. Other sources include NRC-IRAP, IRAP-MART, Western Economic Diversification, and some provincial sources.

6.3.6 NRC Industrial Research Assistance Program (IRAP)

The National Research Council's Industrial Research Assistance Program (NRC-IRAP) has been in operation for over 40 years and is known world-wide for being one of the best programs of this kind. IRAP's mission is to stimulate innovation in Canadian small and medium-sized enterprises (SMEs). In the year 2004/2005, 2615 projects got funded and the budget for 2005/2006 is $ 167 million. In addition to project funding IRAP has 235 Industrial Technology Advisors (ITAs) which are located in 90 communities across Canada. The ITAs coach a client project through all stages of the innovation process, providing technical advice, referrals and other innovation services as needed.

A considerable share of university spin-offs has received IRAP support, and these spin-offs perform better as 72% has received VC funding compared to 44% of all spin-offs. IRAP is generally considered as a very important initiative, especially

because of the funds provided and because of the consistent long-term operation. Combined with R&D tax credits, IRAP support can fund up to 60-70% of the cost in an R&D project. According to our informants the IRAP support does not overlap with initiatives such as I2I because IRAP works from industry side while I2I fund from the university side.

6.3.7 Department of Industry Commercialization pilot

The 2004 federal budget set aside $75 million over the next five years for two pilot competitive commercialization funds to be managed by Industry Canada. One of the funds will provide $50 million over the next five years to further strengthen the commercialization capacity of university and research hospitals. The remaining $25 million fund will encourage the commercialization of research conducted in federal government laboratories. Industry Canada was required to establish a private sector committee to assist in designing the funds, and implementing the competitive process, including setting objectives and criteria for evaluating proposals. This committee asserted that one way to increase the capacity for commercialization is to provide the existing technology transfer offices with access to experienced entrepreneurs, business networks, and resources to move the technologies further into the market place, and faster. They also agreed that there is a gap in the commercialization process in between the end of the research & development stages and the beginning of the venture capital stage. Activities such as concentrating on getting experienced entrepreneurs involved, developing business plans, and incorporating a customer focus into the technologies would help to address the current gap.

The two funds will be flexible, and considered as an experiment where each fund will support about 5 projects on a competitive basis. Funded project have to consist of a consortium of universities and research hospitals and have to be administered by a Commercialization Management Board with a majority of members coming from the private sector. Hence, the funds are based outside universities and their TTOs in order to facilitate technology pull. Applicants that are leveraged by external funds have a strong application, but no fixed percentages required. The funded projects have to undergo rigorous monitoring of results on an annual basis.

The pilot is considered an opportunity to try different approaches to increasing the commercialization capacity. The lessons learned and the gathering of best practices from the different approaches will give an indication as to which approaches work in certain circumstances and feed into future commercialization initiatives from the federal government. By January 2006, however, these funds are still not available.

6.4 OUTCOME AND METRICS

The high number of actors at different levels from federal and provincial government, national and regional agencies, network organizations, and universities and their TTOs and ILOs makes it extremely difficult to assess the outcome of a single initiative. There are, however, a large number of studies and statistics available.

6.4.1 Quantitative studies

Several studies have investigated the number of spin-offs in Canada. The Statistics Canada conduct a survey of intellectual property commercialization in the higher education sector on a bi-annual basis. The 2003 survey [12] reports that universities and hospitals created 64 spin-offs in 2003, for a total of 876 created to date. Another study by NRC-IRAP identified 816 spin-offs in 1999 [16], a number that is likely to have reached 1200 today. In addition, the federal laboratories have been a source of spin-offs, but a 1999 survey indicate that the number is about one tenth of the university number [17]. The number of high-growth firms, or so called gazelles, is remarkably high among Canadian spin-offs at 19% [6]. Further, 93 spin-offs have been listed at one or more stock exchanges and data from 585 spin-offs show 29 900 jobs created and $ 6.1 billion in sales for 2004.

Many Canadian research institutions are included in the AUTM-survey. Having a total research expenditure of $ 3.1 (2.5) billion, the AUTM member institutions reported 45 (58) spin-offs created and 544 (448) licenses executed in 2004 (2003). Further, the NRC has about 105 licenses issued and revenues of about $ 4.75 million from licenses last year [18].

The Natural Sciences and Engineering Research Council (NSERC) has done a study of 141 spin-off companies created by university researchers that have received grants from NSERC during the last 30 years. These companies generated total of $ 3.5 billion in sales and have almost 13 000 employees in Canada in 2004. The two largest companies have almost 4 000 employees in 2004 and $ 1.1 billion in revenue. The 4 universities with most spin-off companies in this study are University of British Columbia, University of Toronto, University of Waterloo and University of Alberta that together counts for 57 of the 141 spin-off companies in the study [19].

6.4.2 Qualitative studies

The one-dimensional focus on measuring the outcome of technology transfer activity by counting the number of patents, licenses, spin-offs, revenue generated

etc. is increasingly critiqued. It is recognized that the major channels for technology transfer are the transfer of people, especially graduated students, and research cooperation with existing industry including faculty consulting. Hence, licensing and spin-offs accounts for only a small share of technology transfer from research institutions and their impact might be difficult to separate from the other technology transfer activity.

Furthermore, the available statistical tools are not able to fully measure the impact from technology transfer activity on the Canadian society. It is a challenge to quantify the investments of NSERC whose role is "*to make investments in people, discovery and innovation for the benefit of all Canadians*", or the goal of CIHR which is "*improved health for Canadians, more effective health services and products and a strengthened Canadian health care system*". The need for more in-depth accounts of the outcome from commercialization activities is addressed by a yearly publication from NSERC [19]. This booklet gives a one page description of 141 university spin-offs that have emerged from NSERC supported research and has been used both internally and by politicians. From 2003 the same trend occurred in the AUTM survey which included a much-expanded discussion explaining the ultimate goal of academic and nonprofit technology transfer. This report included the stories behind 25 technology transfer success stories in the United States and Canada. Case studies are, however, used mainly for illustration. A challenge experienced with relying more on case studies is that it is difficult to find people who can do good case studies.

The rhetoric seems to be changing from a strong focus on financial measures towards more soft measures including a wider conception of technology transfer impact on social and economic well being. Apparently, agencies such as NSERC try to convey to universities that the goal is not revenue from projects, but benefit to Canada and Canadians. The logic is that the universities should not only seek revenue for themselves as the government has invested a lot in universities for social and economic purposes. As seen from NSERC the goal is "*to promote knowledge-based wealth creation in Canada. That is, the goal is to grow our economy and provide the jobs and quality of life that will retain our highly qualified personnel. This is a long term goal that requires a long term approach based upon relationship building, which cannot be focused primarily upon today's bottom-line*". Also in US the TTOs are more viewed as a part of the universities' societal responsibility than as a source of revenue for the universities. According to NSERC the most important output of all programs for technology transfer is training (except I2I), and the best vehicle for technology transfer is transfer of people.

6.4.3 Program evaluation

Ideally, evaluators would like to measure impact on the Canadian economy and well being, but according to the evaluation expert at NSERC, it is impossible to measure cause-effect relations of single programs, because things work so interwoven. Program evaluations are usually based on a contribution approach where it first is addressed what happened, and then estimated what would have happened if not the program were in place. At NSERC the evaluations are usually done by a consultant, but managed by evaluators at NSERC. The IPM and I2I programs will be evaluated in 2007/2008 based on an RMAF (See Box 5.5).

Box 5.5: Result-based Management and Accountability Framework (RMAF) at NSERC

The Result-based Management and Accountability Framework (RMAF) is a blueprint for managers to plan, measure, evaluate and report on results throughout the life cycle of a policy, program or initiative. During the last years, RMAFs have been more common as a tool for evaluation and assessment of programs at Canadian agencies. This is partly as a response to requirements set by the Treasury Board. The Natural Sciences and Engineering Research Council (NSERC) has the most well developed approach, using RMAFs for all their programs. According to the evaluation manager, this kind of structured approach is still rare among other granting institutions in Canada and not found among any the other G8 countries either.

An RMAF typically includes five key elements:

- A profile briefly describing what the program, policy, or initiative is.
- A logic model showing how activities are intended to achieve planned outcomes.
- An ongoing performance measurement strategy ensuring that achievements will be measured appropriately.
- An evaluation strategy specifying the evaluation work required.
- A reporting strategy ensuring adequate reporting of results.

According to the evaluation manager, a culture change was needed to implement the RMAF, because program managers have to collect the data on an ongoing basis. This took about two years. One of the advantages of the RMAF is that evaluations are much easier and more precise when the data are collected on an ongoing basis compared to evaluations based on data collected after the program period.

6.5 INTERVIEWS IN CANADA

During our visit in Canada, February 2-10 2006, we had meetings with the following persons:

- Anne Alper, PhD, Manager of the RPP Planning and Budget Research Partnership Programs, NSERC, Ottawa
- Tim Angus, Senior Policy Analyst, Innovation Policy Branch, Industry Canada, Ottawa
- Denys G.T. Cooper, PhD, Senior Advisor Technology and International, NRC, Ottawa
- Guy Drapeau, PhD, Portfolio Manager at Information, Communication & Manufacturing Research Partnerships Program, NSERC, Ottawa
- Glenn Egan, Managing Director, Venture Capital, Business Development Bank of Canada, Ottawa
- Jean-Claude Gavrel, Director, Networks of Centers of Excellence of Canada, Ottawa
- Mike Hewett, Business Development Manager, Westlink, Vancouver
- J. Adam Holbrook, P. Eng, Associate Director at Centre for Policy Research on Science and Technology, Simon Fraser University, Vancouver
- Larry, Lam, P Eng, Director, Technology Seed Investments, Business Development Bank of Canada, Ottawa
- Jean-Jacques Ledoux, Manager, Industry Partnership Facility, NRC, Ottawa
- Angus Livingstone, Managing Director, University-Industry Liaison Office, University of British Columbia, Vancouver
- Elicia Maine, Assistant Professor, Segal Graduate School of Business, Simon Fraser University, Vancouver
- Linda McKenzie, Deputy Director, Innovation and Industry Programs, CIHR, Ottawa
- Kristin Melsom, First Secretary, Royal Norwegian Embassy, Ottawa
- Shannon Miles, Manager, Technology Innovation at Hydrogen, Fuel Cells and Transportation Energy CANMET Energy Technology Centre, Vancouver
- Ezra R. Miller, Principal, Ibex Consulting, Ottawa
- James Miller, Policy Analyst, Knowledge Infrastructure Directorate, Innovation Policy Branch, Industry Canada, Ottawa
- Susan Morris, Chief, Evaluation Policy and International Relations, NSERC, Ottawa

- John de la Mothe, Canada Research Chair in Innovation Strategy, University of Ottawa, Ottawa
- Michelle Peel, PhD, Deputy Director, Commercialization Programs, CIHR, Ottawa
- Morna Paterson, Director, Federal Partners in Technology Transfer (FPTT-PFTT), Ottawa
- Jean-Pierre Rodrigue, International Relations Analyst, NSERC, Ottawa
- W. Brett Sharp, PhD, Technology Transfer & Prototype Development Manager, University-Industry Liaison Office, University of British Columbia, Vancouver
- Ingrid Schenk, D Phil, Policy Analyst, Innovation Policy Branch, Industry Canada, Ottawa
- Stephen Smith, Flintbox, Vancouver
- Meira Sudds, Flintbox, Vancouver
- Robert Therrien, Portfolio Manager at Environmental and Natural Resources Research Partnerships Program, NSERC, Ottawa
- Yoga Yogendran, PhD, Director, Technology Development and Commercialization at Institute for Fuel Cell Innovation, NRC, Vancouver

7. FINLAND

In 2005, for the third year in succession, the World Economic Forum's Global Competitiveness Report ranked Finland as the most competitive economy in the world, ahead of the USA and Sweden. Policy studies often refer to Finland as a world class model having an innovation environment with high R&D investments, high number of patents filed, highly educated workforce, and a high share of high-technology based firms, just to mention a few indicators. Finland has become a major exporter of electronics and other high-tech products accounting for over 30% of exports.

7.1 OVERVIEW OF THE FINNISH R&D SYSTEM

Since the economic crisis in the 1990ies, with an unemployment rate of almost 20 % in 1994, Finland has achieved a remarkable growth in R&D expenditure. Finland has become number three in the world after Sweden and Israel, with an effort of 3.5% of GDP. It is, however, estimated that Nokia alone accounts for one third of all expenditure on R&D in Finland. The central element in 'the Finnish model' is the well-developed networks in and among companies and universities, and their strong orientation toward R&D cooperation [20]. 70% of Finnish innovative firms cooperate with other firms, universities or public research institutes [21]. In comparison, the EU average is 25%. It is generally agreed that public funding in general and Tekes in particular has been a crucial change agent in promoting this transformation of the Finnish economy. The main actors in the Finnish science and technology system are outlined in Figure 6.1.

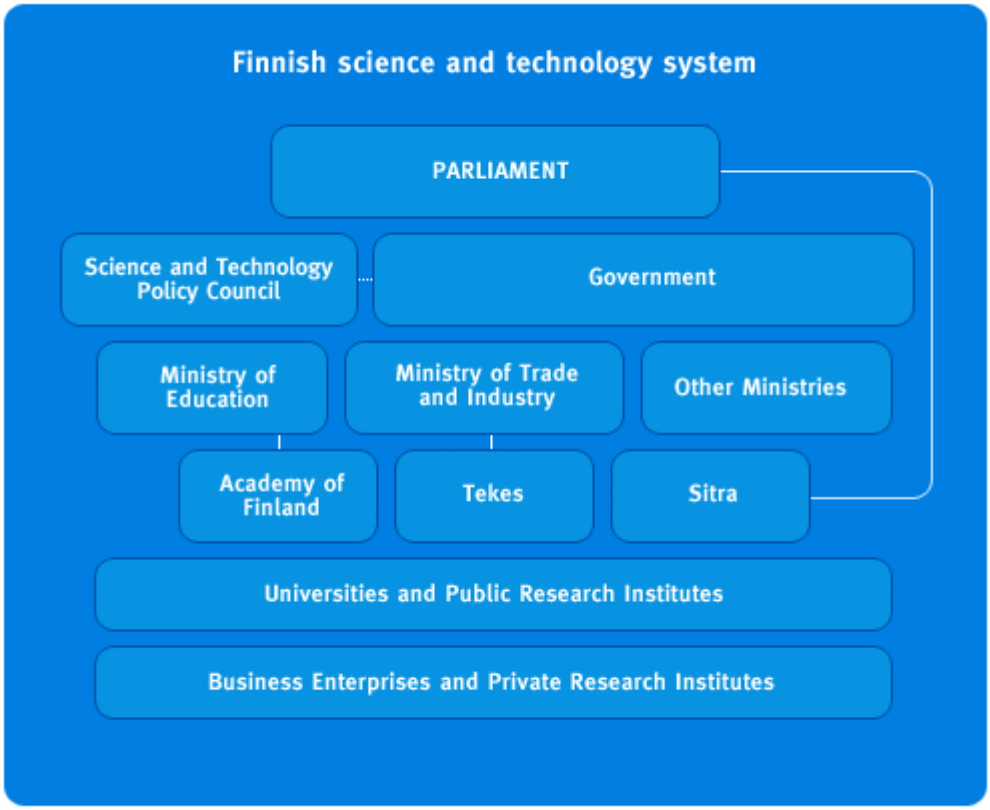

Figure 6.1: Main operators in the Finnish innovation environment (Source: www.reserach.fi)

The Ministry of Education is responsible for matters relating to education and training, science policy, higher education and the Academy of Finland. The Ministry of Trade and Industry is responsible for matters relating to industrial and technology policies, the National
Technology Agency (Tekes) and the Technical Research Centre of Finland (VTT). Nearly 80% of government research funding is channelled through these two ministries [3]. The distribution of state R&D is shown in Table 6.1.

	R&D funding	Share of R&D funding
	Mill. €	%
Universities	416,7	26,1
Academy of Finland	223,5	14,0
Tekes, the National Technology Agency	448,4	28,1
State research institutes	259,4	16,3
University central hospitals	38,0	2,4
Other research funding	208,0	13,1
Total	1 594,0	100,0

Table 6.1: R&D funding in the state budget in 2005 (Source: www.reserach.fi)

7.1.1 Innovation policy development

In the late 1990s the emphasis of Finnish science and technology policy shifted from promoting R&D, to promoting R&D, internationalization and commercialization. Currently, the policy makers in Finland give strong attention to globalization and the corresponding internationalization policy. A key challenge is seen as fostering internationally competitive high-growth SMEs. To make more companies grow is considered to be more important than creating more start-ups. Hence, the supply of venture capital is another important innovation policy area

The extension and strengthening of network co-operation is seen as one of the key questions in the development of the innovation system in Finland. A number of projects and initiatives have been created to promote the transfer and utilization of knowledge. Recently, there have been two major initiatives to promote cross- and intra-sectoral collaboration. First, the Centre of Expertise Programme aims to enhance regional competitiveness by strengthening innovation, renewing the production structure, and creating new jobs within selected expertise areas. Second, the cluster programs aims to support R&D activities that strengthen clusters and

collaboration between the industry and public organizations as well as company to company cooperation including user-opinions.

As in most other countries, increased commercialization of research is seen as an important vehicle for succeeding in creating internationally competitive industries and firms. This priority is, however, mainly expressed by the Ministry of Trade and Industry and not so much by the academic sector. Although the coordination between the responsible agencies is said to be improved in recent years, the 2004 annual report from Academy of Finland does not include commercialization as a topic. Compared to other countries, Finland has been late in implementing reforms in the university sector which gives the universities a clearer responsibility to be actively involved in commercialization of research. Recent changes in legislation instruct the universities to include the third mission as part of their activity and open the possibility for universities to become shareholders in public companies. From 2006, also the IPR legislation is changed, giving the universities, not the researcher, ownership of IP emanating from university research. Nearly the same legislative change was implemented in Denmark in 2000 and in Norway in 2003. The Finns, however, made one compromise with the academic community; the university researcher still owns IP from pure basic research.

7.2 OVERVIEW OF ACTORS AND COMMERCIALIZATION INITIATIVES

This section presents the main actors in Finland responsible for initiatives to increase commercialization of research. The innovation environment in Finland consists of a large number of actors. The main groups and their position are sketched in Figure 6.2.

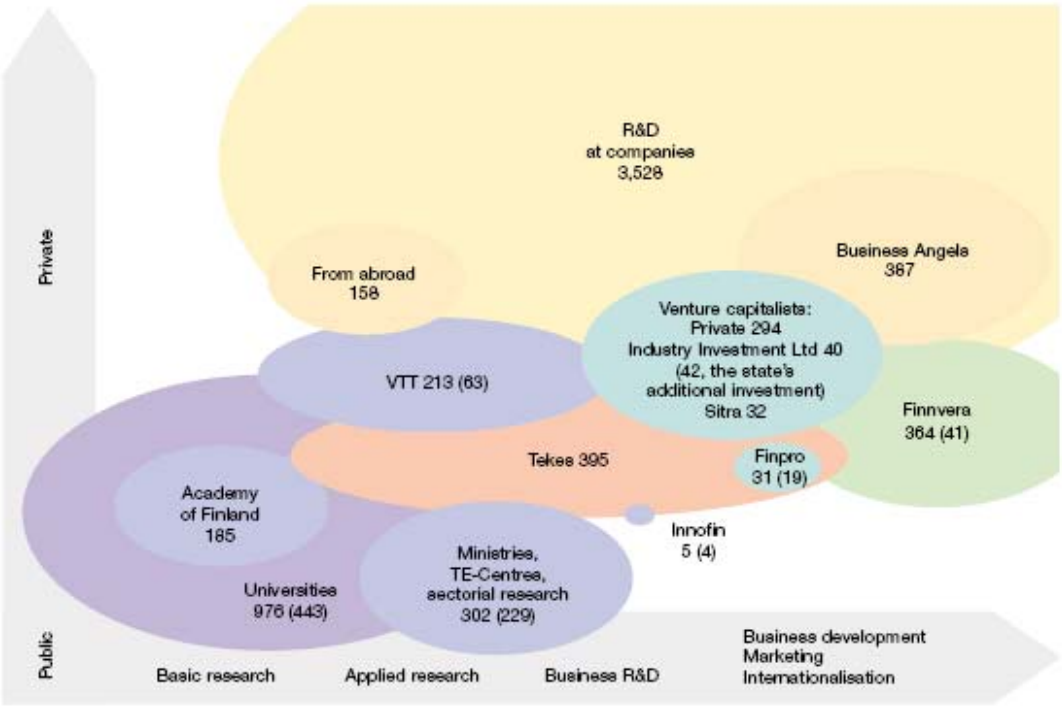

Figure 6.2: Different financiers focus on different parts of the innovation chain. The figures show the total extent of each organization's operations in 2003 in millions of euros. The figures in brackets show how much financing comes directly from the state budget. Tekes and the Academy of Finland receive almost all their financing from the state budget (source: Tekes [22]).

7.2.1 The National Technology Agency -Tekes

As shown by Figure 6.2, Tekes is the largest player in the intersection between performers of research and potential users of research. Tekes play a central role in the Finnish innovation system and contributes to the development of innovation policies in cooperation with the Ministry of Trade and Industry. Tekes share of the public budget is growing and take a large part of public funding of the innovation system. In 2004, Tekes supported 2242 research and development projects with a total of € 237 million for corporate projects and € 172 million for universities, research institutes, and polytechnics.

Tekes is set up to support technology development projects and networking initiatives. Tekes is a risk taking organization, and according to key informants this implies that the project failure rate should be relatively high. Collaborative research

is heavily promoted by Tekes' financing schemes. Usually, Tekes have funded only technology development, but in recent years also projects after the technology phase have been supported through initiatives such as the TULI program.

7.2.2 Technical Research Centre of Finland VTT

The VTT is the largest public research institute with about 2660 R&D personnel in departments across Finland and a turnover of € 218 million in 2004 [23]. 31% of VTT's budget is basic government funding. Until 2006, each VTT institute was responsible for the commercialization of research. The Biotech institute has been the most active. In dialogue with its funding body, the Ministry of Trade and Industry, the creation of spin-offs is now included as a part of the output from VTT. Currently, the CEO at VTT speaks highly about the importance of spin-offs. From 2006, VTT has set up a new department focusing on commercialization of VTT research, VTT Ventures, with an annual budget of about €10 million. VTT Ventures will be jointly accountable with other units for VTT's IP strategy and its implementation, and for developing new professional practices for commercialization.

Since the 1970s, however, there have been a total of 70-100 spin-offs from VTT. Furthermore, VTT has been active in patenting, with about 1000 patent application the last 20 years, but the issue now is to do something about the patent portfolio. The attitude among VTT researchers is not seen as a hindrance to commercialization compared to the situation in the universities. The largest barrier is said to be the lack of instruments to fund or support the development of commercialization projects, such as proof-of-concept funds. The TULI program, however, contributes with small sums in this phase. Traditionally, it has been difficult for a VTT researcher to get leave of absence to work on a commercialization project. Furthermore, the close connection between researchers and companies in VTT might explain why spin-off based commercialization is less prevalent.

7.2.3 The universities

All the 20 Finnish universities are state-run, with about 44% of their research funding awarded over the national budget. In addition there are 29 polytechnics funded both from government and municipalities and conducting industry relevant research. In about 1995 the Science technology Policy Council outlined a national innovation system. At the same time there was a discussion about the university legislation and IP ownership. As a result the universities started offices called Innovation Services, which have a mission similar to industrial liaison offices

(ILO) found e.g. in the US. The Innovation Services could also own IPR, but this had to be negotiated with the researchers from case to case.

All universities have industrial liaison offices and some run innovation centres. They attempt to promote research and technology transfer by helping researchers in applying for external research funding, drafting contracts and managing the research projects. Some research offices have more personnel and offer wider services. In these cases they are likely to be called research and innovation services or innovation centers. The services offered cover a huge variety of consulting, information, training and organizational services. Some of the staff members are not employed by the university but by the Finnish Foundation for Inventions through their innovation manager initiative (see section 6.3.1).

The policies supporting the commercialization of research in universities and public research organizations are divergent. For instance, VTT and Helsinki University of Technology have adopted a more rigorous IPR strategy while many other universities and research institutes are still in the learning phase. According to well informed persons, there are still some cultural barriers in the universities; there are no dedicated funds for innovation support infrastructure and little academic education in entrepreneurship.

There are little quantitative and qualitative information available on the innovative output from Finnish universities [3]. A study by Meyer et al. [24] identified 530 US patents granted between 1986 and 2000 which could be related to university researchers as inventors. The bulk of these patents are owned by industry; whereof 56 are owned by Nokia.

7.2.4 Regional level

At a regional level, technology centers, science and technology parks, centers of expertise, Foundation for Finnish Inventions, and technology transfer companies form the commercialization infrastructure. Finnish science parks provide premises and services for both high-tech start-up companies and more established businesses. The Foundation for Finnish Inventions is a state-owned organization that supports and helps private individuals and entrepreneurs develop and exploit invention proposals both within Finland and internationally.

In 1997, T&E centres were established to implement innovation activities at regional level alongside with several other tasks related to regional development. The T&E centres supports innovative activity and constitutes meeting places between the university and industry, supports business incubators, and organize

training and education. The organization of TE-centres is perceived as functioning well by the SMEs for its proximity to industry and regions. However, its role in the national innovation system is blurred because it has to meet both national and regional expectations [3].

7.2.5 Seed and venture funding

According to a recent study, government funding, directly or indirectly, is still a main contributor to the Finnish seed capital segment (Seed capital investment in Nordic countries). The most significant public venture capital organizations are Sitra and Finnvera. In addition, the government venture capital firm Finnish Industry Investment (FII), was established in 1995 to promote the development of venture capital in Finland.

The Finnish National Fund for Research and Development (Sitra) is an independent public foundation under the supervision of the Finnish Parliament. Sitra played a significant role in the establishment of the Venture Capital Association in 1990. The Fund provides venture capital for high-tech enterprises has its own research program and organizes training programs. Sitra's activities are financed by the yield from its own endowment capital and the return on its venture capital investments. Sitra's own activities include technology transfer and venture capital investments in emerging and technology-based start-up companies as well as spin-offs from large companies. Sitra's PreSeed service package has been created to accelerate the emergence of new technology-based businesses, improve capital management and introduce companies to the providers of further funding, including private venture capitalists. The PreSeed service consists of two initiatives: LIKSA and INTRO which is described in Section 6.3.4 below.

Finnvera plc is a specialized financing company owned by the Finnish government. It offers financing services to promote the domestic operations of Finnish businesses and to further exports and internationalization of enterprises. Finnvera grants loans to enterprises and entrepreneurs, and issues guarantees and export credit guarantees to enterprises and financiers. Also the EU financing programs are mediated through Finnvera in Finland. The main emphasis of Finnvera is on financing already active enterprises with stable income, accepting a higher credit risk than the banks do. Funding of R&D activities is not a special emphasis of Finnvera, although it is possible to finance such activities through the Development Loan.

New technology-based firms in Finland have the last couple of years experienced difficulties in getting external finance in their start up phase. There has been a

visible gap in seed funding since year 2000. So, Finnvera has been redirected to seed finance in recent years and has recently developed an equity instrument (Aloitusrahasto Vera Oy) in addition to their traditional risk loan instruments. Moreover, Tekes introduced a capital loan for starting up technology-based companies. With this loan Tekes shares the financial risk borne by the founders of a company and lowers the threshold for setting up a new company. In 2004, two calls were launched, producing a total of 158 applications. Based on the first of these, 25 decisions totaling € 2.2 million were made.

Another interesting development is the reorientation of Finnish Industrial Investments (FII). This organization was originally designed as a public fund in fund investment instrument, but following a new set of governmental guidelines in 2003 the investment strategy was changed. In addition to the fund in fund activity, FII are now doing direct investments in new technology-based firms. FII made 40 direct investments in 2004. It is also interesting to note that Sitra has reduced their ambitions as an actor doing direct investments in Finnish growth companies. Nevertheless, this means that three different publicly funded organizations have developed seed capital instruments. This is confusing and the initiatives are seen as competing instruments by the users. The lack of coordination between the different actors is also seen as a potential problem. On the other hand, there are a number of governmental sources available for projects seeking seed capital funding. Another concern is the lack of focus on the competence dimension when setting up these instruments. The three initiatives reported here are in their “early” days, and there exists no data about short term or long term performance.

7.3 DESCRIPTION OF SPECIFIC INITIATIVES

Many of the organizations in the innovation environment are set up to support R&D and innovation, and the total numbers of instruments offered are numerous. It seems difficult to get a full overview, and one review of selected initiatives by Ahvenharju et al. [25] included 40-50 different instruments. Some of our informants estimated the number to be more than 100. Even well informed persons have limited overview, and the difficulty of an entrepreneur or SME to navigate among all instruments are frequently mentioned. The number of instruments specially targeted at commercialization of research is, however, fewer. Innovation policies in Finland seem traditionally to have been directed at existing companies to increase their R&D capabilities and collaboration with public R&D institutions. Hence, few measures have been put in operation to increase entrepreneurial activity in public R&D institutions. This university-industry collaborative approach seems to work well in research areas closely linked to practice, such as engineering. In

more basic research areas such as biotechnology, however, there is room for more targeted initiatives.

There are only three national programs or initiatives to facilitate commercialization of research in the early stage which have been in operation for some years; the Innovation Managers, Venture Cup, and the TULI program. In addition, the LIKSA and INTRO programs might be important when a spin-off firm has been established. Further, there are several new initiatives such as the VTT commercialization department and a number of regional initiatives such as the university innovation services and science parks.

7.3.1 FFI Innovation Managers

In the mid 1990s, the Finnish Foundation for Inventions (FFI) placed innovation managers at most Finnish universities. As these regionally based positions were employed by FFI centrally, networking at a national level was facilitated. Their operation varies, however, due to large differences in the focus and conditions for working with commercialization at the different Finnish universities and regions. Currently, there are 28 innovation managers in universities or at Employment and Economic Development Centers in different parts of Finland.

FFI aims to serve as a link between inventors, innovators, consumers, businesses and industry in Finland or other parts of the world whether it is a matter of setting up production, licensing, or any other means of exploiting an invention. In addition to the innovation managers, FFI has 24 technical and commercial experts and a package of instruments including: financial support (risk financing, grants and loans), marketing and commercialization of inventions, search for Finnish and/or foreign partners, licensing offers, information on inventions and innovations through media coverage, seminars and relevant trade affairs, and legal and other assistance in licensing negotiations and preparing agreements.

One example of how the innovation managers are integrated in the university sector is the Helsinki University of Technology (HUT). In 1998, HUT established Otaniemi International Innovation Centre (OIIC) as a "One Stop Shop in Technology Transfer". OIIC works with Research Liaison, Contract Management, Innovation Services, Career and Recruitment Services, and Alumni Relations. The staff is a combination of university employees and about four of the Innovation Manages hired by FFI.

7.3.2 Venture Cup

Another initiative which is partly aimed at promoting research based start-up in early phase is Venture Cup, which in 2006 is running its 6th season in Finland. Venture Cup is organized by universities, polytechnics, business incubators, and technology centers in 13 different regions across Finland. The main sponsors are Ministry of Trade and Industry, Tekes, and McKinsey & Company. Venture Cup Finland is a three-stage business plan competition for aspiring growth companies. The competition is primarily designed for researchers, teachers, and students, yet it is open for everyone. Participating teams go through a process of education, coaching and screening, which will develop business ideas into complete business plans. Prizes totaling € 100 000 are awarded to the best business plans.

According to our informants, Venture Cup is a visible initiative with a good brand and good reputation among venture capitalists and businesses in Finland. Although it varies from university to university, the Innovation Managers are reported to cooperate well with Venture Cup. The participants are, however, mostly students, although some research-based projects participate. Venture Cup is said to be complementary with TULI, and received more than 342 ideas in the first phase this season.

7.3.3 TULI

The most targeted initiative to support commercialization of researched-based results from Finnish universities and research institutes is the TULI-program. The TULI program operates in the pre-commercialization phase and is funded by Tekes with an annual budget of € 2.5 million. The main goal of the TULI-program is to promote new, technology-based businesses coming from applied research in Finland. Its objective is to recognize and find research-based innovations and offer them expertise in commercial development. It is a practical continuum for projects previously funded by TEKES although this is not considered as a restricting factor. TULI's focus is to promote commercial utilization of innovations through new start-up companies or by technology transfer into existing companies, for example by licensing.

TULI awards a 100 % grant of € 10 000 in maximum per project to provide business expertise by consultants. These commercial experts are chosen in cooperation between the TULI-coordinator and the innovator. The consultants conduct market research, partner search etc. The maximum level of funding per project is € 10 000. The innovator maintains full rights over his/her innovation. Data security and the rights of the innovator are highly emphasized.

TULI is coordinated by the Finnish Science Park Association (TEKEL) and is operated by 8 regional operators across Finland. The TULI-program was evaluated and modified before the start of a new program period from April 2002. The regional operators were selected on the basis of an open competition. The FFI Innovation Managers are considered as important for the TULI program, as they contribute with about 1/3 of the ideas. The TULI-program is also related to the INTRO and LIKSA programs for further development of the ideas.

Box 6.1: The TULI operation in Otaniemi, Espoo

The Otaniemi campus in Espoo has 3000 researchers and about 15 000 students, mainly connected to Helsinki University of Technology (HUT) and VTT institutes. According to information brochures, Otaniemi is the largest high-tech centre in the Nordic countries.

The running operation of the Espoo TULI program is taken care of by a project manager at the Technopolis science park, assisted by a half position. The TULI operation is governed by a project management team of about 10 persons who meet 4-5 times a year. This team consists of key representatives from the research and innovation actors in Espoo, and they are well harmonized in order to have a common picture of the mission and key tasks of the TULI program. The decision about what project to support is taken by a Project Team consisting of about 10 persons from the local business community meeting once a month. Each project is presented in plenary before the decision about funding is made. The TULI project manager maintains a shortlist of consultants which are used, and the Project Team agrees on what consultant is most suitable for each assignment.

The marketing of the TULI program is done on a network basis through contact persons at each research department. The IP owners are considered to have a particularly important role in promoting the program, and the fact that the Vice Rector at HUT and a VTT professor are members of the TULI national board is important in this respect. VTT arranged a business idea competition in the spring 2005 where the top 5 ideas automatically received TULI support. The competition received 46 ideas in total, whereof 15 qualified for TULI support.

TULI Espoo received 173 ideas in 2005, but the support is limited to about 65 projects a year based on an annual budget of € 500 000. Half of the projects are licensing cases, the other half spin-off projects. About 30% of the ideas are commercialized. The fast and un-bureaucratic operation and a strong integration

with universities and research institutes are pointed out as important for the future development of the TULI-program. TULI means 'fire' in English, and the program is marketed through brochure along with TULI-matchsticks in the research groups.

Half of the start-ups emerging from a TULI project contact Technopolis for further support. Technopolis has a complete set of services available for start-ups, and the TULI program is an important source of ideas for the discovery phase where Technopolis offer the Quick Scan program. Technopolis offer a basic incubator package for € 100-150 a month plus rent for office space of € 200-300 a month. The incubator package is subsidized by Tekes and T&E by about 500 € a month. About 45 new companies are accepted each year, while 150 ideas go through the Quick Scan test. About 12 persons work with start-up services at Technopolis.

7.3.4 INTRO and LIKSA

Sitra's PreSeed service package has been created to accelerate the emergence of new technology-based business, to improve capital management and to introduce companies to the providers of further funding. The PreSeed service has two arms: INTRO and LIKSA.

Introduction to Initial Investment Market (INTRO) is aiming to introduce business ideas of new technology enterprises to capital investors. About 40 enterprises are accepted to the program per year. The INTRO service takes care of the efficient presentation of start-up enterprises so that they can find both institutional and private investors. It operates through company presentation forums, focused investment negotiations and a Web service. INTRO is complemented with DIILI, a search service for marketing professionals ready to join start-up businesses, and LIKSA, a financing instrument for preparing business plans.

Funding for Business Idea Development (LIKSA) is a Sitra and Tekes funded program to fund development of business ideas for start-up enterprises and for international expansion
About 200 enterprises are accepted to the program per year. Enterprises receive a maximum of € 40 000 to make a business plan. Whilst writing the business plan, certain market research tasks can be undertaken. The company has, however, to be in the process of making a business plan and planning to look for venture capital investments in order to qualify for the LIKSA program. Sitra claim a first right to invest in the LIKSA cases.

7.4 INTERVIEWS IN FINLAND

During our visit in Finland, 12-14 December 2005, we had meetings with the following persons:

- Erik Furu, Business Development Advisor, Technopolis Ventures Ltd., Espoo
- Mari Hjelt, Dr., Gaia Group, Helsinki
- Antti Joensuu, Deputy Director General, Technology Department, Ministry of Trade and Industry, Helsinki
- Peter Kelly, Dr., Department of Industrial Engineering and Management, Helsinki University of Technology, Helsinki
- Pirjo Kutinlahti, Senior Researcher, VTT Technology Studies, Espoo
- Tatu Laurila, Director, Culminatum Ltd., Helsinki Region Centre of Expertise, Espoo
- Aila Maijanen, Senior Technical Advisor, Tekes, the National Technology Agency, Helsinki
- Markku Maula, Professor of Venture Capital, Department of Industrial Engineering and Management, Helsinki University of Technology, Helsinki
- Tuomo Pentikäinen, Programme Manager TULI Programme, Finnish Science Park Association, Espoo
- Henrik Tötterman, Assistant Professor, Hanken Swedish School of Economics and Business Administration, Helsinki
- Ville Valovirta, Research Director, Net Effect Ltd. Helsinki

8. IRELAND

8.1 OVERVIEW OF THE IRISH R&D SYSTEM

During the nineties, Ireland formed a new enterprise policy emphasizing means to strengthen their knowledge-based industries. National policy was formulated to make effective use of EU programs. In addition to the EU Fifth Framework Program for Research & Technological Development, Ireland has seven national Programs in Advanced Technology. Among others, Ireland established centers of expertise to offer specialist services to industry. An important part of this new policy has been to develop a distinctive culture of higher education research, with special emphasis on biotechnology and information technology. Ireland also made significant efforts to attract inward investments from multinational companies.

As a result the country is the second largest exporter of software and related products in the world. The multinationals and especially US companies have established production and development units in Ireland to benefit from closeness to the EU and UK markets, low costs of labor, and a low 10% company tax. The Irish economy outperformed all other European economies in the 1990's, recording a growth rate throughout that period of three times the EU average. Ireland's per capita GDP rose from 66% of the EU average in the 1980s to over 100% in the late nineties.

Increased competition from low cost countries in Asia and the new EU members in Eastern Europe called for a new strategy. There was an understanding within industries and the government that the Irish companies would not be able to compete on price in the future. Also, the Irish authorities acknowledged that Ireland was too dependent on resource-based and mature industries like the food and beverage industry. Ireland therefore had to improve the development of new industries, and increase their attractiveness among multi-national companies. As a response to this new objective, it was felt necessary to increase competence within the work force and provide a R&D platform for emerging industries and especially high-tech companies.

In the late 1990s, Ireland lacked research capacity in several strategic areas. The innovation performance was low. In 2001, the EU-15 average R&D expenditure was 1.98% of GDP and the EU-25 average was 1.93%. Ireland R&D expenditure in percent of GDP was 1.4%, significantly below EU averages. Ireland was also lower than the European average (EU-15). Ireland was comparatively low on a

number of R&D parameters including venture capital, number of researchers, scientific papers published, and patents (EPO and USPTO).

8.1.1 Innovation and commercialization policy

Within the new innovation policy, an increased emphasis was laid on product innovation and the development of strong high-tech industry clusters. The leading principle of Irish policy was that the enterprise support structures and processes needed to be adjusted to the development of Irish industry. A National Development Plan for 2000-2006 was established to develop an effective innovation structure. It greatly increased the level of R&D funding and support to a selection of investment and stimulation programs.

The National Development Plan introduced an increase in the R&D investments in Ireland from € 0.5 billion in 1994-1999 to € 2.5 billion in 1999-2006. With a high increase in research funding, the challenge was to ensure that the innovation system delivered the planned and required outputs. In 2004, the policy emphasis was described in the report "Building Ireland's Knowledge Economy the Irish Action Plan for Promoting Investments in R&D to 2010" [26]. This report proposed R&D targets related to the Lisbon agreement and made recommendations to the Inter-Departmental Committee for Science, Technology, and Innovation.

The Innovation Plan for 2000-2006 is now replaced by another plan expected to speed up the innovation process even further. An evaluation panel of the Science Foundation Ireland (SFI) recommended stronger cooperation between SFI, the universities, and Enterprise Ireland to better identify outputs from research that can be commercialized, and find mechanisms for linking these ideas to industries. At the individual level, they suggest more flexible working conditions for researchers with commercial ideas. At university level, the emphasis is on the TTOs consultancy skills and skills to optimize the selection of management teams of commercialization projects. Their recommendation also includes encouragement for business schools to increase teaching and research in innovation processes and in commercialization of research.

8.2 OVERVIEW OF ACTORS AND COMMERCIALIZATION INITIATIVES

A large amount of basic and applied research funding is channelled through the Department of Enterprise, Trade and Employment. The objective is that these research investments channelled both to the university and the larger corporations will increase the number of high-tech products from both new and established

companies. In 2000, the Science Foundation Ireland (SFI) was set up to undertake and support strategic research within the universities and research institutes. SFI increased its funding levels from € 10 million in 2001 to € 121 million in 2005. It established 163 research groups employing 1150 researchers and 450 PhD students. Twenty per cent of the research groups were led by scientists coming from abroad. It also established six Centres for Science, Engineering and Technology together with major industry corporations. Increased efforts were oriented towards technology assessment and intelligence, monitoring industry technology development and new platforms in Ireland and abroad.

A gap in the Irish research support system was identified in the phase of bringing applied research towards commercialization. Enterprise Ireland is recommended to develop "competence centres" to address industrial needs for more applied research and to help link industry to the research outputs from the research institutions. In the 3rd sector, the universities were regarded important in the fulfilment of the National Innovation plan. 90% of fundamental research is performed within the seven largest universities. In addition there are 14 technology institutes. The main research institutions were meant to provide increased university-industry relations providing applied R&D services for the corporations. Also, inspired by the US university system, the objective was to increase the commercialization of research results through selling licenses to the private sector, and through spinning-out new companies. With only a few examples of spin-offs and licensing agreements within the university sector, one felt that there had to be stimuli for commercialization to bridge this "development gap".

The Irish Council for Science, Technology and Innovation (ICSTI) developed a National Code of Practice for the management and commercialization of intellectual property from publicly funded research, and the implementation of procedures was given a priority for all public research organizations. A special responsibility for commercialization was given to Enterprise Ireland (EI), the Irish National Economy and Business Development Agency. Enterprise Ireland was established in 1998 as a merger of several different agencies. The aim was to have one single customer interface that could offer tailored support for enterprises across Ireland. Investing in research and innovation is one of EIs five main activity areas. The target groups for this effort were the research institutes and the researchers, together with the companies facilitating spin-offs and commercialization of patents.

The Campus Companies Program was established as an Enterprise Ireland initiative. This program was aimed at helping researchers interested in commercializing from the college campus. Till 2000, the program had assisted about 140 enterprises, and it was estimated that over 2000 jobs had been created.

The program was seen as an instrument to provide training for lecturers, and researchers interested in gaining business and commercial skills. The Enterprise Platform Program was a one-year long rapid incubation program. This full salary support scheme was designed to provide hands-on support and management development for entrepreneurs who wish to start their own business. The program operated in connection with seven educational institutions providing support for university start-ups.

In 2001, a renewed commercialization program was formed. Within this program there were three main tools. First, there was a commercialization fund providing support for the research based commercialization project through the different phases up to a licensing agreement or a new firm. Second, an advisory and partly funding scheme for the patenting process was established. Third, so-called Client Teams was developed to provide specialized support at university level. The client teams were divided into three groups according to the research fields in priority. These were ICT, bio technology, and industrial technology. The client team employees are spending part of their time at a university.

The government and Enterprise Ireland also discussed schemes to bridge market imperfections for the new high-tech companies, especially during the early growth phase. The private investors (business angels) and the seed capital funds were not able to provide the capital necessary for the new high-tech firms. The support system for the commercialization process was therefore supplemented with investment schemes where Enterprise Ireland provides “soft” long-term equity capital to develop the business platform and to finance growth.

Enterprise Ireland also wanted to bridge an anticipated demand side imperfection as to knowledge and networks for high-potential firms. They therefore introduced the High-growth development teams, providing advisory support for smaller firms with growth potential. An important part of the High-growth firm program has been to develop the seed capital market for early stage ventures, especially prior to the prototyping stage. Also, the venture capital market has been in focus especially in the ICT and biotechnology sector.

8.3 DESCRIPTION OF SPECIFIC INITIATIVES

Enterprise Ireland is responsible for the main financial packages for the university researchers. Ireland has three main schemes for research commercialization; Client teams, Commercialization fund, and Patent fund and advice. In addition, they got an incubator program that offers space and support to entrepreneurs across the

country who wants to develop their projects within the structure of a college campus.

8.3.1 Client teams

The client teams work with researchers who are interested in seeing their research being put into commercial use. Enterprise Ireland has client teams in three areas: biotechnology, industrial technologies, and informatics. The team member represents a competence resource for the researchers. They can act as an agent for the entrepreneurs when they are seeking to commercialize their research and assist in building external networks.

Box 7.1: Enterprise Ireland Client Teams: EI Bio

The Enterprise Ireland Client Teams work both at national level and at the universities to facilitate spin-offs and patents commercialization, contributing with their industry networks and specialized science and industry competence. One of the three groups is the Biotechnology team. The Enterprise Ireland Biotechnology Directorate team (EI Bio) forms the crucial link in the commercialization chain for biotechnology research; connecting the researchers who conduct the research, and the entrepreneurs, industrialists, and companies who apply the fruits of that research. EI Bio works in partnership with all its stakeholders and clients - industrial liaison and technology transfer offices, research funds, research institutions, research teams, bio-entrepreneurs and companies, and with Enterprise Ireland's other sector teams to commercialize the outputs of publicly-funded research for Ireland's food, health, and life sciences sectors.

EI Bio has five strategic focus areas: pharmaceuticals and healthcare, food and agriculture, EU programs, publicly funded research, and bio-incubation. Each area has a multi-disciplinary team made up of people skilled in the three core competencies of project/strategic management, the relevant technologies, and research commercialization.

EI Bio has located some of the staff as close as possible to the research institutions. A number of the biotechnology commercialization specialists and biotechnology project officers are situated at the TTOs on selected campuses. The purpose of this arrangement is to build strong alliances with the research institutes and their technology transfer offices and to respond quickly to their needs. EI Bio commercialization staff is assigned to Dublin City University, Trinity College

Dublin, University College Cork, University College Dublin, National University of Ireland, Galway the University of Limerick and the Royal College of Surgeons in Ireland. EI Bio also continues to forge strong new relationships with other campuses involved in biotechnology.

8.3.2 Patent fund and advice

Enterprise Ireland provides Intellectual Property advice on the protection, development, and commercialization of patentable technology. In appropriate cases, Enterprise Ireland can also provide financial assistance related to the cost of patenting. In 2004 € 1 million was channelled towards this type of funding.

Enterprise Ireland offers advice in the following areas:

- The use of intellectual property rights (patents, copyright, designs and trademarks)
- Confidentiality agreements
- Licensing (negotiations, royalty rates etc.)
- TechSearch - acquiring technologies external to the company, not readily available from commercial sources
- Technical development

8.3.3 Commercialization Fund

The commercialization fund started in 2001. In 2004 they spent about € 15 million funding 93 projects. The commercialization fund provides financial support in three development stages.

- Proof of concept phase (early project phase)
- Technology development phase
- Business development phase - Commercialization of research and development CORD

Proof of concept phase

The proof of concept support is oriented towards activities to establish the commercial potential of a scientific concept and examine the potential market for projects that are original and innovative. Through the “Proof of concept” scheme, individuals or small groups work on short applied projects to develop a product concept through to a stage where a route to commercialization is clear. The planned route to commercialization may involve either a campus company or licensing. Under this scheme, Enterprise Ireland supports academic researchers in

establishing that a scientific concept is both sufficiently robust, is seen to address a viable market, and is not encumbered by intellectual property considerations.

Through the "Proof of concept" scheme, grants to an indicative level of € 90 000 may be awarded for a period typically of up to 12 months or exceptionally 18 months, subject to a competitive evaluation process. To assist in the assessment process, four expert panels are involved. There were three rounds of evaluations in 2005. Proposals may be submitted at any time and proposals that miss one evaluation period are automatically forwarded to the next round for assessment. The 2003-2004 call for proposals attracted 313 entries. The National Research Support Fund Board recommended a total of 96 projects for funding at a total cost of € 7.2 million. The approval rate is varying between 26% and 41% for each round.

The technical merit of the application when it comes to methodology, technical feasibility, and innovation benefits count for 50% in the evaluation, the commercial potential in the meaning of potential markets and sector relevance 30%, 10% for project management, and 10% for track record.

The technology development phase

The technology development support is aimed at major technology development around platform technologies or groups of products built around a new technology. The underlying technologies must be sound and there should be an identifiable market. The support should get the technology developed into a concept strong enough to engage the industry or develop a business platform.

The technology development grants are subject to the terms of a grant agreement between the host institution and Enterprise Ireland. Enterprise Ireland covers 100% of all eligible costs (e.g. personnel, equipment, material and travel) typically up to € 350 000 for projects with typically three years duration. Grants are given to projects leading to technologies that may be of commercial interest to existing industries in Ireland, that are transferable by means of license or other practical arrangements, or that have the potential to provide the basis of new business areas and spin offs.

The projects are evaluated by four independent evaluators, two from the business environment and two from academia. 75% of the ranking is built upon commercial and scientific content. The applicants have to demonstrate experience in the commercialization of projects, indicate previous technology transfer projects, and to provide exploitation plans. In 2005, 75 applications within life science,

informatics, and industrial technologies were received. 41 were approved and received a total funding of € 13.5 million.

Business development phase - Commercialization of research and development (CORD)
The key aim of the Commercialization of Research and Development (CORD) grant is to bring a new product idea/business ventures from Irish third-level educational institutions to the market. Grants can be given to knowledge-based campus companies, academic entrepreneurs, non-academics interested in forming a campus company, and research associated with the Programmes of Advanced Technology (PATs) and the Technology Centre Programmes.

To receive a grant, certain criteria's must be met. The product idea or business venture must involve:

- an innovative technology, which may have been supported under Enterprise Ireland's Technology Development Phase
- a unique application of an existing technology
- an internationally traded service that can be developed into a high potential start up

The CORD grants are designed to enable the commercial viability of the projects. Funding is available for both market research, product trials/market assessment, establishing links with potential joint venture partners, cost analysis, and financial projections. The CORD grants may be approved for up to 50% of eligible expenditure with a ceiling of € 38 000 per grant. There is a detailed maximum expenditure limit for numerous items, for example wages, consultancy, travels, prototype, and promotional materials.

To receive the grant at the completion of the study, a claim form must be submitted together with a final report outlining the conclusions of the study regarding the viability of the project ideas. These documents must be received before the full or balance of the grant can be made. For grants of over € 3 174, an auditor certificate must be attached. In some cases, an interim grant payment can be made after agreement with the Campus Company Manager.

The Commercialization Plus scheme,
For ideas that have a high potential and still have a way to go before commercialization, IE has a Commercialization plus scheme for selected projects. The project is selected by the IE organizations and is not openly announced. The

project may here receive up to € 50 000 for a 6-12 months period. In total, if a project goes through all phases, it will receive about € 500 000.

Enterprise Platform Programme (EPP)
During the business development phase, it is also possible to achieve support through the Enterprise Platform Programme (EPP). Participants in the program need to have a well developed business idea that has the potential to be transformed into a profitable company with export potential.

Box 7.2: The Enterprise Ireland Enterprise Platform Program (EPP) and the High Potential Start-Up Program

The EPP is a one-year long training and enterprise support program aimed at the needs of entrepreneurs in a business start-up situation (www.enterprise-ireland.com). The Enterprise Platform Program tries to meet the need for increased competence among researchers on the threshold of starting their own company. The business plan should be investor ready. It provides both salary and competence support through training and counseling. Each participant receives a mentor and has to go through an intensive training course on entrepreneurship and business management. They also are introduced to a network of venture capitalists. The EPP provides support to the following activities:

- One-to-one business counseling
- Access to the training and consultancy services of partner organizations
- Access to resources including incubation units, pilot plant, and meeting facilities
- Introduction to a support network of mentors, venture capitalists, and other support agencies

If the participants are leaving full-time employment and have an eligible business concept, a grant funding of € 550 per month is given through the EPP to assist the entrepreneurs' businesses in their first year. This funding is meant to 'soften' researchers' transition from their existing secure job to a start-up business. So far, there have not been dramatic increases in the number of applications. The EI administration is of the opinion that all the good projects receive funding, and that the funding level also is sufficient. There is also the possibility of additional support from Enterprise Ireland CORD scheme, with a limit of € 38 000 per year.

After they have started their firm and ended the EPP program, Enterprise Ireland has a special scheme for high potential growth firms. The High potential start-up

program (HPSU-unit) is business development advisors helping out with organizational aspects, network development, and external financing. This means that the founder of a spin-off firm will have a follow-up and support scheme for the most difficult phases of business development.

8.3.4 Practical implementation of programs

At Enterprise Ireland, the administrators of the commercialization fund rely on external panels to evaluate projects. They also help out projects that do not get funding to make a better application, and they have good contact with the university TTOs to improve their quality of applications. There is varying competence at the universities as to support of new projects.

The TTOs and Innovation Service department at the universities play a major role in managing the university's third sector activities. The larger universities have their own Dean of Research and Innovation heading this sector. These departments can also have their own board. Some have all the deans within this board, and representatives from Enterprise Ireland. The TTOs of the university is organized in their own umbrella organization as an Innovation and R&D Centre having direct dialogues with the government about the conditions at the universities.

The TTOs try to increase the knowledge about the potential for commercialization through open meetings at each department. They link up to the management at the different departments. Having local representatives at each department is also discussed as a solution. The TTOs of the university play a major role in the development of the projects ready for funding from EI, and the application phase. The TTO supports the project owners in building up a good application. The university TTO has to acknowledge every application from researchers. However, after the money is received, the project is independent, and the research team decides how to spend the money within the conditions of the contract.

The Enterprise Ireland representatives at the universities follow up the commercialization projects with in an advisory role as to finance, links to other parts of the EI organization, and networks to private companies. These representatives also bring back to EI knowledge about what is happening at the universities, and give opportunities for better coordination and improvement of the national programs.

8.4 RELATION TO OTHER PROGRAMS AND ACTORS

The Enterprise Ireland initiatives directed to the researchers are complemented with different support schemes after the company is established or after a patent is filed. Especially a system for linking the firm or the patent to other companies is well developed through the EI client teams. There is also program for high potential growth firms that are ready to help the firms. The High potential start up program (HPSU-unit) is business development advisors helping out with organizational aspects, network development, and external financing. The EI also provides equity funding together with private interests.

Enterprise Ireland has provided € 27 million to provide Business Incubation and Commercial Research and Development space in institutes of technology and incubation centers at universities. Participants supported by the Business development fund can have mentor support and an intensive training course to produce business plans and link up to venture capitalists. In addition to the Enterprise Platform Program, the universities provide their own programs for entrepreneurial education.

There is a general opinion among the TTOs that they are under-funded. The Innovation service offices at the TTOs have recently received funding from Science Foundation Ireland to fund some of their coordinating and advisory services. The university also supports this sector. For the larger universities the support to the Innovation department may amount up to € 700 000.

8.5 OUTCOME AND METRICS

The total level of spin-offs and patent commercialization is still at a low level in Ireland. At UCD, one of the largest universities, they had sixteen new ventures in their Campus Development program for 2004. At UCD twenty patent applications were filed in 2004 and the UCD spin-off companies have attracted € 11 million in investments.

The commercialization fund started in 2001 and has so far not developed a clear track record. In 2004, they spent about € 15 million for this funding on 93 projects. The size of the program has been flexible, with increased total support according to the number of good projects.

As for knowledge transfer between companies and universities, Ireland received an average score in the IMD World Competitiveness Yearbook 2004/2005. The 2004 Forfás Innovation Networks Report identified several barriers to more effective

knowledge transfer between academia and enterprise in Ireland including lack of widespread knowledge of third level research projects, difficulties in drawing up intellectual property rights contracts, gaps in technology time horizons, and differences between industrial and academic cultures.

Sources:
[26-30], www.forfas.ie, www.tcd.ie, www.ucd.ie/nova, www.enterprise-ireland.com

8.6 INTERVIEWS IN IRELAND

During our visit in Ireland, 12-13 January 2006, we had meetings with the following persons:

- Professor Patrick Gibbons, Vice-President for Staff and Administrative Systems, University College Dublin UCD
- Professor Catherine Godson, Vice-President for Innovation and Corporate Partnerships, University College Dublin UCD
- Bridgeen McCloskey, Operations Manager, University College Dublin UCD
- Audrey Crosbie, Industry Liaison Manager, Trinity College Dublin
- Dr. Eoin O'Neill Director Research and Innovation Services, Trinity College Dublin
- Dr Margaret Woods, Technology Transfer Manager, Trinity College Dublin
- Professor Igor Shvets, Physics Department, Trinity College Dublin
- Gearoid Mooney, Program director Client teams ICT, Enterprise Ireland
- Barry Fennel, Manager Commercialization Fund, Enterprise Ireland
- Mary Gillick, Head of Strategic Management Biotechnology, Enterprise Ireland
- Paul Roben, Director Biotechnology Commercialization, Enterprise Ireland
- Bob Keane, Office of Science and Technology Department of Enterprise, Trade and Employment

9. THE NETHERLANDS

9.1 OVERVIEW OF THE DUTCH R&D SYSTEM

The quality of scientific research in the Netherlands is of high international standard. What has been seen as problematic is the weak interaction between the knowledge infrastructure and the private business sector. The Netherlands score relatively high when it comes to R&D as a percentage of GDP, but as for many smaller countries the low private R&D activity within industry is regarded a problem. Compared with Germany, USA and UK the number of patents filed by universities and the number of high-tech companies started is at a low level. The result is that the Dutch business sector generates relatively little turnover from new or improved products. The highly innovative high-tech industry sectors are not well represented in the Netherlands and the number of spin-offs from knowledge institutions lags behind other countries. Further growth is also a problem area, as the Netherlands has relatively few fast-growing companies.

9.1.1 Innovation and commercialization policy

Five Foresight reports from the Dutch Cabinet in September 2001 drew up the main issues and policy options for future efforts to increase innovation and growth. The Foresight study on Education and Research, "Learning without boundaries", presented three paradigms for the development of an effective system of public research, responsive to the needs of the 21st Century. The focus was on the researcher, the research institution, and the user of public research. The Dutch Research Council (NWO) Strategic Plan 2002-2005, “Themes with talent” focused on a new role for the NWO in coordinating government funding from various government departments. The objective was to achieve more synergy between research efforts and practical application.

The thinking around national innovation systems made the Ministry of Economic Affairs and the Netherlands Research Council increase the proportion of their technological research that is pursued through programmatic instruments. During the 1990s, a growing proportion of public sector support for research was made contingent up private-public co-operation and co-financing. This policy was continued together with emphasis on a more demand-driven funding of universities, with incentives for knowledge transfer to companies in the funding of universities. The budget for more strategically oriented competitive research funding was increased. Policy was aimed at making IPR (especially patents) better

known as an instrument that can help stimulate innovation. New areas of policy emphasis were cluster thinking, and focus on entrepreneurship and new-technology-based firms. New technology-based firms had been neglected in the Dutch innovation policy as the initiative has been left to universities or regional government bodies. New technology-related initiatives were therefore to be launched at national level.

The main priorities of the Dutch innovation policy have been to improve the interaction between public research and industry partners, and to provide public research organizations with incentives to become more market orientated. The budgets for more strategically oriented competitive research funding have been increased. Policy has been aimed at making IPR's (especially patents) better known as instruments that can help stimulate innovation. New areas of policy emphasis are the cluster approach, and an emerging focus on entrepreneurship and new technology-based firms.

Market imperfections were regarded present within several areas. As to entrepreneurial skills, there was expected to be lack of information on relevant coaching and advice services for high tech start ups. High transaction costs because of limited information, or a limited network were a fundamental problem. A limited focus on entrepreneurial education in technological institutions and lack of entrepreneurial culture was also a problem. Finally, risk capital in an early stage was lacking due to high screening costs for the investors. This information asymmetry meant that investors would be very reluctant to fund the development phase of a project. As a background for the TechnoPartner program it was estimated that high-tech start-ups faced an average financial 'gap' between € 200 000 and € 2.5 million during the first two commercialization steps.

The basis for current innovation policy was outlined in the 2003 White Paper "Action for innovation". The general objective of the innovation policy was split in a number of operational objectives. One of these focused on a well-functioning IPR-system. The second was emphasizing more start-ups development efforts. One acknowledged that the Dutch national innovation systems had problems translating fundamental research into new products and services, resulting in a limited number of spin-offs from the public research infrastructure, and problems encountered by high-tech start-ups. The objective was therefore to improve the climate for high-tech start-ups in order to increase their number.

In 2003, the Ministry of Economic Affairs developed a new scheme, the TechnoPartner structure with a broad set of measures to deal with these problems. The TechnoPartner Action Programme was developed in cooperation with the

Ministry of Education, Culture and Science. The new platform was a result of a reorganization of past high-tech start-up policies such as Twinning, BioPartner and Dreamstart.

In 2004 the Valorisation Grant was started as part of a joint SBIR-pilot of the Technology Foundation (STW) in collaboration with the Dutch Research Council and the Dutch Organisation for Applied Scientific Research (TNO).

9.2 OVERVIEW OF ACTORS AND COMMERCIALIZATION INITIATIVES

The Dutch innovation system includes a relatively fragmented national innovation support program, with ten major instruments, all under the Ministry of Economic Affairs. There are a large number of executive agencies and other organizations such as the Dutch Research Council and private companies which deliver the programs on national level. The argument for this is that a portfolio of organizational forms creates flexibility in choosing delivery organizations for different types of support programs. A quite decentralized and fragmented science and research community comprising of 13 Universities, 18 institutes under KNAW (Academy for Arts and Sciences), 6 NWO (Dutch Research Council) institutes, 5 Large Technological Institutes (GTIs), 4 Technological Top Institutes (TTIs), 14 TNO Institutes, and a number of state owned research and advisory centers. The advisory boards are active in the areas: health research (RGO), agriculture (IGRA), nature and environment (RMNO), development co-operation (RAWOO) and spatial planning (NRO).

9.2.1 NWO the Dutch Research Council

NWO is the main national research organization of the Netherlands. It promotes research quality by subsidizing the best proposals submitted by researchers, developing thematic priorities where necessary, and manages a number of research institutes. In the Netherlands, research funding is organized along disciplinary lines. Each branch of science and humanities has its own department within NWO.

9.2.2 STW the Technology Foundation

STW the Technology Foundation is the Dutch funding agency for applied research. The objective of STW is to stimulate high-quality technical-scientific research and to promote the utilisation of knowledge. The main instrument to achieve these goals is the “Open Technology Programme” (OTP). Within the OTP, research proposals with commercialization opportunities can be submitted. Both scientific

quality and commercialization perspectives are important, thus stimulating the interaction between public and private sector. STW's Valorisation Grant is an effort to increase commercialization of scientific knowledge and public-private interaction.

Tenured university staff can apply for a research grant, provided that their proposal includes aspects of utilization. STW can fund research projects from any field, although most grant applications belong to science and technology. Funding comes partly from the Ministry of Economic Affairs and partly from the Ministry of Science and Education. The latter part, about two thirds, is channelled via NOW. Some of the budget comes from intellectual property rights.

9.2.3 TechnoPartner

The TechnoPartner programme aims at an improvement of the high-tech start-up climate. The high ambition is to turn the Netherlands into a country where it is common practice for researchers and students to start their own company.

TechnoPartner is a separate organization set up to administrate the TechnoPartner program. It provides high-tech start-ups access to capital, knowledge, experience equipment and a service platform for high tech entrepreneurs. TechnoPartner is also oriented towards motivating knowledge institutes and investors to offer financial support and knowledge to entrepreneurs. Together with STW they represent the most important commercialization programs in the Netherlands.

9.2.4 Organization at university level

The organization at university level is characterized by a high degree of decentralization, with special roles for departments and research institutes. The three technical universities of Delft, Eindhoven and Twente have profiled themselves as entrepreneurial universities, together with the Wageningen University with its specialization in animal, plant and food science. These universities are to a large extent organized with specialized campus research institutes.

The university may have an office for corporate and legal affairs. They take care of the university IP, and are also marketing their patents on the internet. At the University of Delft, as an example, they have a Legal Affairs department within the University Corporate Office that serve in a broker function.

The practical implementation of the commercialization efforts is the responsibility of the university departments. This also includes entrepreneurial courses and

training for the spin-off entrepreneurs. There has been only limited TTO capacity so far. At department and institute level the universities are now developing a network of technology transfer officers that helps out the patenting and the spin off, provides competence support, and helps in networking towards the industry.

9.2.5 Cooperation with other agencies and programs

Zones of opportunity

In 2005, "zones of opportunity" (kansenzones) for start-ups and fast-growing companies were established. It was a joint initiative of the three Technical Universities of Delft (TUD), Eindhoven (TU/e) and Twente (UT) and the three municipalities of these cities. Within these zones, experiments are started to improve services for starting and fast-growing firms. The poor quality of service to start-ups and high-grow firms was identified by the three universities as a major obstacle. Within zones of opportunity, companies are supported by facilities, coaching and assistance for the application for subsidies, and licensing. So-called "formula managers" are available to help young and growing companies. In addition, the business development organization SenterNovem will set up contact points for business within these zones. A total budget of € 1.2 million for five years is allocated to the three zones of opportunity around the three universities. The four pilot projects are to provide the government with lessons and experience on how to create an excellent business climate for start-ups and fast-growing companies. The four hot spots are: the Eindhoven/Southeast Brabant 'brain port', as part of the Eindhoven-Leuven-Aachen top technology region, the East Netherlands region (the Twente, Wageningen and Arnhem-Nijmegen conjunction, the North Wing of the Randstad (including the Utrecht region) and the South Wing of the Randstad.

Seed funds through TechnoPartner seed facility

The TechnoPartner seed facility is an integrated part of the other programs within the TechnoPartner action plan. The program is implemented by the organization SenterNovem.

The objective of this facility is to encourage and mobilize the bottom end of the Dutch risk-capital market in such a way that high-tech start-ups are able to meet their capital requirements. In order to encourage the investor to invest in the early lifecycle phase of the high-tech start-up, the risk/return ratio of such investments must be improved. The seed facility aims to achieve this, either by means of reducing the risk for the investor or increasing the return on investment. The budget for this activity is € 10-12 million per year.

Only closed-end venture capital funds are eligible for the Seed facility. In addition, the following criteria must be met for applying for the arrangement:

- At least three shareholders or partners must participate in the fund
- The fund must have the form of a public or private limited company, partnership or limited partnership
- The sole aim of the fund should be to eliminate the 'equity gap'
- Investments must be made during the fund's first six years. The fund must be liquidated at the latest 12 years after its inception.
- The fund plan must state the way in which support to high-tech start-ups is provided

The participating funds which invest in high-risk high-tech start-up businesses can apply for a loan from TechnoPartner. A loan that equals the amount deposited in the fund, up to a maximum of € 4 million, can be given through the facility. There is a flexible pay-back arrangement for the funds. If revenues are generated, the funds will only have to pay back 20% until they have earned back their investment. After that, the funds will have to pay back 50% until TechnoPartner has earned back its investment. Additional income is divided between the funds and TechnoPartner on an 80-20% basis.

9.3 DESCRIPTION OF SPECIFIC INITIATIVES

9.3.1 Valorisation grants and the SBIR program from STW

The small business innovation research program (SBIR) is for researchers at universities that want to create a spin-off from a research institution. The grant can be used for product-market analysis, for development of a prototype, for development of personal skills, and for protection of intellectual property. The budget of the Technology Foundation STW has increased over the years. At present the budget is € 43 million per year, of which 40% comes from the Ministry of Economic Affairs and 60% from the Ministry of Education, Culture and Science. The latter part is channelled via the Netherlands Organisation for Scientific Research (NWO), the Dutch research council. The program provides support in three phases:

Phase I Feasibility study
This phase is oriented towards evaluation of the scientific and technical merit of an idea. Awards are for periods of up to six months. Total grant amount is € 25 000. The government funding is 100%.

Phase II Valorization of project
Grants are for periods of up to two years. Maximum support is € 200 000. The government funding is 100%.

Phase III Commercialization
This phase requires the use of private sector or non-SBIR Federal funding. The maximum STW subsidy per project is € 2 million. Project applications submitted to STW for more than € 0.5 million requires a contribution from the project owners. The amount of the compulsory contribution is determined by the cost of the project over € 0.5 million. Tenured faculty members from universities can apply for a research grant covering material and investment costs, the cost of temporary personnel. Criteria are scientific quality and that the project is directed towards commercialization.

As to evaluation of projects, experts are asked to give comments on the proposal in a written form, according to a fixed list of criteria. The set of comments is sent to the applicant (all comments are then anonymous) and he or she is asked to formulate a separate answer to every remark. The final result is a document that contains a point by point discussion of the merits of the proposal, a discussion conducted between experts.

9.3.2 Technopartner

The TechnoPartner initiative for the creation of technology-based start-ups was launched in October 2004. The aim of the TechnoPartner program is achieve a structural focus on knowledge exploitation among research institutes. The program includes measures towards seed, pre-seed, coaching, facility sharing, tracking and tracing, patents, networks, stimulating the entrepreneurial spirit and institutional changes and internationalization. TechnoPartner comprises a package of three interrelated actions:

1. TechnoPartner Seed facility
Oriented to stimulate and mobilize the bottom end of the Dutch venture capital market, to secure high-tech start-ups capital in the early phase after foundation. This scheme is presented above.

2. TechnoPartner Knowledge Exploitation Subsidy Arrangement (SKE).
This is a pre-seed support scheme in the phase prior to start-up. This scheme includes a patent facility that contributes to the professionalizing of the patents policy within the knowledge institutes.

The objective of the SKE arrangement is to effect a structural focus on knowledge exploitation among universities and publicly financed research institutes to create more and better high-tech start-ups, and to support knowledge institutes in building up a market oriented patent portfolio. The SKE focuses on public-private consortiums, with a minimum of one public research institute. These consortiums can apply for project money. The consortium
must submit an integrated plan of in which all modules and elements are dealt with. The plan must outline the current facilities with regards to knowledge exploitation and commercialization and indicate how these facilities will be improved in the next five year period.

TechnoPartner provides support for screening and scouting, patent applications, access to equipment and networks of specialists and soft loans. The SKE can add up to € 2.5 million per project. Fifty percent of the costs can be subsidised; the remaining fifty percent must come from the consortium. During the 5-year running period of the SKE, a total of 18 subsidy applications will be supported, covering each province. Each of these 18 consortiums is expected to issue a total of 360 pre-seed loans per year that may result in 180 new high-tech start-ups, half of the spin-offs from research institutes.

The SKE consists of the following elements:

1. *Screening and scouting.* TechnoPartner encourages the development of methodologies for making visible the commercial potential of research at an early stage (screening) and finding scientists and/or entrepreneurs who wish to commercialize this research (scouting). Fifty percent of the costs for this purpose are subsidized and it is also possible to bring in third-party expertise.

2. *Patents*. This module focuses on making funds available to public research institutes to finance part of the costs associated with applying for patents. The patent-related subsidies will incorporate stimuli to promote the utilization of patents by high-tech start-ups and/or existing firms.

3. *Access to equipment*. This part finances research institutions or businesses that make their research and testing equipment available to high-tech start-ups

4. *Coaching and support.* TechnoPartner provides the high-tech start-ups with a network of coaches, each with their own specialty, so that they do not have to reinvent the wheel for every aspect. The institutions efforts to introduce (pre-) high-tech start-ups to their network qualify for a TechnoPartner subsidy.

5. *Provide (pre-seed) soft loan.* The objective of this scheme is to provide pre-high-tech start ups with pre-seed capital. Research institutes and private companies that cooperate to set up a fund for providing soft loans to (pre-) high-tech start-ups are eligible for a subsidy. The size of the subsidy is fifty percent of the fund's starting capital. In order to guarantee continuity, the (pre-) high-tech start-up has maximum 6 years to pay-back the loan. The payment can take place at a low interest rate or no interest at all. The soft loan gives the pre-high-tech entrepreneur more time for developing the idea before start-up.

Box 8.1: The Technopartner Knowledge Exploitation Subsidy Arrangement

The background for the Technopartner program was that the Netherlands for a long time had ignored measures oriented towards commercialization of research through spin-offs and patents. The legislation has not been supportive, nor the university culture. The Netherlands has made several studies showing that they are lacking behind as to patents and spin offs. The Technopartner program was a large scale response to this challenge. It was a part of a new innovation policy and the new financial tools launched by the Ministry of Economic Affairs and Ministry of Education, Culture and Science. It was decided to administer the Technopartner program through a new organization. The SKE Knowledge Exploitation Subsidy Arrangement is implemented by regional consortiums between at least one university or research institute and private interests. Based on a five year development plan, they achieve funding for a broad set of activities. Out of the total funding for TechnoPartner of € 25 million a year, € 10 million go to up to 18 consortiums. The financial package for the university-business consortiums on a long term with rules for how to spend the money. This program is covering all phases, and also includes pre-seed soft loans, funding for screening and scouting, patent applications, access to equipment and networks of specialists and soft loans.

The SKE can add up to € 2.5 million per project. Fifty percent of the costs can be subsidized; the remaining fifty percent must come from the consortium. The budget for the SKE part of Technopartner is € 10 million per year. The ambition is that the Technopartner program shall contribute to 90 spin offs per year.

3. TechnoPartner platform
This scheme is oriented towards providing information and expertise to founders on the obstacles faced by high-tech start-ups. The platform will also monitor bottlenecks faced by high-tech start-ups and put them on the policy agenda. The TechnoPartner Platform provides information to (potential) starters, matching up starters with subsidy tools, stimulating collaboration between regional networks, monitoring developments in different sectors and distributing good practices. The budget for this facility is € 1.8 million per year. The future platform will work on increasing the number of (potential) starters through the stimulation of entrepreneurial culture.

9.4 OUTCOME AND METRICS

In the first round of the Valorisation Grant in 2004, 82 proposals were submitted and evaluated. 35 proposals received a positive appraisal, and a total of 21 proposals were awarded a grant because of budget constraints.

The TechnoPartner action program has a budget evolving from € 11 million in 2004 to € 37 million in 2007. The budget for the SKE part of Technopartner is € 10 million per year, including € 2.5 million for the pre-seed module, 2.5 million for the patent module, and 5 million for the screening & scouting module.

Partly as a result of the lack of entrepreneurial culture, the entrepreneurial climate in many research institutes is relatively underdeveloped compared to other countries. Only 14% of Dutch Universities consider the encouragement of spin-offs important compared with estimated 70% in other countries. The number of patents awarded in the Netherlands is rather high. However, the number of university patents is low. During the nineties, the universities applied for 223 patents, less than 2 % of the total number of patents. 10% of the company patents were expected to be realized in partnership with universities.

The government estimated in 2004 that around 100 spin-offs were established from universities and research institutes each year. It was estimated that 10% of the

Dutch high- tech spin-off came from the universities. Compared with other countries this meant that The Netherlands had a 30-40 % lower spin-off rate. 2/3 of all high-tech start-ups employed fewer than 5 persons; 80% did not make use of the support of incubators, and 2/3 of all high-tech start-ups came from the ICT sector. A benchmark study by Top Spin International revealed that the spin offs from 29 research institutions in the Netherlands was 107, an average of 6.4 per university. The average of universities in other comparable countries was 7.1. Correcting for the size of the institutions, the annual number of spin-offs per 1000 employees within the research institutions where 1.69 versus 1.86 in other countries. Per € 100 million turnover, the Dutch spin-off rate where 2.4 compared with 3.1 in other countries. In the above cited study, the universities argued that the reason for this lack of performance was limited financial resources to stimulate spin-offs, absence of entrepreneurial culture, insufficient availability of expertise within the institutions to support spin-offs, tension between traditional tasks and commercialization of knowledge, and insufficient space and facilities.

Sources: [31-37]

10. SCOTLAND

Scotland is a part of United Kingdom and accounts for 8% of the population (5 million people) and has a similar GDP per capita. Scotland is autonomous in areas like education, health, justice, economic development and transport. Defense, tax, social macro economy, policy etc. is, however, still controlled by the United Kingdom. Scotland's strong tradition of education and research played a crucial role in the development of its modern economy. Universities in Scotland continue to produce a disproportionate high level of internationally leading research. On every per capita measure of competitive bidding for research funding, Scotland out-performs the rest of the United Kingdom. Still, the Scottish company R&D is 50% lower than the UK. In EU terms, Scotland is in the top quartile when it comes to performance in basic research and in the third quartile when it comes to corporate R&D. These differences between levels of investment in R&D between knowledge-generating and knowledge-exploiting organizations result in an imbalance as the university sector more like a "core" EU region while the corporate sector more like a "peripheral" location [38].

10.1 RATIONALE FOR SUPPORTING COMMERCIALIZATION OF RESEARCH

The basic rationale related to governmental support of commercialization of research from Scottish universities and research institutes is related to the fact that Scotland has a strong science base while their industry base is less developed. There is a belief that it is possible to strengthen the industry base by stimulating the commercialization of research from Scottish universities. The support of commercialization of research is to a large extent related to activities at the universities in Glasgow, Edinburgh, and Aberdeen. Furthermore, there is definitely a "cluster" thinking if looking at the Scottish efforts to establish capabilities in new technology areas. There is a dedicated focus in supporting the industrialization of research within life science, energy, and tech-media.

There are basically two organizations that provide funding and support to commercialization of ideas from the main universities; namely Scottish Executive[4] and Scottish Enterprise. The Scottish Executive has a dual role by taking a lead role in policy formulation and development, and at the same time administering a

[4] The Scottish Executive is the devolved government for Scotland. It is responsible for most of the issues of day-to-day concern to the people of Scotland, including health, education, justice, rural affairs, and transport.

number of schemes designed to enhance innovation in Scottish businesses. Scottish Enterprise is the main economic development agency for Scotland, funded by Scottish Executive. One of Scottish Enterprise's main priorities is the commercialization of academic ideas into good business opportunities. They are organised with headquarter in Glasgow (with national teams) and 12 regional offices.

10.2 DESCRIPTION OF THE INITIATIVES

In Scotland there seems to be a two-folded strategy when it comes to the support of commercialization of research. On the one hand, some schemes are funded and operated by Scottish Executive or Scottish Enterprise teams. On the other hand, there are also examples of programs developed and run by other organizations and funded by Scottish Enterprise. They have, however, managed to create a pipeline of mechanisms available for ideas with a high-growth potential. The main programs with an explicit focus on stimulating the creation of spin-offs from the university (or alternatively licensing technology) are the Proof of Concept programme and the Enterprise Fellowship programme. Scottish Executive operates the SMART and SPUR schemes which are suitable as initial sources of funding when a new company becomes an own legal entity. Furthermore, Scottish Enterprise has a key role in bringing in seed-capital to the firms established from the schemes mentioned above. The next sections will present the schemes in more detail. We have also included a description of the Intermediary Technology Institute scheme, which was launched in 2004 in order to facilitate development of new technologies for new markets. Finally, we will, as an example of best practice, give a presentation of the experiences from an initiative to facilitate commercialization from the public health sector in Scotland.

10.2.1 Proof of Concept programme

The Proof-of-Concept Programme (PoC) is operated by Scottish Enterprise and supports the pre-commercialization phase of leading-edge technologies emerging from Scotland's universities, research institutes, and National Health Service Boards. Projects are typically occurring after advances are made during curiosity-driven or strategic research. This is usually after a background patent has been filed, but before: a full lab-scale demonstration of the technology, any pre-production development/prototyping, and commercial funds for development has been made. The main aim is to fill the gap between basic "blue sky" research and market exploitation. Applicants must demonstrate that their ideas have originality and true commercial potential. Ideas should have the potential to form the basis of either a new high growth business or a license to an existing company. The PoC

program has received over 750 applications since the inception in 1999. The program has a bidding round every year and six funding rounds are completed. £ 28.1 million have been awarded to 172 projects.

Potential applicants from universities and research institutes are assisted from their technology transfer offices when preparing an application to the PoC programme. These applications are evaluated by the PoC team. This team forms a group of eight people employed by Scottish Enterprise. After a “due diligence”, a panel (with individuals inside and outside Scottish Enterprise) will decide which projects that get funding. Funding is normally provided for a two year period and the maximum award has been £ 200 000. This is, however, about to change, and projects can now apply for PoC funding for longer periods and an amount exceeding the previous limit. This “extension” is primarily related to special needs of life science projects. Eligible cost covered by this funding are all direct attributable costs like; personnel (employees of institution, not students), additional essential equipment (justification required), market assessments, patent costs, subcontracting, and other costs such as travel expenses (justification required). The program can provide 100% cost coverage but does not cover any overhead to the university or the technology transfer office. The PoC team appoints an “outcome” manager for each project. This is an experienced consultant supposed to support and secure focus on commercial issues during the PoC process. The Outcome manager, the university project team, the commercialisation contact, and the Scottish Executive facilitator form a project group. This group meets every 3 months to monitor progress with regard technical, financial, and commercial issues.

10.2.2 Enterprise Fellowships

If the proof of concept phase provides the desired results, the next milestone could be to apply for admittance to the Enterprise Fellowship Programme. This initiative help individual academic researchers to develop spin-out companies, and is funded by Scottish Enterprise and delivered by the Royal Society of Edinburgh.

The programme provides a 12 months salary support to develop the idea as well as business training in order to take the idea forward. This includes access to networks of mentors, business experts, and professional advisors. This can be regarded as elite training as only 10 – 15 individuals are admitted each year. The partnership with Royal Society of Edinburgh - Scotland's national academy - provides access to world-class technologists, industrialists, and entrepreneurs. In total 60 Fellows have received awards and completed the programme at a cost of circa £ 3 million. An award is typically around £ 50 000 (30 000 salary, 10 000 training, and 10 000

other costs). The additionality from this program is remarkable as out of the first 60 awards, 35-40 participants have formed new business ventures. The public and private sector investments in these companies are in excess of £ 50 million, representing a gearing of 17:1. The reader should, however, bear in mind that many of the projects already have got their "quality assurance" through development within the PoC programme.

Another important attribute with this programme is the "direct link" to "business angel"s' syndicates. Scotland has a vibrant "business angel" market with several well organized syndicates. These syndicates are of course important as capital source but individuals in these syndicates will often be able to act as mentors for Enterprise Fellowship candidates. Examples of companies formed with assistance from an award are Intense, XstalBio, Virtual Clones, IceRobotics, and Biopta.

10.2.3 "SMART AND SPUR" awards

Entrepreneurs/projects with both PoC award and participation in the Enterprise Fellowship programme should be able get a SMART award. Successful applicants receive funding of 75% of the cost of carrying out a technical and commercial feasibility study lasting between 6 and 18 months. The maximum award is £ 50 000. SMART winners who successfully complete their projects and who need more help to develop a preproduction prototype can get further support through the SPUR programme. SPUR grants help small to medium sized enterprises (SMEs) to develop new products and processes involving a significant technological advance for the UK industry or sector concerned, up to pre-production prototype stage. Awards can be made to independent businesses and groups with less than 250 employees. The programme provides grant support for expensive leading edge technology development in areas such as telecommunications and biotechnology. To be eligible for support, projects must normally involve eligible project costs of at least £ 1 million. Assistance of up to £ 500 000 at 35% of eligible costs is available to support development up to pre-production prototype stage. These two programmes are operated by Scottish Executive.

10.2.4 Intermediary Technology Institutes (ITIs)

The ITIs was established in 2003/4 by Scottish Enterprise. Their objective is to identify emerging global market opportunities and technology platforms within Life Science, Information and Communication Technology (ICT), and Energy including oil industry, energy conservation, and alternative energy sources. Research may then be commissioned, either from Scottish universities or elsewhere, to enable Scotland to take advantage of new market opportunities. The

sectors targeted by the ITIs are recognized as being among Scotland's strongest in terms of global competitiveness.

Each ITI has a budget of £ 15 million per year for which an annual Operational Plan is produced within the framework of a rolling three-year Strategic Plan. Each ITI has a Board of Directors and there is a joint Executive Committee of the three ITIs plus the Chief Executive Officer. ITIs are arm's length bodies, funded by Scottish Enterprise, but with a high degree of independence. The intended role of the ITIs is to identify potential market opportunities and enabling innovative personnel in universities to take inventions from the laboratory bench to the pre-commercialization phase. This function will complement other initiatives such as the 'Proof of Concept' fund and the 'Co-investment fund'.

10.2.5 Seed capital funding

Scottish Enterprise has a separate department, Scottish Enterprise Investments (SEI), which develop and run seed investment and venture capital investment programs. Their primary objective is to get more money and more investors into the Scottish market in order to address the capital gap experienced by new technology-based firms in Scotland. Based on comprehensive annual mapping of the capital situation in Scotland they are operating two capital instruments and are developing two new ones to be launched within a year.

Young companies often experience difficulties in raising sufficient funds from banks and private investors due to their size and risk profile. The Business Growth Fund (BGF) was launched in July 1999 in order to improve the availability of finance for start-up and growing companies in Scotland. Until 2002 the Business Growth Fund provided loans of between £ 20 000 and £ 100 000 to business that satisfied criteria related to their size, commercial viability, and growth prospects. In 2002, after an appropriate market consultation, SEI announced that Scottish Enterprise's Business Growth Fund should be re-launched as a debt and equity vehicle working in the same funding bracket. The new equity option meant that young companies can use the Business Growth Fund to improve their balance sheet in order to leverage support from banks and other investors. The Fund is designed to improve the availability of finance and investment for small start-up and growing companies in Scotland. The Business Growth Fund is not intended to displace other sources of finance and a condition of the Fund's support is that other funding sources have been explored. At least 50% of the company's financing requirements must be met (matched) by non-public sector sources (could be other equity sources, own savings, investment from "business angels", etc.).

The Scottish Co-investment Fund (SCF) is an instrument developed in order to increase the number of and capacity for investment of private sector investors active in the Scottish early stage market. Traditional public involvement in private equity, through investment in limited partnerships, carries the risk of displacing the private sector. The SCF differs by working with the existing formal and informal private equity investor base, involving them in the process rather than excluding them. Through the SCF, Scottish Enterprise Investments provides equity funding to small and medium-sized firms on a purely commercial basis with selected co-investment partners. Each co-investment partner is allocated an amount of funds available for use in an individual investment. Applicants for support have to apply directly through investment partners. Industry sectors eligible for SCF investment includes: technology, creative businesses, electronics manufacturing, and pharmaceuticals. The SCF is partly funded by the European Regional Development Fund. The partner finds the investment opportunity, negotiates the investment deal, and invests cash together with SCF money on equal terms. This means that private sector investors can bring more cash to deals, and spend less time finding that cash. It also means that SCF will share the risk of making an investment.

When completing a deal, SEI can assign an Account Manager (no cost to investee company or partner) to help the investee company realize their growth plans. The fund strikes agreements with co-investment partners who are able to demonstrate a track record, and have strong commitment and the motivation to handle early stage “hands-on” investments. A vibrant ”business angel” market is of vital importance in order to get as much as possible out of these “gearing” capital instruments (see also the description of the SMART scheme).

Further, based on the annual mapping of the Scottish venture capital market SEI plan to launch two new instruments:

1) National investment product:
    - Target companies: start-ups and those raising first round finance with growth potential
    - Amount: up to £ 50 000 per company
    - Building block, £ 1 for £ 1 private sector leverage
    - Flexibility: debt and equity
    - Investment decisions taken by SE investments (+investment committee)
    - Estimated 40-60 deals totalling £ 2 million a year

2) Scottish investment fund:
    - Develop private sector market capacity

- Co-investment model
- Invests £ 2 - 5 million in syndicated deals
- Deal promotion Partners
- Syndicate Partners
- Investment decisions taken by SE Investments (+ inv committee)
- Estimated 10-12 deals £ 15 – 20 million per year

The investment infrastructure after the implementation of these two products is illustrated in Figure 9.1:

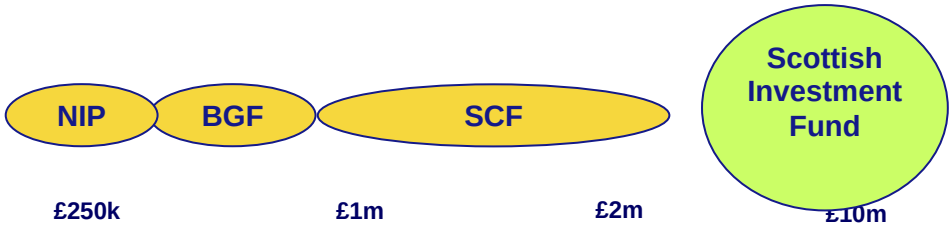

Figure 9.1: Investment infrastructure in Scotland

Moreover, Scottish Executive/Scottish Enterprise and Braveheart business angel syndicate have developed “The SMART Equity Scheme” and the “the PoC equity scheme”. This is a joint venture between Braveheart, the Bank of Scotland, Scottish Universities and the governmental bodies. This is an investment scheme specially designed in order to fund ideas which get a SMART award. Braveheart and Bank of Scotland have come together to provide an early-stage fund to back companies emerging from several Scottish Universities. The projects and proposals are filtered by the University Commercialisation Department for "investor readiness" before being passed on to the Braveheart Group. A successful SMART or PoC Award is a pre-requisite for access to the scheme as this involves a large part of the technical diligence. The Braveheart Group undertake a detailed review of the financial projections and meet with the company founders before a short summary paper is passed out to the partners in Bank of Scotland. The initial investment is then made; usually in conjunction with the SMART or PoC awards and the company proceeds from there.

Box 9.1: Commercialization from the health sector – The Scottish Health Innovations

Scottish Health Innovations Limited (SHIL) was established in 2002 in order to

support the development and commercialization of innovations arising within the National Health Service (NHS) in Scotland. SHIL is funding from the Scottish Executives Chief Scientist Office, Scottish Enterprise, Highlands and Islands Enterprise, and the Department of Trade and Industry. The company seeks to identify and develop new technologies which can be exploited through partnerships with the private sector. It is a not for profit company and any profit goes back to NHS. The total funding for the first five years is £ 3.2 million. Six people are employed, primarily experienced business people. In the start-up phase, SHIL has spent considerable resources in creating awareness and changing cultures in the NHS.

SHIL provides advice and assistance on market application and intellectual property protection to investors and researchers throughout NHS. Thereafter it can add considerable value to these innovations by providing managerial and funding support during their development and commercialization. They have established four subsidiary companies to give greater business focus to its product development and commercial interests:

- Scottish Health Devices Ltd (SHDL) is a product development company specializing in medical devices, diagnostics and therapeutics.
- Scottish Health Software Ltd (SHSL) is a product development company specializing in software and other IT related technologies.
- Scottish Health Licensing Ltd (SHLL) is a company involved in licensing out products directly from NHS Scotland.
- Scottish Health Equity Ltd (SHEL) was established as a company to hold equity in any new companies spun out from NHS Scotland.

Achievements the first three years include:

- Introduced procedures for audit, disclosure and evaluation of IP
- Clarified position on ownership of IP
- Guidelines for rewarding inventors
- Considered 400 proposals, 35 “onboard”
- Facilitated 3 licensing agreements
- Participated in 3 spin-offs (these companies have leveraged £ 3 million in additional funding)

10.3 OUTCOME AND METRICS

Initiatives like the PoC and the Enterprise Fellowship program, established in the late 90s, where evaluated and adjusted a couple of years back and will be evaluated again this spring. This illustrates the "metrics" thinking within the Scottish Enterprise. If there is a new, untested approach, they begin with a small-scale pilot project. Evaluation of the pilot helps Scottish Enterprise and their partners to refine the initiative before scaling it up. Regular evaluations of an initiative (usually by a 3rd party) keep them relevant and help in responding to upcoming needs. Basic outcomes from some of programs are given in Table 9.1.

"Bridge"	**Cost to date/ Invest-ments**	**Summary of Technology Transfer Outcomes to Date**		**Private /public follow on unding raised**
		Spin-outs / Start-ups	IP Licensing Deals	
Proof of Concept Programme	***£ 28m (since '99)***	***17 (15 more in pipeline)***	***22 (5 more in pipeline)***	***£ 22m***
Enterprise Fellowship Programme	***£ 3m (since '97)***	***35-40 (estimate - under review)***	***Not tracked***	***> £ 50m***
Business Growth fund/Scottish co-investment fund	***£ 18m***		*-*	***£ 57m (only private risk capital, not including follow up investment)***

Table 9.1: Outcome from Scottish initiatives.

It is also interesting to notice that Scottish Enterprise plan to undertake a very comprehensive mapping of outcome from the Intermediary Technology Institutes (ITIs). This mapping of outcome will be related to the following resource classes; financial, physical, human, knowledge, market, and social capital.

10.4 INTERVIEWS IN SCOTLAND

During our visit in Scotland, 9-11 January 2006, we had meetings with the following persons:

- Sara Carter, Professor, Stirling University, Stirling, Canada.
- Wendy Fernie, Proof of Concept Programme, Scottish Enterprise
- Cameron M. Macdonald, Chief Executive, Scottish Health Innovation Ltd.

- Alasdair Mackay, Head of Business Development Service, University of Strathclyde
- Colin Mason, Professor, Hunter Entrepreneurship Centre, Strathclyde University, Glasgow, Scotland.
- Pat McHugh, Head of Market Development Investment Directorate, Scottish Enterprise
- Clive Reeves, Technology Collaboration, Scottish Enterprise
- Alex Reid, SMART Scotland, programme manager, Scottish Executive
- David Roson, Director - Innovation Development, Competitive Businesses, Scottish Enterprise
- Hugh Ross, Head-Innovation Grants, Scottish Executive
- Madeline Smith, Senior Executive – Innovation Development, Competitive Businesses, Scottish Enterprise
- Tom Tumilty, Innovation Policy Unit, Scottish Executive

11. SWEDEN

Sweden is in the top class when it comes to R&D expenditures per capita in the world. This position is kept mainly because of large spending on R&D in businesses. Led by giants like Ericsson and AstraZeneca, private companies accounts for about 75% of Sweden's R&D spending [39]. Commercialization of R&D from universities ranks Sweden relatively low, in the sense that there are relatively few spin-off companies from R&D community in general and from universities in particular.

11.1 OVERVIEW OF SWEDISH R&D SYSTEM

Funding of R&D in Sweden is organized in phases based on how far the projects have come. Basic research is mainly funded by The Swedish Research Council (Vetenskapsrådet) which primarily funds research at universities. Vinnova is Sweden's main actor in applied research and commercialization activities. Vinnova is sector organized and has programs to fund both business and university based research. Vinnova was established in 2001 and has an annual budget of about SEK 1 billion.

Ministry of the Environ-ment	Ministry of Health and Social Affairs	Ministry of Education and Science	Ministry of Industry, Employment and Communications			
FORMAS Research Council for Environment, Spatial Planning and Agricultural Sciences	**FAS** Research Council for Working Life and Social Sciences	**Vetenskaps-rådet** Swedish Research Council	**VINNOVA** Swedish Agency for Innovation Systems	**NUTEK** Swedish Agency for Industrial Development	**The ALMI Group**	**ITPS** Swedish Institute for Growth Policy Studies

Figure 10.1: Sweden's initiatives for funding R&D [40]

11.1.1 Commercialization policy

The Swedish policy package for promoting commercialization of academic knowledge has placed high emphasis on promoting the emergence and development of an enterprise culture at the universities and colleges [41]. Important tools in this regard have been efforts to improve the incentive structure within the universities and research institutes.

Swedish law allows researchers at universities to keep **ownership of patents**, which is an exemption from the general regulation on patents developed for employees. Whether to keep or remove this clause has been debated since the 1990s [41]. So far the conclusion has been to keep the clause. The arguments for this decision are partly that patenting is a very costly affair and that it is questionable whether the benefits for universities outweigh the costs.

To facilitate commercialization of research, the governmental policy has been to provide resources to universities to give them the possibility to offer support to researchers who are interested in the matter. Vinnova has pointed out that a number of auxiliary measures as equally important focusing issues for policy intervention in this area [41]. These include supporting increased mobility between academia and the corporate sector as well as promoting the development of a Nordic initiative for patent insurance at the European level.

At the same time as efforts are being made to change cultural values, the infrastructure for supporting the new set of values is also being put into place, often through the same mechanisms such as network building [41]. Different policy initiatives focus upon creating bridging mechanisms which would act as facilitators for commercialization either through capital infusion, network and competence exchange, or in terms of education programs.

In the 1970s, a number of mechanisms were introduced to promote the transfer of knowledge from universities to the wider society, many of which are still in effect today [41]. Among these was the establishment of **contact secretaries** whose duties partly included assisting university researchers in patenting and starting companies. Measures allowing researchers at universities or university colleges to work either part or full time for a company or another organization during a specified period were established. To increase networking and collaboration with the industry, adjunct professors and industrial doctoral students were also introduced.

In the early 1980s the first **science parks** were established. The purpose was to offer a good working environment for research and development intensive firms. Two main types of activities can be found in the Swedish science parks [41]. Firstly the research and development departments of large firms are located here for the purpose of networking and recruitment and secondly spin-offs from universities or university colleges. Initially science parks were limited to providing physical facilities, but later the functions of science parks have been expanded to include support for patent applications, venture capital, etc.

Box 10.1: The Third Mission in Sweden

Sweden has been in the forefront among the Nordic countries when it comes to taking the role as an economic actor into legislation. In 1998 the Third Mission of the university was established. The text in the legislation is: "Högskolorna skall också samverka med det omgivande samhället och informera om sin verksamhet" which in English is "The Universities should also collaborate with the external society and inform about its activities". Although this is a broad mission, it has triggered activities and led to focus both on research collaboration and commercialization.

11.2 OVERVIEW OF ACTORS AND COMMERCIALIZATION INITIATIVES

This section presents the main actors in Sweden responsible for initiatives to increase commercialization of research. As said initially in this chapter, most of the research in Sweden is performed in industry. Up until now public initiatives have been focused mostly on creating collaboration between university and industry. Hence, there are few initiatives on national level which are comparable to the FORNY program in Norway, which are focused on commercializing R&D from universities.

11.2.1 Swedish Agency for Innovation Systems -Vinnova

Vinnova, the Swedish Agency for Innovation Systems, became operational in 2001. The Agency integrates research and development in technology, working life and society. Vinnova´s main roles are:

- ✓ to finance research, development and demonstration activities that meet the needs of business and the public sector

- ✓ to foster co-operation between universities, industrial research institutes and business
- ✓ to promote the diffusion of information and knowledge, especially to small and medium-sized enterprises
- ✓ to stimulate increased Swedish participation in the EU´s general R&D programmes.
- ✓ to evaluate and develop the Technological Prescience process
- ✓ to develop the role of research institutes in innovation systems

11.2.2 Foundations for Technology Transfer (Teknikbrostiftelsen)

Seven regional Foundations for Technology Transfer (TBS) were founded in 1994 by the Swedish Ministry of Industry and Trade. The foundations worked mainly with the universities but also with other local actors promoting regional innovation systems. In total SEK 1 Billion was invested into funds until the end of 2007 when the inflation compensated funds had to be paid back to the government. TBS-foundations were located across the country in the main university areas of Sweden: Gothenburg, Linköping, Luleå, Lund, Stockholm, Umeå, and Uppsala.

The mission of each TBS was to increase the industrial growth in the region by promoting knowledge transfer between industry and academy, including commercialisation of academic research and entrepreneurship among academics. A key objective of the limited time project funding was to encourage them to seek external funding and to become self supporting on their own right. The following incentives and policies were used to improve knowledge exchange between academy and industry [42]:

- ✓ Commercialisation functions for university-based ideas and innovations
- ✓ Simple and effective entrance functions for companies into universities
- ✓ Defined academic products and processes in line with industry needs

11.2.3 From Foundation for Technology Transfer to Innovation Bridge

The Foundation for Technology Transfer was evaluated by Riksrevisionsverket in 2001 and got a good review. But there is still a funding gap in the transition stage where research funding ends until either customers or investors pick up the technology. So in order to avoid loosing the momentum that Foundation for Technology Transfer had created, the government initiated ways to continue the activity. From March 2005 the Innovation Bridge (Innovationsbron) was established. The seven companies in former Teknikbrostiftelsen have been organized into one integrated company with 7 daughter companies. The fund in former Teknikbrostiftelsen, The Incubator Program in Vinnova and SEK 200

million seed capital from Industrifondet is now in the Innovation Bridge. The new company has approximately SEK 2 billion and the new company has also a 10 year life time before the public share is to be paid back. The seed capital funding from Industrifondet is 200 million SEK, Vinnova will put in approximately SEK 500 million and the fund of SEK 1 billion in former Foundation for Technology Transfer is currently the Innovation Bridge basis.

11.2.4 University holding companies

In the mid 1990s, eleven University holding companies were formed for financing the commercialization of R&D [43]. Each holding company were given between 4 and 6 million SEK in equity capital from the government, but have since relied on self generated income and external support, especially from the TBS-foundations. The holding companies gave the universities some flexibility and mainly have had two roles. It allows the universities 1) to take ownership in spin-off companies based on R&D and 2) become a regional actor that can own strategic companies or organizations such as incubators. The practice of what the universities have used the holding companies varies from university to university [44]. The self-reported outcome from the holding companies' activity is as follows [45]:

- ✓ The holding companies have contributed to the establishment of 300 companies (but invested in a smaller share of these)
- ✓ The established companies employs more than 2000 people in Sweden
- ✓ More than SEK 2.7 billion have been invested in these companies
- ✓ The established companies have an annual revenue of one billion SEK
- ✓ The holding companies have also contributed to commercialization through patenting and licensing

11.2.5 University hospitals

Karolinska Institutet is one of Europe's largest medical universities. It is also Sweden's largest centre for medical training and research, accounting for 30% of the medical training and 40% of the medical academic research that is conducted nationwide. Karolinska Institutet´s mission is to improve the health of mankind through research, education, and information (http://www.ki.se).

Karolinska Institutet has built up an innovation system with three organizational bodies. Karolinska Innovations AB (KIAB) offers the researchers and entrepreneurs of Karolinska Institutet support and practical assistance in commercialising their intellectual property rights. Karolinska Innovations have created 25 companies and signed 20 licence agreements with pharmaceutical companies. The 25 spin-off companies from KIAB have raised SEK 500 million in venture capital and currently employ approximately 200 people. Karolinska

Development (KD) is an investment company that focuses on early investments and active management of its pre-selected portfolio companies. Karolinska Investment Fund (KIF) invests in research and development projects in medicine, biotechnology and medical technology conduct by Karolinska Institutet and other medical schools, universities, and comparable academic institutions.

Box 10.2: Chalmers School of Entrepreneurship

Chalmers School of Entrepreneurship Chalmers University of Technology in Gothenburg is the second largest technical university in Sweden with about 10 000 students, 2500 employees, and a strong focus on research. Chalmers has traditions for innovation support from about 1970, including an infrastructure for commercialization of research and a track record of 225 direct spin-offs as by 1998 [46].

Chalmers School of Entrepreneurship (CE) began as a pilot project in 1996 aiming at commercializing research-based ideas, while at the same time educating students to become future entrepreneurs [47]. This pilot project has been continued and developed further towards its current form. CE recruits students from engineering, business, and design schools at the bachelor level. Each year around 20 students are selected on the basis of comprehensive applications and interviews both by CE's staff and psychologists. About one third of the applicants are found qualified to participate in the one-and-a-half year study program. The aim of the selection process is to identify students who are motivated and capable of becoming entrepreneurs.

The study is built around a real innovation project where groups of three students are establishing a new venture on the basis of a research-based idea. Many of the ideas are acquired from researchers at the Chalmers University, but now also projects are recruited from Karolinska Institutet and Uppsala University. For an idea to be accepted, the inventor should be motivated to become a partner in the project group. Other criteria for an idea to be of interest to CE are that the intellectual property right issues are clear, that the idea has a high (global) potential, and that it is technically validated.

The students are provided with relevant courses, action-based projects, and after half a year they choose what team and what project to work with. A limited company is formed around each project and located in CE's incubator facilities. Experienced business people are involved as board members. The education is

based on, and adjusted to, the challenges and needs of each company. The operating cost of CE is about one million EUR a year, funded by the university, other public funds, as well as private funds. Evaluations show:

- ✓ 31 companies formed in the years 1997 – 2004
- ✓ 156 full time jobs created by the 31 companies
- ✓ Valuation of the portfolio is about SEK 300 million (approx $40 million)
- ✓ Venture Capital raised is about SEK 45 million ($6 million) in 2004

11.2.6 Seed capital in Sweden

Sweden has the oldest and most developed venture capital market in the Nordic region. To fill gaps especially in the early stage seed market, however, the government is taking a role and has established several seed funds. Through Industrifondet the government is addressing capital needs, whereas Industrifondet has invested in regionally seed funds and also the Innovation Bridge seed fund.

The seed fund in the Innovation Bridge is both central and regional at the same time. The Innovation Bridge is as mentioned in chapter 10.2.3 consisting of seven companies, but managing one seed fund. All investment decisions are made in the regional Innovation Bridge companies if they want to invest, but all seven companies are sharing one fund.

11.3 DESCRIPTION OF SPECIFIC NATIONAL INITIATIVES

11.3.1 Vinnova's program VINN NU

VINN NU is funding business development activities in new established R&D based companies. This program is funded by Vinnova in collaboration with the Swedish Energy Agency. The goal of the program is to make it easier for R&D based companies to prepare for a commercial development, find more funding and become prosperous Swedish companies. From the program point of view, at least 50% of the awarded companies should have received funding for further growth within two years after the VINN NU project is finished and after five years, at least 20% of the companies should be a Swedish growth company.

The program is organized as a competition, where 20 projects each year will receive an award of SEK 300 000. In 2005 there were approximately 80 applications for VINN NU. The application process for the company is sending a

company and technology description to Vinnova. The projects are screened by Vinnova staff and the finalists are interviewed by Vinnova staff before awards are given. In 2006, 10 awards will be given in the spring and 10 awards in the fall. At least 75% of the company needs to be owned by individual persons, and the company should not have received funding from Venture Capital etc.

In 2005 there were 16 out of 20 projects that originated from university, though that is not a requirement. The VINN NU has been a program in Vinnova since 2001 and has yet not been evaluated, but the program will be evaluated during 2006.

11.3.2 Vinnova's program Nyckelaktörsprogrammet

A new program called Nyckelaktörsprogrammet has just been announced in February 2006. The program aims to develop processes and competence at universities and colleges so that they are more professional in their role to:

- ✓ collaborate between R&D community, private companies, and society
- ✓ utilize competence and commercialize R&D

During the year of 2006 the universities and colleges that participate will need to evaluate themselves and point out strengths and weaknesses when it comes to industry collaboration and commercialization of R&D.

11.3.3 Venture Cup

Venture Cup is a business plan competition established in 1998 in Sweden. 2 years later the competition was established in Norway. Venture Cup is organized in 4 regions in Sweden, South, West, East and North. Inn all regions, Venture Cup is an independent foundation with universities, McKinsey and the Innovation Bridge as arranging partners. The total amount of funding is about 15 MSEK pr years to run the competition in all 4 regions. In 2004 there were:

- ✓ Approximately 850 projects in phase 1
- ✓ Approximately 350 projects in phase 2
- ✓ Approximately 200 projects in phase 3

Venture Cup has been very successful in Sweden, the results are far better compared to Venture Cup in Finland, Denmark or Norway. Venture Cup has established themselves as a brand at the universities and has generated several hundred companies. Approximately 10% of the participating projects in Venture Cup are research-based, but the goal is to improve this number even further.

11.4 INTERVIEWS IN SWEDEN

During the work with Sweden December 2005 – February 2006, we had phone call interviews with the following persons:

- ✓ Kjell-Håkan Närfelt, Vinnova
- ✓ Ann-Louise Persson, Vinnova
- ✓ Kari Gustafsson, Innovation Bridge Uppsala
- ✓ Mats Lundqvist, Chalmers School of Entrepreneurship
- ✓ Johannes Eng, Venture Cup Väst
- ✓ Jan Nylander, Innovation Bridge (e-mail Q&A)

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