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Between entrepreneurship and technology transfer: Evaluation of the FORNY programme

Siri Brorstad Borlaug, Leo Grünfeld, Magnus Gulbrandsen, Einar Rasmussen, Lars Rønning, Olav R. Spilling og Evgueni Vinogradov

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Preface

This report is the result of an evaluation of the FORNY programme commissioned by the Research Council of Norway. The background for the evaluation is that the current programme period will be terminated by the end of 2009, and the results of the evaluation will be an important basis for designing the future programme.

The evaluation has been organised in collaboration between NIFU STEP (lead partner) and Bodø Graduate School of Business, Menon Business Economics and Nordland Research Institute with the following staff contributing to the project:

NIFU STEP: Siri Brorstad Borlaug, Magnus Gulbrandsen, Olav R Spilling and Agnete Vabø
Bodø Graduate School of Business: Einar Rasmussen
Menon Business Economics: Jørgen Bækken and Leo Grünfeld
Nordland Research Institute: Tommy Clausen, Einar Lier Madsen, Lars Rønning and Evgueni Vinogradov

Olav R Spilling has been the project coordinator.

The work has been organised in close collaboration with the FORNY staff. Many meetings and seminars have taken place, which have provided ample opportunities for discussion of the evaluation approach, preliminary results and various issues related to the organisation and the performance of FORNY. This has created a very constructive and inspiring setting for the work, and we hereby express our gratitude for having had this opportunity to working with a most interesting – and challenging – project.

Oslo, April 21, 2009

Randi Søgnen — Deputy Director

Finn Ørstavik — Research Director

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Summary

The general conclusion of the evaluation of FORNY is that despite the positive additionality and the successful targeting of high technology commercialisation projects, the overall results of FORNY are not very impressive. It should be mentioned that comparisons are extremely difficult and there may be indirect results and a positive dynamics taking place. Still, we worry about the lack of firms that have grown large and the generally poor growth rate compared to international cases. Although there are contextual explanations for this low performance – like the structure of the R&D system, the legislative changes in 2003 and the universities and colleges' follow-up – the general picture is that the results of FORNY are less than satisfactory, also given the substantial funding devoted to the programme over the years. A key issue is the balance between putting a lot of resources into creating a few spin-offs that are expected to have a significant growth potential versus spreading the resources on the creation of many companies. FORNY may have to do both but has succeeded in neither: many firms survive but they remain very small and seem to fail to attract capital in the growth phase.

The following is a chapter-by-chapter summary of the whole evaluation report. Readers with little time for all the empirical and theoretical analyses may proceed to read Chapter 9 which discusses the future development of FORNY.

The FORNY programme is the main policy instrument supporting commercialisation of publicly funded research in Norway. FORNY was originally started as a project in 1995, and it has been operated by the Research Council of Norway (RCN). The background for this evaluation report is that the current programme period will be terminated by the end of 2009. There is a strong interest from the Research Council as well as the Ministry of Trade and Industry to replace FORNY with a new programme for research based commercialisation. In order to develop a sound basis for deciding on the future organisation of the new programme, the Research Council has organised a broad process for discussing and developing the new strategy, and the purpose of the current evaluation is to provide an input into this process.

The evaluation

The overarching questions for this evaluation are: i) what is the performance of the FORNY programme in terms of successful commercialisations? ii) How can this performance be explained given the characteristics of the system of research institutions the programme is addressing and the way the programme presently is organised? With this as our point of departure, the evaluation tasks have been organised around the following themes:

- Theoretical perspectives and international experiences
- Organisation and implementation of the FORNY programme
- FORNY start-ups, commercialisation and firm performance
- Survey of FORNY start-ups and licence agreements
- The FORNY programme in interaction with other policy programmes
- Gender perspectives

- Implications for the future development of FORNY.

Theoretical perspectives and international experiences

There are several theoretical rationales for policy interventions, but the most common rationale for providing support to commercialisation of academic research has been related to the market failure argument which denotes a situation where the allocation of resources of production or use by the free market is not efficient. Thus, market failure is often used as a justification for government intervention through financial support and other means. In the innovation system literature, this argument is often expanded to a justification of policy interventions based on system failure The main focus of the systemic approach is the complex interactions between different actors and institutions, and from this perspective policy makers need to intervene in areas where the system is not functioning well. All systemic failures are potential targets for intervention, however, the state is legitimised to address the failure only if state intervention provides the most efficient solution.

Our review of international experiences shows that the most successful examples of high impact from commercialisation of research seem to be based on bottom-up processes. Moreover, the regional conditions differ highly, making it unlikely that a 'one size fits all' structure will be successful. Thus, a key challenge is to identify the 'driving factors' behind successful commercialisation processes at institutional and regional levels. Two main approaches seem to characterise successful examples of value creation from the commercialisation of research. One is a strong dedication from the university or research institution to promote technology transfer to achieve academic, economic, social, and financial benefits. The other is a strong regional commitment to promote the start-up and growth of knowledge or technology-based new ventures. The strongest potential is released if both these 'driving factors' are well established and linked together.

Organisation and implementation of the FORNY programme

Our analysis of the present organisation of FORNY concludes that it is characterised as a decentralised and loosely coupled system. The programme has a small secretariat with limited resources, and it has limited capacity for a more active involvement in developing the strategies of the programme. Moreover, the present system of commercialisation actors or technology transfer offices (TTOs) is fairly fragmented. There is no clear structure of organisation and specialisation, the most important principle of organisation is that of regionalisation; to a lesser extent the TTOs are specialised on disciplines or types of commercialisations.

While some of the TTOs are well embedded in the strategies of their mother institutions, others are not. Although the mechanisms of commercialisation are complicated, an important factor that may explain the good performance of some of the TTOs is how the mother institution has adopted commercialisation as part of its main strategy, and that working with commercialisation projects is regarded as an integrated part of the activity of the institution. Naturally, the working conditions for the TTOs are quite diverse. While the TTOs serving research institutes may specialise in specific technologies and thus easily can be integrated in

the activities of their mother institutions, the situation of the TTOs serving the universities is more complex; they deal with researchers from different disciplines, the incentives for researchers to commercialise are limited, and it is often unclear to what extent the research institutions actually give priority commercialisation activities.

The TTOs have not yet succeeded in bringing up a sufficient number of projects with a great potential for commercialisation. The strategies pursued so far by many of the TTOs have not been successful as their resources to a significant extent have been tied up in projects with limited prospects for exits. The TTOs that generate substantial results seem to have staff with more generic disciplinary competence and industrial experience. However, the situation is fairly complicated, and an important issue for the future development of the program is what type of competence the TTOs should have and, moreover, what role a TTO should have.

FORNY start-ups, commercialisation and firm performance

Since 1996 the FORNY programme has generated approximately 300 start-ups. Today, these firms report a total of 900 MNOK in turnover and an employment of approximately 700. These figures are strongly dominated by a few companies like Opera Software. The median firm turnover is around one million and its value added and employment are close to zero NOK and one employee respectively. Approximately five percent of the firms display patterns that are consistent with a high growth path and a strong future potential for employment and value added contribution. These higher degree commercialisations do not represent successful cases per se, but rather potential cases. In this perspective, the figures are low. This does, however, not imply that the number of firm closures is high among these start-ups. On the contrary, the survival rate is over 90 percent each year. We find reason to claim that this pattern is driven by the fact that the vast majority of these start-ups remain small firms with limited or no activity.

Technology and R&D intensive start-ups face a long period of high and climbing costs before reaching a phase where commercialisation yields revenues and finally profits. In light of this pattern, using value added as a success criterion is inappropriate. FORNY start-ups should actually not report too high value added figures as that may signal low willingness to invest during the first years. The most relevant performance measure when studying early stage firms is sales or output growth.

We have shown that the vast majority of FORNY start-ups have received very limited amounts of capital. Clearly, many of the start-ups should not receive capital as the projects turn out to be commercially unsuccessful, yet the share of firms that actually receive significant amounts of capital to enable large early stage investments is surprisingly low. This may indicate that some of the potentially successful start-ups receive insufficient capital flows. This picture is further enriched when we look at what kind of capital firms are supplied with. More than 60 percent of the capital comes through public sector channels, mostly in the form of transfers. Supply of equity capital is surprisingly limited when we look at the start-ups after some years.

Most capital is raised in the very first years after establishment. The need for additional capital is rather growing over time. Hence a pattern with low capital supply in the later stages may constitute a problem.

Survey of FORNY start-ups and licence agreements

The survey of the FORNY start-ups and licence agreements suggest that the firms and licenses which were developed with support from the FORNY programme were research-based and innovative. The spin-off firms and licenses were mostly related to knowledge-intensive Industries like information and communication, medicine and biotechnology. Moreover, the surveyed firms reported a highly innovative orientation with involvement in R&D activities. The licensees also described the relevant technologies as highly innovative, challenging the existing technologies in the industry and generating new ideas. Thus, the FORNY programme contributed to the intended activities.

The majority of the spin-off firms surveyed stated that their firm would not be started or the start would be delayed for an indeterminate period without TTO support. Moreover, TTOs added significantly to the scale and efficiency of the spin-off activities. The data also suggest that the impact of a TTO is largest at the early stage of the spin-off process, indicating that the TTOs successfully contribute to bridging the gap between academic research and start-ups.

The results of the role of the TTOs for licensing are mixed. On one hand, both sellers and buyers of licenses indicated the important role which TTOs played. Without this support, the majority of licences would not be developed within any foreseeable time frames. On the other hand, when compared to other actors, TTOs were reported to provide very little contribution to the development of technology. This ambiguity may be an artefact of the questionnaire design. There is also an alternative explanation. The respondents may over-emphasise the effects of a TTO because they are generally interested in the continuation of public support. However, when comparing the effect of a TTO to one's own contribution, the respondents may over-emphasise their own role in the process of technology development.

The FORNY programme in interaction with other policy programmes

There are two lessons to be learned from the review of policy programmes with relevance for the FORNY start-ups. First, a major challenge when it comes to commercialisation of R&D relates to mobilisation of entrepreneurial intentions among academics. In spite of the large number of policy programmes focused on mobilisation in education, there is a question whether these programmes reach the future academics. The entrepreneurial mindset needs to be stimulated among academics as well as among the students who may become future (academic) entrepreneurs. That is, in order to recruit more academics into the FORNY programme, a broader mobilisation within academic institutions may be necessary. Within FORNY the infrastructure funds may partly cover the mobilisation phase. Still, cultural changes require long term commitment, and there is a need to continue and possibly strengthen the focus on mobilisation for entrepreneurial intentions in academic communities.

As a second lesson, we find that there are plenty of programmes directed towards the very early stages in the start-up process, including FORNY itself. Yet, the number of programmes and the amount of financial resources directed towards the phases following directly after the start-up process are more limited. This coincides with a period or phase of moderate capital supply through equity capital and loan financing. In the later growth stages, FORNY firms with a higher degree of commercial success tend to be better endowed with public sector financing (e.g. OFU/IFU and seed fund investments). Hence, if the public sector support programmes contain gaps, we believe that the early growth phase is the most vulnerable period for FORNY start-ups. With the early growth phase, we speak of a period of 1-3 years after the firm has been established.

Gender perspectives

The analysis of FORNY confirms the tendency that the share of women involved in technology transfer is significantly lower than what should be expected if the recruitment to commercialisation projects followed the share of women working in the research fields the projects stem from. Thus, there seem to be gender biased selection processes possibly because women may be less oriented towards market and competition oriented activities than men. On this background, gender issues are important for the future organisation of FORNY since its operations seem to strengthen the general tendencies of gendered divided structures in academia as well as in the business world.

However, a main issue to be considered is if the gender issues related to FORNY are specific enough to justify special actions *within* the framework of FORNY to stimulate women's participation in commercialisation. At least as far as the specific FORNY instruments are concerned, i.e. commercialisation funds, proof of concept funds and leave of absence grants, it may not make much sense to implement specific gender related instruments. Instead, we will recommend that broader and more comprehensive strategies should be pursued independently of FORNY. Actions taken in order to improve the gender balance in academia will also have an impact on the gender balance in commercialisation processes, in particular if the actions include measures to motivate women in academia for an entrepreneurial career.

Implications for the future development of FORNY

FORNY started out with an emphasis solely on creating spin-off companies. Its approach, the system it supports, and the wider institutional and legislative system have all changed quite dramatically over the years. Some important features are the strong growth of public research, the removal in 2003 of the teacher exemption clause and the clearer mission for universities and colleges to support exploitation of research results, and the realisation that spin-offs are only one of several pathways to successful commercialisation. The FORNY programme has shown a willingness to experiment and learn, and there are many signs of enthusiasm and increased professionalism in the commercialisation system. Still, there are a number of challenges that should be addressed in the future design of FORNY, and we have the following recommendations:

Clarify the goals of FORNY: We recommend that the programme goals should be clear, concise and more focused on the specific tasks of the programme. Furthermore, the goals should be more dedicated to the core institutions it addresses (universities, colleges, research institutes, hospitals) and more specific in how to approach them. The goals should also place FORNY in a wider institutional system supporting entrepreneurship and technology transfer, including RCN, IN and SIVA and their various instruments. There should also be a good and clear link between the goals of FORNY and its funding mechanisms/instruments. Finally, the goals should ideally give some directions about the development of selection criteria and evaluation procedures.

Improve coordination in the commercialisation system: Our suggestion would be to take coordination to a higher level in RCN and IN – the two owners of the FORNY programme. Perhaps a high-level group can be created that discusses relevant instruments for all phases of commercialisation/entrepreneurship and not least the linkages between these instruments. New approaches involving stage-based or milestones-contingent support as well as a mentoring programme could be considered.

Improve coordination in the TTO system: We suggest a rethinking of the support for the TTOs to allow them to become more closely embedded in their regions and institutions and to play a broader role in entrepreneurship and technology transfer than the FORNY funding itself can support. The support may be created in a somewhat similar manner to other centre of excellence support programmes in RCN.

Embed commercialisation in the research system: We suggest that FORNY works more actively for a better integration of its goals and activities with those of the research system it serves. FORNY should not be satisfied with becoming a general support mechanism for HEIs and some other research institutions, providing basic funding for TTOs and similar organisations. One solution would be to have a "matching funding" criterion: for each NOK of TTO support from the institutions' *own funds*, FORNY can put up a matching NOK. Another solution would be to expand and change the incentive funding scheme to give stronger incentives to the involved research institutions rather than the TTOs.

Reduce bureaucracy: We suggest that FORNY takes some steps in making the programme more like other R&D programmes where proposals are evaluated by independent "peers". We would also recommend that – given the number of levels and actors in the commercialisation system – reporting and application procedures are kept fairly minimal. In the first phase of support, the system could perhaps be based more on trust rather than applications and reporting.

Gender imbalances: We suggest that gender imbalances are targeted more broadly than within the frames of the FORNY programme. Nevertheless, a mentoring programme could have a component targeting women in particular.

In sum, we believe that FORNY should make a clearer distinction between supporting the commercialisation system/the TTOs and supporting the good ideas and their champions. The first could be made into a mechanism resembling other centre of excellence initiatives in RCN, rewarding good TTO performance and encouraging the relevant research institutions and regions to become more involved. Idea support could be stage or phase-based and model its selection and review processes on other R&D/innovation programmes in RCN and other organisations. FORNY itself could then develop into the programme for TTO support and mobilisation for commercialisation and entrepreneurship, or it could develop into the programme for commercialisation of research-based or knowledge-intensive *ideas* (maybe including advanced ideas also from students and other groups). A third possible option is that FORNY continues as a general commercialisation programme like today. This would still require a clearer demarcation between support for the system and support for the ideas, and a weakening of the ties between the TTO s and the FORNY central organisation.

1 Introduction

The FORNY programme is the main policy instrument for support of commercialisation of public funded research in Norway. The programme is operated by the Research Council of Norway (RCN) which has initiated an evaluation of the programme. In this chapter we will summarise the mandate for the evaluation and give an overview of the approach of the evaluation project.

1.1 The evaluation task

The background for initiating an evaluation of FORNY is that the current programme period will be terminated by the end of 2009. There is a strong interest from the Research Council as well as the Ministry of Trade and Industry to pursue the FORNY programme with a new programme on research based commercialisation. In order to develop a sound basis for deciding on the future organisation of the new programme, the Research Council has organised a broad process for discussing and developing the new strategy, and the current evaluation is just one of several activities in this process. There is an internal working group and an external reference group that also will provide input to the process. In addition, some study tours and an international seminar have been organised in order to summarise international experiences on commercialisation of research.

The mandate for the evaluation is formulated as follows (our translation):

> The Research Council aims at contributing to increased commercialisation of research results of public funded research also after 2009. The evaluation will be a part of the Research Council's strategic analysis and development of a new programme or new measures for strengthening the innovation capability in the research institutions.
>
> Thus, the objective of the evaluation task is two-pronged; first, the Research Council wants an analysis of the total impact FORNY has on innovation activities and value creation in Norway, and an assessment of FORNY compared to alternative measures that might have given better results. Second, the Research Council wants an analysis of opportunities for developing powerful measures for commercialisation of research from 2010 to meet the future challenges regarding commercialisation of research. The objective should be to strengthen the capability of public funded research institutions to develop more ideas for viable companies or support existing firms in licensing new technology. This should be the main part of the analysis.
>
> The evaluation should provide documentation and analyse and evaluate:
>
> - The theoretical and experience based basis for designing the programme
> - The programme's ability to compensate for system failure, including market failure. The evaluation should analyse the FORNY actors' opportunities for exploiting alternative measures or obtain support from alternative financial resources if the programme is terminated
> - The programme's ability to achieve its goals, taking into consideration the total use of resources; the total spill-over effect and value creation should also be assessed

- Good practice and design of similar programmes and measures in countries which may be compared to Norway
- The different parts of the programme compared to other similar or complementary measures, and analysed in the context of the national innovation system and the Government's aim to develop a general and integrated system of policy measures
- The organisation of commercialisation units regarding regional organisation as well as internal competence and capacity, and related to quantitative and qualitative aspects of the research institutions served by the commercialisation units
- If the programme should focus on the research fields with the highest potential for commercialisation
- The importance and organisation of the different measures of the programme, and to identify potential areas not well covered by the programme. As part of this, it should be analysed if the programme should include pre-seed funding. The programme measures should also be analysed in the context of the FORNY actors' structure and competence, and their ability to build and take advantage of supplementary competencies through building networks and collaboration between the actors.

Evident from the mandate, the objectives of the evaluation comprise a fairly complex set of tasks and expectations. Thus, we have emphasised to develop a good overview of the programme and its achieved results and main impacts. Moreover, given the Research Council's strong emphasis on the future development of the programme, an important objective of our analysis has been to identify weaknesses in the organisation and the strategy of the programme as this will provide a basis for developing suggestions for the design of the future programme.

1.2 The evaluation approach

Our evaluation of FORNY is based on a programme evaluation design, in which we analyse the programme as an organisation of input resources, which are implemented within the framework of an organisational structure. The input resources in FORNY are the different funding schemes by which economic resources are allocated to the actors participating in the programme, while the main part of the organisational structure in the FORNY is constituted by the TTOs. Thus, in the analysis of the programme, it is important to distinguish between FORNY as a programme for providing support, directly or indirectly, to the specific commercialisation projects; and FORNY as a programme for developing a system of actors that facilitates the selection and retention of these projects.

This is the rationale for distinguishing between two evaluation approaches, i.e. goal attainment evaluation and evaluation of the implementation or organisation of the programme.

When analysing the goal attainment of the programme, there are two key questions to be analysed: i) are the results are in accord with the programme goals, and ii) are the results produced by the programme? (Vedung 1997). When analysing the implementation of the programme, the key question is more complex: to what extent is the chosen model of organisation feasible for supporting and facilitating the processes the programme is aiming at.

In addition to the evaluation approach outlined above, our evaluation is based on a system approach, and this will be the overarching framework of the evaluation. A system approach entails that innovation processes are interactive processes where a number of actors are involved. The results of the programme do not only depend on the actors participating in the programme and their strategies for organising their activities; the results are as much influenced by other actors in the system and the structure of the whole system, for instance the characteristics of the research institutions and the industrial structure.

The rationale of the FORNY programme is the perceived "gap" between academic research and industry and the need for facilitating processes that may lead to increased commercialisation of academic research. In this context, the main objective of FORNY is to contribute to the development of the system by supporting organisations that may serve as intermediaries, to contribute to bridge the gap between academic research and industry, and to provide economic resources adequate for stimulating processes of commercialisation.

On this background, the overarching questions for this evaluation are:

i) What is the performance of the FORNY programme in terms of successful commercialisations?
ii) How can this performance be explained given the characteristics of the system of research institutions the programme is addressing and the way the programme presently is organised?

Based on knowledge about international experiences, we will examine the main weaknesses related to the present organisation of FORNY, and in what directions FORNY should be developed in order to facilitate more and better processes of commercialisation. As a part of this, we will also analyse how FORNY interacts with other programmes and policy measures, and how FORNY and other relevant programmes should be developed in order to improve processes of commercialisation of research based knowledge.

The evaluation project is empirically based on three web-based surveys:

The TTO survey

The technology transfer offices (TTOs) constitute the major organisational units of the programme, and a questionnaire was sent to all the TTOs participating in the programme in 2008, with questions on staff, competence, strategy, portfolio and networks. (See questionnaire in appendix.) Responses were obtained from all the 14 TTOs. Supplementary information about the TTOs has been obtained by checking their web pages, annual reports and accounting data.

Survey of FORNY start-ups

Since the start of FORNY in 1995 around 300 firms have been established with support by the programme. A questionnaire was sent to the firms that were established in the period 2001-2008 asking questions about their origin, the entrepreneurial team, innovation and research

activity, exploitation of other policy instruments etc. Furthermore, the questionnaire included a number of questions regarding their evaluation of the importance of different types of actors in the different stages of their development, including their assessments of the importance of the TTOs and the FORNY programme. The total population of firms was 158, contact information was obtained for 138 firms, and responses were obtained from 72 firms, which give a response rate of 53 percent of the firms with contact data.

In addition to the survey data, the analyses of FORNY start-ups has to a significant extent been based on register data (public available data on firms, enterprises, accounting data etc.) and data on ownership and equity capital available from Menon's database (one of the partners in the project). The advantage of these data sources is that they give data on all existing firms.

Survey of licence agreements

Two surveys were organised to collect information about the licence agreements. One survey addressed the licensers, the other the licensees. Questions were asked about the technology behind the licence, the importance of the FORNY programme for developing the technology, and characteristics of the firms and the researchers that were involved in the licence agreement.

1.3 The structure of the report

The rest of this report is structured as follows. First, we introduce the FORNY programme in Chapter 2 giving an overview of its background, development and current organisation. In addition the different schemes of FORNY are described in some detail, and we provide an overview of the total budgets for FORNY as well as some of the main results of the programme.

In Chapter 3 we discuss the theoretical and empirical basis for the FORNY programme. An introduction to the key terms related to commercialisation and policy is found here, followed by a broad overview of the developments in the field of commercialisation and summary of a number of reported results. Moreover, various aspects of government support programmes are discussed, and the chapter concludes by discussing two different approaches to commercialisations; the technology transfer model and the entrepreneurial university model.

In chapter 4 the organisation of FORNY is analysed and discussed. It focuses on the TTOs participating in the programme and discusses their structure, their staffing strategies, competence, networks and collaboration. The structure of TTOs is complex; it has been under continuous development and is still not settled. Key issues are the strategies they pursue for selecting and developing ideas for commercialisation and to what extent they succeed in building portfolios that provide good opportunities for exits.

The two following chapters analyse the commercialisations in terms of start-ups and licence agreements, partly based on register data and partly on survey data. In Chapter 5, the total portfolio of close to 300 FORNY start-ups is analysed. Distinguishing between three levels of

commercialisations, it is concluded that just a small share of the firms develop into potentially fast growing firms. In addition various aspects of the development of the portfolio of firms are discussed. This is followed up in Chapter 6 which, based on survey data, analyses in some detail the origin of the commercialisation projects and their characteristics like technology, innovation and research activity, and how the impacts of the FORNY programme on their development are assessed.

Chapter 7 contains analyses of the FORNY programme in relation to other policy programmes. Among the FORNY start-ups, a significant share takes advantage of other support schemes, and SkatteFUNN, the incubator grants and the OFU/IFU programmes are particularly important. The chapter discusses the interaction between FORNY and the other relevant programmes, and analyses to what extent there are gaps in the policy instruments, and if additional instruments should be developed.

In Chapter 8 gender perspectives in the FORNY programme are discussed focusing on the role of men and women in commercialisation projects, and to what extent the gender imbalance in these projects calls for any kind of reorganisation in the design of a new programme. The analysis partly draws on an international survey on "Careers in Academic Professions" (CAP), partly on data on gender obtained through register data, survey data and data from FORNY. The chapter discusses how the new programme should position itself according to the RCN's action plan on the gender equality policy.

In the concluding chapter (9), the overall results of FORNY is summarised and possible explanations for the performance of the programme are discussed. This is followed up by a discussion of what is the potential for commercialisation of research in Norway, given the organisation of the Norwegian research system and what we can learn from international experiences. As commented in Chapter 3, two broad strategies for commercialisation can be identified, i.e. the technology transfer approach and the entrepreneurship approach. With this framework, the chapter summarises some basic principles related to the organisation of FORNY that might be used in the future design of the programme.

1.4 Some reflections

The work has been organised in close collaboration with the FORNY staff, with a number of meetings and seminars, which have provided ample opportunities for discussion of the evaluation work, preliminary results and various issues related to the organisation and the performance of FORNY. Unlike the context of many other evaluation projects, the RCN seems very determined to reorganise the programme in the future and has been very interested in all kinds of critical reflections around the programme and suggestions as for its future organisation.

The evaluation mandate comprises a fairly complex set of tasks and expectations, and it has been quite challenging to organise the evaluation project. The literature is far from conclusive

regarding how government programmes for commercialisation of public funded research should be organised. Given the mandate of the evaluation, we aim at providing an overview of the basic organisation principles of the programme and it's achieved results in terms of commercialisations and analyse this against international experiences. However, we are facing some challenges and these are described below.

First, it turned out to be a quite complicated task to analyse the TTOs; their structure is rather heterogeneous and they are organised in different ways and pursue different strategies. It would have been quite interesting to go more into details, for instance to analyse the relationships between the TTOs and the research institutions and to what extent the TTOs are embedded in the institutions they are serving. Second, in the analysis of the TTOs, it would have been preferable to have data from other sources than the TTOs themselves, especially information on issues such as their competencies and their interaction with researchers. In the survey the TTOs reported that they regarded their competence fairly adequate. However, other actors might have a different perception. Ideally we should have carried out a survey directed towards the research institutions in order to obtain their perception of the TTOs. This was left out due to the scope of the project and limitation of resources.

Third, a very critical issue is how to assess the 'performance' of this type of support programmes. In accordance with the main goals of FORNY, we have focused on commercialisations in terms of start-ups and licence agreements. However, as discussed in Chapter 3, we have the metrics problem: What are the adequate indicators for evaluating the programme? There is also a problem related to defining an adequate time horizon for assessing the performance of the programme; how many years should we follow the projects in order to conclude regarding the results of the programme? Fourth, there are challenges in regard to what extent the performance of the commercialisation projects actually can be attributed to the FORNY programme. Even though we have employed an approach that is commonly applied in this type of evaluation, there is still a significant risk of making misjudgements about the additionality. Yet another weakness is that other forms of impacts of the programme like knowledge spill-over have been beyond the scope of the evaluation and are not analysed. Thus, there are a number of limitations in our approach that have to be kept in mind when the results are discussed.

2 The FORNY programme

The creation of new ventures based on academic research, or academic entrepreneurship, has become an objective for policy makers and universities across Europe. In line with the international trends, the FORNY programme was established during the 1990s and is the main support mechanism for commercialisation of public funded research in Norway. In this chapter we give an overview of the organisation and development of the programme, and how it relates to other relevant policy instruments.

2.1 The history of the FORNY programme

The FORNY programme was established as a project within the Research Council of Norway (RCN) in 1995 as a result of a pilot initiated in Trondheim and Oslo in 1994. The first strategy document points out the following direction of its operation: "… to contribute to innovation and through this value creation and employment in Norwegian industry. This will be achieved by strengthening the ability to commercialise research-based business ideas that emerge within the universities and research institutes." (Bolkesjø & Vareide, 2004). The strategy document outlined two target areas for the programme; to establish an infrastructure to lower the barriers towards commercialisation at the research institutions, and to professionalize the commercialisation process aiming at increasing both the number and quality of commercialisation projects. Commercialisation was seen to occur either through a licence to an existing firm or through the start-up of a new firm.

Instead of targeting the researchers directly, the FORNY programme worked through what in the programme traditionally has been denoted as 'commercialisation units', which we here will call TTOs (technology transfer offices). The TTOs were connected to the major research institutions in Norway, and they also functioned as science parks and acted as the operators of the FORNY programme at the regional level. Until the expansion in 2002, there were six TTOs. In most cases these were jointly owned by the research institutions, public agencies, and private firms. These TTOs specialised in supporting entrepreneurs from research into business. Their assistance included the evaluation of an idea and its commercialisation prospects, implementation strategy with regard to IPR, adding competence, providing commercial networks, and access to financing. Developing a founding team of entrepreneurs and support in working out business plans were also important tasks. The TTOs were awarded commercialisation funds as an annual lump sum based on an application to the FORNY programme and were free to decide what projects to support.

FORNY became an independent programme within the Research Council from 2000. The main goal of the programme was to "contribute to increased value creation based on research results in Norway and thereby contribute to strengthening the knowledge- and technology-base in Norwegian industry". The programme had three sub-goals; increased number of ideas with sufficient value creation potential from researchers; an efficient realisation of potential busi-

ness opportunities through new ventures or licences; and an increased and closer cooperation between support actors to realise an efficient and comprehensive support system.

The experiences since the start in 1994 led to some changes from 2000. There was clearly a need for a stronger involvement from the research institutions. Thus, the funds that earlier were granted as one sum to the TTOs were now split in two: the infrastructure funds, where the research institution had to apply for a 50 per cent cost covering of the activities, and the project funds that still were awarded directly to the TTOs.

From 2001 a new programme plan outlined a new main objective for FORNY: "to increase the value creation through commercialising knowledge-based business ideas with a high value creation potential". The removal of the points about "Norway" and "Norwegian industry" may signify an increased emphasis on non-spin-off commercialisations and on international collaboration in entrepreneurship.

The responsibility of the research institutions towards commercialisation of research results was emphasised in 2003 through the removal of the teacher's exemption and transfer of the ownership to the research institutions. This gave the research institutions incentives to more actively engage in commercialisation and select their partners for these activities. The result was a more complex system with an increased number of actors supporting academic entrepreneurship and competing for funding from the same sources.

2.2 Goals and organisation

The general objective of the FORNY programme is to increase wealth creation in Norway through commercialisation of research based business ideas. The programme is aimed at universities, university colleges, research institutes and university hospitals. In order to achieve its objective, the FORNY programme will (our translation):

- Contribute to change attitudes and behaviour in the research institutions in order to make the search for commercialisation opportunities an integrated and prioritised part of the research activity
- Contribute to the establishment of professional organisations and systems for the commercialisation of research at the research institutions
- Contribute to make competent and relevant commercialisation 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.
- Increased supply of ideas
- Positive value in the projects
- Increased coordination within the innovation system
- That measures are good and appropriate for all phases of the development
- Competence as a basis for knowledge and learning
- Positive development of the programmes repute and status

The FORNY programme is organised as illustrated in Figure 2.1. The resources for running the programme are provided by the ministries, the Research Council of Norway (RCN) is the operator of the programme, and the implementation of the programme basically takes place by allocating resources to the TTOs which select and follow up the commercialisation projects. The main direct output of the programme is commercialisations in terms of start-ups and licence agreements.

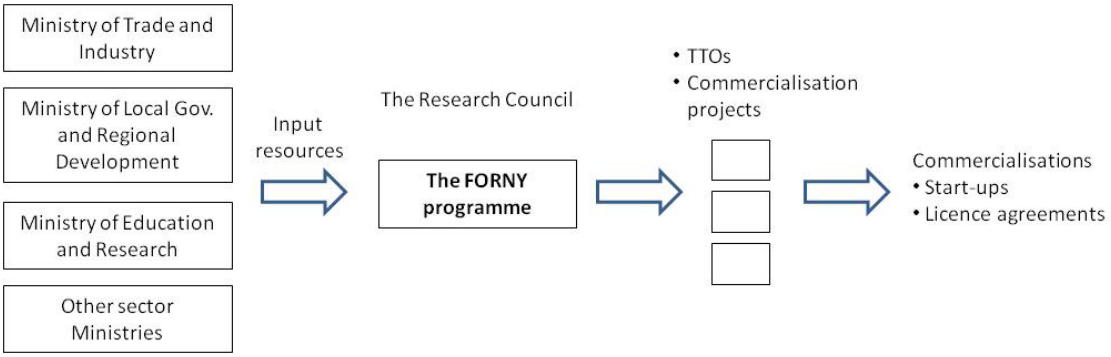

Figure 2.1:Organisation of the FORNY programm

Reflecting the growing emphasis on strategies for commercialisation of research, it has been a significant growth of the budget for the FORNY programme since 2000. While the budget was 44 million NOK in 2000, it has been tripled up to about 130 million NOK in 2008 (Table 2.1).

Table 2.1 Funding and total budgets of FORNY 2000-2008 (mill NOK)

Ministry/Agency	2000	2001	2002	2003	2004	2005	2006	2007	2008
Ministry of Trade and Industry	17,0	16,5	30,4	46,0	46,0	50,5	72,5	69,8	72,7
Ministry of Local Government and Regional Development	12,0	14,0	13,5	14,6	12,6	12,5	12,5	14,5	10,5
Ministry of Education and Research				12,0	17,5	14,0	13,0	13,0	13,0
Ministry of Fishery and Coastal Affairs							5,0	5,0	5,0
Ministry of Agriculture and Food							5,0	5,0	5,0
Innovation Norway	15,0	15,0	15,0	20,0	20,0	15,0	15,0	13,0	13,0
Other programmes*)							3,0	9,0	14,0
Brought forward from previous year					2,7			5,7	-2,8
Total	44,0	45,5	58,9	92,6	98,8	92,0	126,0	135,0	130,4

*) Support provided for proof of concept from other programmes managed by RCN (Verdikt , Renergi, Nanomat and Fuge).

During the early years, funding of the FORNY programme was provided by the Ministry of Trade and Industry and the Ministry of Local Government and Regional Development. Part of the funding was transferred via Innovation Norway. The Ministry for Education and Research became involved in 2003; this was motivated by the changes of the university legislation and the abolishment of the teachers' exemption. Later, the Ministry of Agriculture and Food and

the Ministry of Fishery and Coastal Affairs have also become involved, although with smaller contributions.

It appears from the table that the main growth of FORNY has occurred in two leaps. The first was in 2003 when the Ministry of Education and Research provided funding, and this was matched by a similar growth in the grant from the Ministry of Trade and Industry. The next significant step occurred in 2006 when the Ministry of Trade and Industry again expanded its grants to the programme significantly, and also the Ministries for Fishery and Agriculture started allocating grants to the programme. It appears from the table that the Ministry of Trade and Industry by far is the most significant provider of funding with more than fifty per cent of the total budget for the programme.

The main target group of FORNY is researchers working in universities, university colleges, research institutes or university hospitals that have ideas originating from their research which can be developed into commercial activity. But rather than approaching the individual researchers directly, the FORNY works through funding activities organised by the research institutions themselves and by the TTOs. The core actors in this system are the TTOs which are working locally with the research institutions and handling the deal flow generated by the researchers. During the early years the FORNY programme included six TTOs, mostly organised according to a regional pattern which also was reflected in a regional division of FORNY. In the later years, the structure of TTOs has developed to be more diversified, and as outlined in Chapter 4, there were 14 TTOs by the end of 2008.

Most of FORNY's budget is channelled through the TTOs. However, from the infrastructure funds (see below), also other institutions than the TTOs may obtain support - to build culture and raise the awareness of commercialisation and research based entrepreneurship among students and staff. In 2005 there were 48 institutions altogether that could obtain grants, including 15 TTOs, seven universities or specialised universities, 18 research institutes, five university hospitals, and 13 state university colleges. In 2008, there were 47 institutions that received grants from FORNY.

2.3 Funding schemes in FORNY

The FORNY programme now operates four different funding schemes and one performance-based incentive scheme that all are aimed at increasing the commercialisation of research from Norwegian R&D institutions. An overview of the FORNY budget by type of funding is provided in Table 2.2.

Table 2.2 FORNY budgets by funding schemes 2000-2008 (million NOK).

Funding activities	2000	2001	2002	2003	2004	2005	2006	2007	2008
Infrastructure funds	6,7	7,4	7,8	19,0	27,8	28,2	28,3	28,6	27,4
Commercialisation funds	27,0	27,0	27,0	34,8	33,6	35,7	45,0	47,5	47,8
Proof of concept funds			14,0	14,0	14,0	15,0	33,5	52,0	46,5
Incentive funds	7,9	8,0	8,6	10,0	5,4	7,5	7,5	7,5	7,5
Leave of absence grant							5,2	7,0	6,5
Other (brought forward from previous year)	2,4	3,1	1,5	14,8	15,4	5,6	6,6	7,2	9,4
Total	44,0	45,5	58,9	92,6	96,2	92,0	126,0	149,8*)	145,1*)

*) Due to over budgeting of FORNY in 2007 and 2008, the totals for these two years are different from the totals given in Table 2.1.

Idea generation and development of infrastructure (Infrastructure funds)

The research institutions can apply for infrastructure funds in order to include commercialisation as a part of their strategies, to increase the awareness and knowledge about patenting and commercialisation, and to simulate the search for commercialisation possibilities in the research activity. Infrastructure funds are announced annually. The FORNY funding can cover up to 50 percent of the total costs. The FORNY programme can also support the establishment of TTOs at the universities, cooperation between TTOs and other commercialisation actors, alignment of policies and rules at research institutions, and part-funding of patenting costs. This scheme was first set up in 2000, and total grants for 2008 were 27,4 million NOK (see Table 2.2).

Commercialisation funds

The TTOs are awarded commercialisation funds as a lump-sum grant based on a yearly application. The applications need to outline the potential for commercialisation at the institutions and the prior performance is taken into consideration when the funding decision is made. Commercialisation funds can be used locally to cover up to 50 percent of the costs of specific commercialisation projects up to licensing or firm establishment, but not for product development. This scheme was established in 1995, and total grants for 2008 were 47,8 million NOK.

The programme board of FORNY evaluates and makes the funding decision for both infrastructure and commercialisation funds. The application process has previously been criticised in an evaluation of the infrastructure funds (Borlaug et al 2008). It was emphasised that the application process should to a larger extent be based on communication between the TTOs and the FORNY secretariat in order to enhance learning and develop the competence of the applicants.

Proof of concept funds

From 2002, the programme for industry development from medical research was included in the FORNY programme. These funds are now available as proof of concept funds, but this

scheme has expanded and now also provides support to other advanced technologies. Total grants for 2008 were 46,5 million NOK. These funds were granted on the basis of panel evaluations of submitted applications. The applications had to be submitted by one of the TTOs already receiving commercialisation funds. Thus, these funds are assumed to strengthen the prioritised projects and lead to more successful commercialisations with high value creation potential.

Leave of absence grant

Since 2006 FORNY can support researchers who are working on commercialising an idea through the leave of absence grant. This grant covers the cost of the employer from 20 up to 100 percent of a researcher's position availing the researcher to work on a commercialisation project. Total grants for 2008 were 6,5 million NOK.

Incentive funds

Incentive funds (bonus) are awarded to the TTOs on an annual basis depending on the performance measured on a number of criteria. Total grants for 2008 were 7.5 million NOK. The bonus is divided between the TTOs depending on the number of points earned the previous year. For start-ups, points are earned on the basis of external accept of the project measured by external equity funding, pilot customer or industry partner, or loans provided. Additional points may be earned on the basis of the estimated potential value creation of the venture. For licences, points are earned on a graded scale based on licence income (up-front or the first five years) and whether the licensee covers patenting and development costs. The incentive funds have changed quite a lot over the years from an earlier bonus for e.g. the number of start-ups to the more qualitative elements implicit in the present system.

2.4 Results reported by the TTOs to FORNY

The activities organised by the TTOs and other actors receiving support from the FORNY programme is reported regularly on a biannual basis. A very large number of activities are reported. As shown in a previous report (Borlaug et al 2008), a large number of events with an impressive number of participants are organised annually as a result of the support obtained from the infrastructure funds – in 2007 there were close to five hundred events all across the country with more than 12000 participants and in 2008 the number of participants increased even further to more than 15000. Thus, the efforts to build culture and mobilise for entrepreneurship seems to be quite significant.

In Table 2.3 an overview is provided of the number of ideas that have been evaluated and followed up by the TTOs during the years 2005-2008. Annually, around 700 ideas are evaluated, among which around 300 are from the universities. The vast majority of the ideas are submitted by academic staff, while smaller shares are from the students. Around one third of the evaluated ideas are followed up. As there may be overlap between the ideas that are reported followed up from year to year, the absolute number of ideas followed up is probably smaller

than what is reported in Table 2.3. A rough estimate may be that around one third of the ideas that have been evaluated are followed up.

Table 2.3 Evaluated ideas and ideas followed up 2005-2008

	Evaluated ideas				Ideas followed up			
	2005	2006	2007	2008	2005	2006	2007	2008
Universities and specialised universities								
Total	353	326	284	318	128	103	106	127
From academic staff	271	272	258	293	116	99	102	123
From students	66	19	19	23	6	2	1	3
Research institutes								
Total	198	175	150	169	82	69	47	60
From academic staff	123	172	129	153	43	66	41	60
From students	2	10	2	1	2	1	1	1
State university colleges								
Total	149	115	176	110	44	24	21	31
From academic staff	89	49	44	53	29	16	8	17
From students	60	66	133	54	16	11	21	14
University hospitals								
Total	53	75	72	75	28	26	35	55
From academic staff	14	63	58	75	17	22	32	55
From students	1	4	4	0	6	1	0	0
All institutions								
Total	753	691	682	672	282	222	209	273
From academic staff	497	556	489	574	205	203	183	255
From students	129	99	158	78	30	15	23	18

Among the ideas that are followed up, around fifty percent are developed further to the stage of an approved commercialisation. FORNY defines a commercialisation as either a licence agreement or a start-up formally registered as a firm. The project needs to be research based and to have some kind of commercial potential. On average, the programme has approved around fifty commercialisations per year since 2001; however, the number has varied considerably, cf. Figure 2.2. While fifty commercialisations were approved in 2001, there was a falling tendency until 2003, and later there has been a significant growth up to the estimated 70 approved commercialisations in 2008.

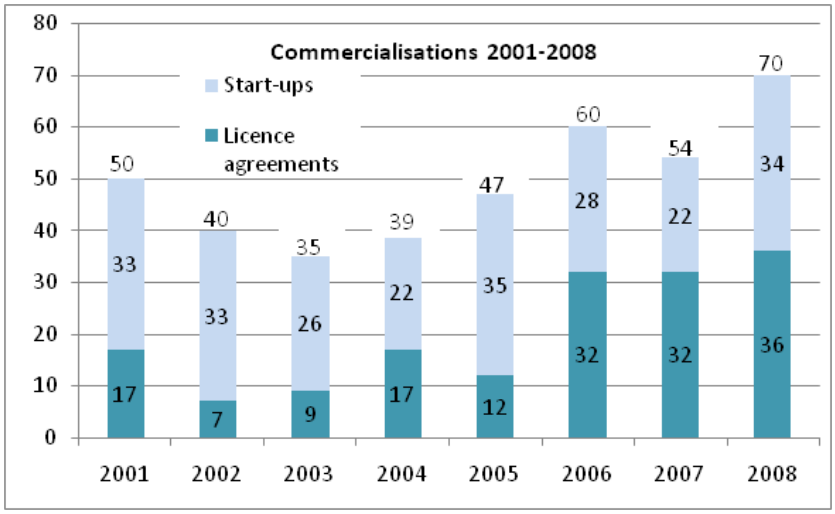

Figure 2.2 Approved commercialisations in the FORNY programme (Data for 2008 are preliminary estimates)

The decline in commercialisations up to 2003 and the following growth may be explained on the background of the changing structure of TTOs participating in the programme. During 2002-2003, a significant uncertainty developed among the TTOs existing at the time due to the planned implementation of the new legislation which included the abolishment of the teachers' exemption and the transfer of the commercial rights of research results to the universities. In 2003-2004, most universities reorganised their work with commercialisation, and new TTOs were organised (cf. Chapter 4) and may explain the growing number of commercialisations in the following years.

Furthermore, we observe the significant shift in types of commercialisations. Originally, the main focus of FORNY has been on commercialisations through start-ups, and during the early years of the programme, start-ups accounted for around three quarters of all commercialisations. Later, this pattern has changed significantly, cf. Figure 2.1, and licence agreements now account for more than half of the commercialisations.

Above we have just summarised the main results of the FORNY programme as reported by the programme itself, and refer to these data just as part of our presentation of the programme and a first indicator of the achieved results. As discussed in Chapter 3, the metrics related to the output of commercialisation programmes is heavily debated, and later in this report we follow up with an extensive analysis of the achieved results of the programme (Chapter 5-6).

2.5 FORNY in the context of other policy instruments.

The basic idea and rationale of FORNY is to contribute to close the gap between research and industrial activity by supporting the commercialisation process from the early stages from idea generation to realised commercialisation, here defined as signing of a licence agreement or

start-up of a new company. The schemes of FORNY address different parts of this process, as summarised in Table 2.4.

Table 2.4 The support schemes offered by the FORNY program

	Infrastructure funds	Commercialisation funds	Project funding
Goal	Institutional change and idea development	Early stage project development	Funding for early stage commercialisation projects
Target area	Support activities and infrastructure at the research institutions	Support TTOs to develop commercialisation projects	Supports specific commercialisation projects

The FORNY programme is part of a larger system of policy instruments. Hence it is important to analyse the programme in the context of this larger system, as the success of the programme to some extent depends on the other policy instruments available. Chapter 7 will describe and discuss these more in depth. The intention here is to give a brief overview, as knowledge of these instruments is important as a backdrop for the chapters prior to chapter 7.

In addition to the RCN, there are two other main actors in the Norwegian innovation policy system: Innovation Norway and SIVA. The latter is important as a provider of infrastructure for facilitating innovation processes, like science parks and incubators, and SIVA runs programmes that provide support for operating these units. In particular, the incubator programme is of importance to FORNY, as many FORNY projects are located in an incubator during the early development of their businesses. Innovation Norway is important as the main innovation agency in Norway and runs a number of programmes aimed at entrepreneurship and innovation. Below we briefly summarise the most important programmes related to the various stages of commercialisation.

Some programmes are aimed at motivating and mobilising for entrepreneurship, and to provide skills and knowledge of relevance to the entrepreneurial process. Of specific relevance to the FORNY programme, are programmes for entrepreneurship education provided by some of the universities, business schools and university colleges. Likewise, there are national initiatives like “Young entrepreneurs” and “Start Norway” which address students with interest in entrepreneurship.

For the start-up phase, there are two programmes provided by Innovation Norway of relevance to FORNY, i.e. the start-up grants and incubator grants; and in particular the latter, which is given to entrepreneurs that have been admitted to an incubator. In the later stages of the firm development, other programmes may be relevant. Innovation Norway run the “IFU/OFU” programmes, which support R&D contracts between small and medium sized enterprises (SMEs) and either larger firms or public institutions. “SkatteFUNN” is a programme operated by RCN which support R&D investments in companies. For many of the FORNY start-

ups, in particular those with a significant growth potential, the seed capital funds are important to provide risk capital.

All these schemes are important for the development of commercialisation projects and play a significant role in the different development phases.

2.6 Previous evaluations

FORNY has been subject to three evaluations, among which the two most recent evaluations will be summarised below. We will also refer to a study on relevant programmes in other countries commissioned by FORNY.

In 2004, an evaluation report on FORNY was published with a main focus on the TTOs participating in the programme (Bolkesjø & Vareide, 2004), i.e. the 'first generation' of TTOs which had been in the programme since its beginning in 1995. One of the conclusions of the report was that the programme has high additionality regarding completed commercialisations, and the programme has contributed to compensating for market failure. The report also analysed the value added of the programme, and claimed that the value added of the programme was greater than the public means that are spent on the programme. However, the analysis of the report was criticised due to a misinterpretation of the concept of value added, and the conclusion was later changed to the opposite, i.e. that the value added at the time was below the total amount spent on the programme.

The evaluation report concluded by identifying several challenges. One challenge is to have enough research money to bring the research results through the proof of concept stage. Other challenges are to contribute to the development of the broader innovation system, achieve closer links to investors financing the following phases of venture development, and improve market adaptation to achieve a stronger market pull effect to balance the technology push dominance within the projects. The evaluation also concluded that too many of the ventures remain in the commercialisation units too long, due to the lack of investors and Industrial partners that may contribute to the development of the project.

A report that followed in 2006 summarised an international benchmarking study commissioned by RCN (Rasmussen et al 2006). The aim of the report was to summarise experiences of policy instruments similar to the FORNY programme. Information was collected from Canada, Scotland, Ireland, The Netherlands, Finland and Sweden. One of the key issues in all countries was how to get academics more interested in commercialisation of research. Few government initiatives were directly targeted at changing the academic culture, and these were usually organised at the regional and institutional level. The TTOs were generally perceived as the key institutions for commercialisation, and several programmes addressed the lack of specialised competence in the field. Although the TTOs constituted the major infrastructure for commercialisation, there is a need for national coordination in order to achieve critical mass of the highly specialised competence that is required. Among other conclusions were the widespread

recognition of the lack of seed capital, and that the largest share of resources were used to support specific commercialisation projects, like proof of concept.

In 2008, the infrastructure funds of the FORNY were evaluated (Borlaug et al 2008). The background for the evaluation was the FORNY secretariat's perception of declining needs for infrastructure funds in the future. The objective of the evaluation was to provide an overview of the current use of the funds and an assessment of the future needs. The main conclusion was that there seems to be a permanent need for infrastructure funds, although not at the same level. It was generally claimed by the TTOs that building culture for commercialisation may be regarded as an integrated part of working with commercialisation. However, it is distinguished between the needs of the well established TTOs working with institutions that have implemented strategies for commercialisation, and the less established TTOs working with institutions which are more premature regarding their strategies for commercialisation. In particular, the report pointed to the university hospitals in which the routines for commercialisation is less developed, and where it is a long way to go to build a widespread culture for commercialisation.

Although it was beyond the mandate of the evaluation, the report also briefly discussed the future organisation of FORNY. Emphasising the need for a stronger focus on research based commercialisation, there might be a potential for improving the performance of FORNY by specialising the programme towards the most research intensive institutions (the universities, research institutes and university hospitals) and leaving the remaining institutions (the state university colleges and regional research institutes) out of the programme. The latter may instead be referred to the general measures for entrepreneurship, and could constitute the backbone of a regionally organised system for commercialisation in which projects with an unclear research base could also be included.

3 Theoretical perspectives and international experiences

In this chapter, we look at the theoretical rationale for using public support to promote the commercialisation of research, and we will present some international examples. Theoretical perspectives and international experiences constitute an important framework for discussing the results of the FORNY programme and for making suggestions for its future operation. We believe that a theoretical and experience-based reflection has two main benefits. First, it allows more conscious attitudes when developing the FORNY programme and other mechanisms to support commercialisation. Through theories and experiences from other countries, pitfalls and practical and political barriers may more easily be identified. Second, it constitutes a basis for a critical review of commercialisation and the public support structure.

In the following, we will discuss theories and experiences that are relevant to FORNY as well as activities that are part of the programme or part of the wider system for commercialisation of research in Norway. This chapter starts with a short review of policy changes and government programmes aiming at increasing commercialisation of publicly funded research. The largest part of the chapter uses existing international literature to explore the outcomes from commercialisation activities to provide a baseline for discussing the Norwegian results. Two models that appear successful are identified; the technology transfer model and the entrepreneurial university model.

3.1 Definitions of key terms in research commercialisation

This section will discuss some of the key terms used in connection with research commercialisation and the provision of government support.

3.1.1 Commercialisation and related terms

Commercialisation is in Norwegian public documents defined as “the exploitation of a research results in the form of a product or process that yields a net economic benefit” (NOU 2002:11). This NOU furthermore states that commercialisation may be the result of a project defined specifically for this purpose, or the unintended consequence of a project with another goal. The definition is not without problems, as it may indicate that the goal of commercialisation activities should be net economic benefits. A research organisation’s efforts to commercialise a certain idea will in most cases aim to get an economic benefit, but this does not mean that maximisation of the financial gains should be the central goal of the organisation. Note that this definition is very close to the main goal of the FORNY programme.

In many cases of public support, commercialisation is related to the public research system, as in the FORNY case. In Norway, the **public research sector** encompasses universities, various types of colleges, research institutes, and hospitals and other public health organisations. For commercialisation **policy**, the aim will often be to maximize the social benefits rather than the economic benefits of each single project.

For practical purposes, “commercialisation of research results” refers to the process whereby **research results** – an idea, a technology, a relationship etc. – are transformed into something that can be sold in a market. This most often happens through patenting, licensing, creation of a spin-off company or product and technology development. A **patent** is a publicly granted monopoly on the production, use and sales of an invention for a limited period of time. A **license** is the right to use a technology that may have been protected through patenting or in other ways. When a company is started based on research from a university and/or based on faculty members leaving the university to work for the company, it is often referred to as an **academic spin-off** company.

Technology transfer can widely be defined as the application of information to use (Rogers, 2002). In a research setting the term is normally defined as the process of developing practical applications from the results of scientific research. Thus, in the context of this report, technology transfer is the process through which the outputs of academic research are conveyed to those who make use of the research results. It is therefore closely related to university-industry relations. Technology transfer can occur in a variety of ways. Indirectly, technology can be transferred through education and research based teaching, through publication of articles, books, and reports, through seminars and conferences, but also through informal contacts and researchers acting as consultants (Cohen et al., 2002). More directly, technology transfer may occur through contract research and industry collaboration and through licensing and the creation of new spin-off firms to exploit new technologies (Rogers et al., 1999). Even though licensing and spin-off firm formation stands for a relatively modest share of technology transfer from academic research (D'Este and Patel, 2007), these channels can be very efficient and in some cases the only way to transfer new inventions into application. Therefore, a significant potential for increased technology transfer might be realized if there exists a well developed competence and infrastructure to use these mechanisms for technology transfer.

Universities and other organisations have often set up **technology transfer offices (TTOs)** that deal with the identification of practically applicable results from science and with the support that is needed to make this happen.

Entrepreneurship is most commonly used to refer to the process of starting up a new organisation, usually a private firm. In a wider sense the term is also used when talking about championing of a creative idea until its fruition. The Austrian economist Schumpeter discussed the importance of entrepreneurs for economic and social renewal, defining them as people (or later organisations) who are able to convert an invention into an innovation. Many universities see entrepreneurship as an important channel for technology transfer (Markman et al., 2005; Siegel et al., 2003). In this view, university spin-offs can be a channel for overcoming some of the obstacles in the technology transfer process by using entrepreneurship as a mechanism. This is in line with the argument presented by Audretsch et al. (2005, p. 70), who claims that entrepreneurship is the missing link between investments in new knowledge and economic growth.

In the previous Norwegian government's "Plan for a holistic innovation policy", the following definition of **innovation** was used: "innovation can be seen as a new product, a new service, or a new production process, utilization or organisational form that has been launched in a market or implemented in production of economic value". **Invention** is the first time an idea for such a product or process (improvement) appears, and commercialisation may thus be seen as the path from invention to innovation.

Two different forces drive technological innovation: market forces and the forces of scientific and technological development (see Kline & Rosenberg 1986). There may be a tension between the focus on technological or scientific "success" or "quality" in research organisations and the success criteria of innovations, which are decided in the marketplace. This implies that in a competition, it is not necessarily the technologically most sophisticated product that wins the highest market share.

Commercialisation of research results is an activity that differs from many other processes of scientific and economic development. First, this may often be related to fundamental and technologically complicated inventions. Second, the distinction between innovation and invention can sometimes be blurred, as has been seen in biotechnology where the invention in itself is the innovation. Third, there is often a considerable time lag between invention and innovation due to both technological and economic circumstances.

3.1.2 Policy related terms

Commercialisation policy can be seen as the policy which regulates commercialisation of research results that public research organisations have or will be granted ownership to and which will be processed with an aim to introduce the idea/technology etc. in the marketplace. The overall goal should be socioeconomic benefits. Thus, commercialisation policy can be seen as a subset of **innovation policy** which aims to stimulate all kinds of commercialisation processes, also when the owner is a private company or another entity. It may still be useful to view commercialisation policy as part of a larger set of mechanisms to promote innovation, as many of them (seed capital, advice, support, tax deductions) may be relevant. Commercialisation policy is also related to **research policy**, as the priorities and organising of research activities will have a strong influence on how inventions and ideas are created and how they can be commercialised.

Government policies to promote commercialisation of research also include support programmes such as FORNY. The rationale for establishing this type of government support programmes is to stimulate activities or behaviour that would be socially profitable, but where other actors do not perform the optimal level of these activities. This way of using government funds is widespread, but highly debated. Salmenkaita and Salo (2002) discuss different rationales for government intervention in the commercialisation of new technologies and outline four different policy rationales. First, the traditional market failure argument that private actors would allocate less resources to commercialisation activities than socially optimal. This may be a result of high transaction costs, limited appropriability, high risk, or information

asymmetry (Bozeman, 2000; Martin and Scott, 2000). Second, they point at systemic failure due to coordination problems among the actors involved in commercialisation. The third factor, structural rigidities, relates to path-dependencies which inhibit the flexibility of the actors in the innovation system. Fourth, Salmenkaita and Salo (2002) points at anticipatory myopia in the innovation system, which may occur when the actors are not acting on the basis of the information they possess because this requires involvement with other actors.

There are several theoretical rationales for policy interventions (Bozeman, 2000), but the most common rationale for providing support to commercialisation of academic research has been related to the market failure argument. **Market failure** denotes a situation where the allocation of resources of production or use by the free market is not efficient. Thus, market failure is often used as a justification for government intervention through financial support and other means, and basic research (maybe also other types of research) is generally accepted as something that would be underinvested in through a free market approach. Similar arguments can be made for the case of commercialisation of research. Especially its early phases will be characterised by many of the same aspects that are used to justify public support for basic research. Lockett et al. (2005) refer to the 'knowledge gaps' encountered by spin-off ventures from public research institutions as an extension of this. Moreover, Lockett et al. (2002) discuss the 'finance gap' faced by these firms, related to obtaining early stage funding. The difficult theoretical and political question is when private funding and support should take over for public support. Not least in the case of commercialisation of advanced research-based ideas and technologies – needing lots of time and resources to develop into a successful new business – there is much talk about a phase (a "valley of death") in between public and private funding. Many are sceptical towards public subsidies in later phases of commercialisation, but others argue that public funding and support should take over in the case of weak private organisations like a perceived lack of venture capital.

In the innovation system literature, this argument is often expanded to a justification of policy interventions based on **system failure** (Lundvall 1999, Schienstock and Hämäläinen 2001). The main focus of the systemic approach is the complex interactions between different actors and institutions, and from this perspective policy makers need to intervene in areas where the system is not functioning well (Edquist and Hommen 2006, Chaminade and Edquist 2006). It may be distinguished between a number of system failures, like the lack of important institutions or organisations, the mismatch between institutions and organisations, or missing links between different parts of the economy. All systemic failures are potential targets for intervention, however, the state is legitimised to address the failure only if state intervention provides the most efficient solution.

A central evaluation criterion then often becomes **additionality** or **subsidiarity** – the extra efforts or benefits that would not have happened without the public support. Policy intervention may to lead to several different forms of additionality related to direct project support, competency building, and spillovers benefiting other participants in the innovation system.

As indicated, these discussions are extremely complicated. Increasing globalisation and internationalisation make the matters even worse. In a commercialisation perspective, one might e.g. ask what should happen when systems failure like the availability of specific expertise is not available within a country's borders. Can FORNY or similar initiatives support ideas and technologies that would not benefit Norwegian society and economic development in Norway– even if the commercialisation could help get important new products into the marketplace?

This section has presented commonly used definitions of commercialisation of research and related terms. Justifications for public intervention are multifaceted and do not give clear directions about the type and level of support in different phases.

3.2 Development and results from commercialisation

Many countries are undertaking reforms with a view to increase the commercialisation of research results aiming to increase the socio-economic impact of publicly funded research. The reforms include both changes in the academic system and instruments for research funding (Benner and Sandstrom, 2000; Slaughter and Leslie, 1997), and the establishment of structures and schemes to support commercialisation activities (Lehrer and Asakawa, 2004a; Mowery and Sampat, 2005; Rasmussen et al., 2006a). In particular, there has been an increased effort to facilitate licensing and new firm formation based on academic research.

3.2.1 A historical perspective

Despite the growth in activity and attention in recent decades, commercialisation is nothing new and it has rarely been controlled and influenced by financial motives alone. Its support and development at some of the success examples (like MIT, Stanford etc.) have been driven by the individual researchers and their units. There is little empirical basis for a claim that Norway generally has been a latecomer in commercialisation (some U.S. universities have been extremely early).

The literature sometimes talks about the Cottrell patent of the University of California (1907) as the first academic patent, but Norway's Kristian Birkeland had been granted several patents before this and there are also other examples. Some universities were early movers; Wisconsin was very active in patenting from the 1920s, Iowa from the 1930s and MIT from the 1940s. Stanford did not start patenting (i.e. patents applied for by the university) before 1969.

In Norway, several of professor Kristian Birkeland's patents formed the basis of the establishment of Norsk Hydro in 1905. Apart from Hydro, Birkeland contributed to starting two other companies. There are also other examples of early patenting and entrepreneurship among Norwegian scientists, and many of the technological disciplines have had strong role models like Ugelstad combining excellent science with engineering-oriented commercialisation.

It should be mentioned that different actors in society can have different interests and experience tensions when it comes to commercialisation. Not least the universities will some-

times enter situations where active commercialisation e.g. through patenting may constitute an economically beneficial path, but where this could hamper the university's obligations to also develop new knowledge openly available to everyone. In many cases this would mean that the organisations which constitute the source and ownership of ideas for a commercialisation programme like FORNY, are not necessarily interested in maximising the economic benefits.

3.2.2 Commercialisation – its growth and characteristics

The international literature on commercialisation is dominated by examples and datasets from the U.S. Universities succeeding in commercialisation, seemingly without negative effects on their research activities, are subject to frequent case studies, anecdotes and site visits. Some of these, like Stanford and Massachusetts Institute of Technology (MIT), are in no way "representative" for universities in general, but rather extremely wealthy institutions with R&D budgets far exceeding most other higher education institutions (HEIs) in the world.

Some of the aspects that distinguish the U.S. from Europe and other parts of the world is the large size of the home market and the high share of the population with a higher education degree within natural science and engineering. Other U.S. special characteristics are a probable cultural emphasis on individual and financial success, a liberal patenting practice and an enormous public investment in all forms of R&D. Another important distinction is the overall HEI structure (see Rosenberg & Nelson 1994). In the U.S. the university structure is highly decentralised with no national university policy. The researchers and the needs of science has only dominated since after WW2; before that most of the HEIs were closely tied to regional needs. Engineering and business disciplines became an integrated part of even the most elite institutions, unlike the development in most of Europe. There is of course a learning potential in looking at the U.S. experiences, but they are not necessarily easily transferable to a Norwegian setting.

The increase in commercialisation through patenting and licenses in the U.S. and many other countries is beyond doubt due to the development and maturity of certain academic disciplines, not least the emergence of biotechnology (Nelson 2001; Nelson & Rosenberg 1994). This technology was in its entirety created in a university setting, which is highly unusual. Biotechnology is in other words an exception – but it is highly visible in the statistics and datasets related to commercialisation. In 1998 41 percent of the university-owned patents in the U.S. were awarded in three biomedical subfields (Geuna & Nesta 2003). At the same time the strongest technological sectors in each country tend to influence the university patenting statistics, e.g. the high proportion of ICT university patents in Finland (Meyer 2003).

Since Cohen and Boyer discovered the fundamental technology for recombinant DNA in 1973 (patent awarded in 1980), there has been an enormous growth in scholarly and commercial activities in biotechnology. Zucker et al (1973) argue that the Cohen-Boyer breakthrough created intellectual resources bound in human capital that could only be exploited through pa-

tenting and active involvement by the academics themselves. The most common pattern is that the academics have established a spin-off company yet remained in a tenured position at the university. This means that the biotechnology industry has largely grown where the most active basic researchers have had their workplace.

Valentin & Jensen (2002) distinguish between three phases in the commercialisation of biotechnology, based on a literature review and an investigation of patents within lactic acid bacteria. The *breakthrough phase* starts with a radical new piece of research and is followed by massive efforts within scientific activity and publication. The radical piece of research need not be the one that scores highest on scientific originality, but it opens up for new and much improved priorities in later research. In the breakthrough phase the first attempts at patenting can be seen. In the next phase – the *consolidation phase* – knowledge gaps will hamper the development of science and commercial activity. The scientific efforts are reduced and the research agendas reoriented. Here, research councils and other support may get impatient. Smaller breakthroughs lead to the *exploitation phase* with a large increase in patenting and an increase in research. The authors claim that in order to harvest from science-based economic growth, it is important that a country or region has key actors – research units and companies – with an attractive international position before the exploitation phase starts. Some other results are interesting, like the strong influence of international scientific collaboration and the different but important role played by both universities and research institutes in commercialisation.

As indicated, various macro factors influence the nature and extent of commercialisation. It has e.g. been found that the number of students in natural science, medicine and engineering has a strong impact on many types of commercialisation (Henrekson & Rosenberg 2001). These authors also argue that Swedish welfare and taxation schemes and the centralised salary negotiations favour “regular employees” over entrepreneurs. A policy wanting to promote commercialisation might therefore consider such aspects as well. Within the universities several investigations talk about an “entrepreneurial culture” (see e.g. Owen-Smith & Powell 2001) as a general term for aspects of the scientific and institutional culture at universities with commercialisation success. Some of the aspects are earlier success and good role models, incentives (personal gain, research funds), support from colleagues, and positive attention from researchers and administrators when patenting or starting a new firm.

3.2.3 Technology transfer offices

The key instrument for promoting the commercialisation of research at the university level has been the technology transfer offices, also named industrial liaison, knowledge transfer, or technology licensing offices (Carlsson and Fridh, 2002; Chapple et al., 2005). Although US statistics have been collected for many years, a recent European initiative has collected information from Knowledge Transfer Offices in Europe. The Proton annual survey for the fiscal year 2006 included 325 knowledge transfer offices (KTO) in Europe. These offices employed in average 8.3 full time employees, had a budget of EUR 438 000, and were 11 years old in average. On average each KTO registered 18.3 invention disclosures, filed 8.7 priority patent applica-

tions, and were granted 2.5 patents in 2006. When it comes to licensing, the KTOs concluded on average 11.3 deals, obtained licensing revenues from 2.3 agreements, with an average income of EUR 270 000. The average number of spin-offs in 2006 was 1.6, while the average number of start-ups was over 5.

Another survey of TTOs in Europe adds to this picture and shows that industry sponsored research contracts are a very important part of the TTOs' activity (See Box 1).

Box 1: The CEMI Survey of University Technology Transfer Offices in Europe

The CEMI survey addressed the Technology Transfer Offices (TTOs) of all universities located in Western European countries whose researchers published more than 200 scientific articles in the period 2004-2006. Out of the target population of 355 universities 211 responses was obtained. The main findings are as follows:

- Economic development and in particular local development is more important than revenue generation for the majority of respondents.
- Industry sponsored research contracts are equally important or more important than licenses for the majority of respondents, but industry sponsored research contracts are often poorly recorded.
- The average TTO in the sample had 2.9 employees with a PhD degree in Science and Engineering, 2.5 employees with five years of experience or more in industry and a total of 10.8 employees.
- There are large differences in staffing levels across European countries. For instance, the average Austrian TTO has eight times as many employees as the average Swiss TTO per 1'000 scientific publications.
- European TTOs are young: 60% were created in the last ten years.
- 29% of TTOs in the sample receive a share of licensing income or industry sponsored research contracts.
- TTOs from Ireland, the UK, Belgium, Switzerland and Denmark make more licenses than the European average.
- TTOs from Sweden, the Netherlands, Finland, Switzerland and Germany make more start-ups than the European average.
- TTOs from Denmark, Spain, Switzerland and France make more industry sponsored research contracts than the European average.

3.2.4 Commercialisation metrics

A comparison of data from several countries (Heher, 2006) shows that on average one invention disclosure can be expected per 12 to 15 millions of research expenditure. Between 30 percent and 50 percent of the disclosures will ultimately result in a patent or license. The extent of commercialisation seems to be closely related to the research expenditure, while it is difficult to point out specific initiatives or schemes that clearly increase the extent of commercialisation.

The output of the commercialisation activity has mainly been assessed by measures related to the number of patentable inventions, the number of spin-offs, and the revenue generated from this activity. This rather narrow focus is increasingly being criticised (Langford et al., 2006; Litan et al., 2007; Rasmussen, 2006; Sorensen and Chambers, 2008). Only a small part of

new knowledge generated in universities is of a form than can be identified as an invention. Of these inventions, not all are disclosed to the TTO, and much less than half of these result in a patent application. Only a subset of these ever gets licensed, and most will never get a revenue stream covering more than their expenses. Only 145 of 20 086 reported licenses generated more than USD 1 million in 2002, according to the AUTM survey (AUTM, 2003). The overall performance of the TTO operation, even at the top universities, is totally dependent on one or a few multimillion dollar licenses (Carlsson and Fridh, 2002).

The use of quantitative measures (number of patents, licenses, spin-off firms, revenue generated, etc.) of the outcome of technology transfer activity is problematic. Technology transfer from universities can take many forms, and the limited set of quantitative indicators used is able to capture only a subset of the commercialisation activity from universities. 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 account 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. Thus, a too narrow focus on short term indicators could be misinterpreted and could underrepresent positive outcomes. Ambiguities and mismatch between goal formulation and output measures may create difficulties in the relation between funding agencies and the operators of the programmes. There are challenges related to goal formulation and assessment of the results from the commercialisation of research, as the impacts of such a complex array of initiatives are extremely difficult to measure. Thus, an important challenge is to develop better and more relevant output metrics for measuring the performance of government initiatives.

3.2.5 University spin-off activity

US universities are considered as very successful when it comes to commercial exploitation of research results, but a large share of the spin-offs and licensing activity is connected to a small number of institutions. Table 3.1 show the spin-off ranking of the top 20 US universities from 1995 to 2001 and the ranking from 1980 to 1994.

Table 3.1 Spinoff rankings of top 20 U.S. universities 1980–2001

Rank 1995–2001	University	Spinoffs 1980-2001	Spinoffs 1995-2001	Spinoffs 1980-1994	Rank 1980–1994
1	Massachusetts Institute of Technology	218	132	86	1
2	University of California System	148	118	30	7
3	Stanford University	101	73	28	8
4	California Institute of Technology	69	67	2	82
5	University of Washington	74	51	23	12
6	University of Minnesota	85	49	36	5
7	University of Michigan	60	42	18	15
8	University of Georgia	65	41	24	11
9	University of Utah	102	40	62	2
10	Johns Hopkins University	48	35	13	27
11	State University of New York (SUNY)	48	34	14	23
12	University of Southern California	34	32	2	82
12	Penn State University	49	32	17	18
14	University of Pennsylvania	48	31	17	18
15	Purdue Research Foundation	33	29	4	64
15	North Carolina State University	32	29	3	72
15	Columbia University	37	29	8	38
15	University of Virginia	38	29	9	35
19	Georgia Institute of Technology	42	28	14	25
19	Iowa State	45	28	17	18

Source: O'Shea et al. (2005) adapted from AUTM Licensing Survey FY 1980–2001.

Most universities have created significantly more spin offs over the seven years after 1995 than the previous 14 years. With the exception of Massachusetts Institute of Technology (MIT), the universities with a high ranking in the first time period lost their position to other institutions in the second time period. MIT is ranked as the most successful case of research commercialisation in the US. A presentation and analysis of the MIT case is provided in Box 2 below. Although the resources available and the cultural context make it doubtful to compare the MIT case with European universities, some lessons can be learned by delineating successful cases.

Box 2: Massachusetts Institute of Technology (MIT), Cambridge, US

MIT achieved the highest ranking for all universities in the United States between 1980 and 2001 by generating a total of 283 spin-offs. This number is even more impressive considering the faculty size of just above 900, whereof less than 600 in science and engineering. MIT's research expenditures were USD 435.5 million in 2001. O'Shea et al. (2007) suggest the following factors for explaining MIT's success:

- MIT's excellent research in a number of 'practical fields,' combined with a willingness to pursue interdisciplinary research, has been a strong driver in the creation of the knowledge that start-up companies have exploited.
- Over a long period of time, MIT has developed informal internal and external networks between government, industry, and academia. These networks have increased and leveraged research funding at MIT and has allowed for the sharing of knowledge. This has in turn helped to stimulate high-tech entrepreneurship.

- MIT has a number of dedicated and experienced organisational structures such as its TLO and entrepreneurship programmes. These resources are dedicated to promoting emerging technological opportunities within the biotech/ICT sectors and to training potential academic entrepreneurs to create and build successful start-ups.
- MIT has demonstrated a strong commitment to the exploitation of research. This commitment is supported by clear policies, that are consistently applied, that support and encourage start-up formation by academics.
- Within the TLO, MIT has a staff of technically trained, industrially experienced licensing officers. The staff in the TLO office appears to get a great deal of satisfaction from 'getting the deal done.'
- MIT's successful tradition and history at commercialising radical technologies (via start-ups) has created a 'success breeds success' start-up culture among academics and staff.
- Academics within MIT have positive attitudes to commercialising technology and starting companies.
- MIT has a long tradition of industrial and military funding, which has led to commercially oriented innovations.
- MIT is located in one of the leading high-tech clusters in the United States. This gives academics access to critical expertise and resources to spinout ventures.

Also outside the US, spin-off activity is considerable. In UK, one study reported 175 university spin-offs created in 2001 (Wright et al., 2002), while a Canadian survey identified 64 spin-offs from universities and hospitals in 2003 (Read, 2005). These numbers are not directly comparable as they are based on different sources and definitions. Table 3.2 shows university spin-off activity in selected countries. Comparison of different countries is difficult due to lack of statistics on spin-off activity in many countries and the variety of definitions used.

Table 3.2 University spin-offs in selected countries

Country	Period	Number of spin-offs
US	1980-2003	4543
Canada	1962-2003	1100
France	1984-2005	1230
The Netherlands	1980-1990s	300
Australia	1984-1999	97
UK	1981-2003	1650
Belgium	1980-2005	320
Sweden	Up to 1990s	3000-5000 (estimates)
Germany	1997-1999	470-4000 (estimates)

Source: (Wright et al., 2007, p. 2)

Recently, Wright et al. (2008) conducted a study of mid-range universities in Europe to identify their role in knowledge transfer. They studied the University of Nottingham, the University of Ghent, the University of Antwerp, the Free University Brussels, the University of Karlsruhe, and the University of Uppsala. These universities created a small number of spin-off firms each year and had a portfolio of between 5 and 27 spin-offs. The average spin-off from the University of Ghent employed nine people with an average growth rate of 1.5 employees per year. Moreover, the universities in this study also were associated with a number of start-up firms that were informally linked to the university. For example the University of Karlsruhe had col-

lected information on 200 firms that could be traced back to the university. In the same study, Wright et al. (2008) analyzed the licensing activities of top universities and mid-range universities in the UK and found that the top universities had significantly more licensing and options agreements with spin-offs and SMEs than mid-range universities, but did not find any significant difference in licensing to large firms.

The commercialisation of research has been relatively high on the agenda in the UK for the last two decades. A recent study by Lynskey (2008) examined spin-off activity from ten UK universities, including the four largest research universities, three other large universities, and three smaller universities. The average number of spin-off from the largest universities for the period 1998-2002 was 25, while the two other groups of universities had 12 spin-offs in average. Compared to the resource input, the smaller institutions had relatively more spin-offs, but these spin-offs were smaller in size. Some of these differences are reflecting the higher share of medical and life science research at the largest institutions. The main point emphasised in Lynskey's article is that the number of spin-offs is not a good indicator of industry relevance or entrepreneurial activity at university level. Both university strategies and types of spin-off differ highly.

3.2.6 Job creation

Related to the creation of university spin-offs, not only the number, but also the jobs created and the performance of these firms are important. In the book 'Academic Entrepreneurship' Shane (2004) argue that university spin-offs create significantly more jobs than the average start-up firm. He refers to data showing that spin-offs from US academic institutions have created 280 000 jobs between 1980 and 1999, an average of 83 jobs per spin-off. Evidence from Europe suggest that university spin-offs in the UK create an average of 44 jobs, 53 spin-off from the University of Linköping created 650 jobs, 92 spin-offs from the University of Twente created 445 jobs, 25 spin-offs from University of Liège created 250 jobs, and 17 spin-offs from Queens University Belfast created 180 jobs.

Furthermore, Shane (2004) argue that university spin-offs are very high performing companies. He refers to data showing that 18% of MIT spin-offs and more than 8% of all US university spin-offs have gone public. UK evidence show that 25% of university spin-off received venture capital financing. Moreover, the survival rates of university spin-offs are high, often more than 80%.

3.3 Government support programmes

3.3.1 Policy changes and government support schemes

The creation of new ventures based on academic research, or academic entrepreneurship, has become an objective for policy makers and universities across Europe In many countries special initiatives to support the commercialisation of university research have been established (Callan, 2001; Rasmussen et al., 2008). One of the most influential and well-known policy

changes to stimulate commercialisation of university research is the Bayh-Dole Act in the US. This Act transferred the ownership of intellectual property (IP) from the publicly funded granting agencies to the universities, and contemporary policy changes stressed the expectations that the universities could contribute more directly to industrial development (Stevens, 2004). Statistics show that the number of patents granted from US universities have increased from 589 in 1985 to more than 3340 in 1999 (USP&TO, 2000) and the number of start-ups from US universities are doubled from 1994, reaching almost 500 in 2001 (AUTM, 2003).

Although the role of the Bayh-Dole Act in causing this development is debated (Mowery et al., 2001), this success has inspired legislative changes in many countries all over the world. In the UK, policy changes towards more commercialisation of research were implemented in the late 1980s (Slaughter and Leslie, 1997). Countries like Denmark, Germany, France, and Japan followed around the turn of the century (Mowery and Sampat, 2005). The logic is to give the universities incentives to support and build an infrastructure for the commercialisation of research. A part of this development is the establishment of technology transfer offices (TTOs) at most US universities (Carlsson and Fridh, 2002), and recently also in Europe, Canada, and Japan (Chapple et al., 2005; Lehrer and Asakawa, 2004b; Rasmussen et al., 2006a).

A vital, but less scrutinized, part of the implementation of commercialisation policies have been the use of government programmes (Rasmussen et al., 2008). The government efforts to promote commercialisation of publicly funded research have developed rapidly. This may be seen as a result of an emerging gap between two policy areas. Programmes to support university - industry collaboration and applied research are widely used and well established (Branscomb et al., 1999; Jones-Evans et al., 1999). This is also the case with programmes to provide support for entrepreneurs and SMEs (Gilbert et al., 2004; Lundström and Stevenson, 2005) where many countries have increased the focus on support tailored for new technology-based firms (NTBFs) (Heydebreck et al., 2000; Lindström and Olofsson, 2001; Storey and Tether, 1998).

Still, it is increasingly recognised that these two types of programmes are not fully able to address some of the challenges associated with the commercialisation of academic research. First, many studies have pointed at the early stage and embryonic nature of university technologies (Agrawal, 2006; Colyvas et al., 2002; Jensen and Thursby, 2001). As a result, investing in developing such technologies is associated with high uncertainty and any potential revenue will take many years to materialize. Second, the entrepreneurial process may be inhibited by a lack of business experience and commercial skills among academics (Bird and Allen, 1989; Radosevich, 1995; Samsom and Gurdon, 1993; Vohora et al., 2004). Third, barriers related to the non-commercial academic environment and possible conflicts of interest with other university tasks have been frequently discussed in the literature (Anderson, 2001; Mustar et al., 2006).

3.3.2 Types of support programmes

Most European countries have one or several public support programmes oriented at science-based entrepreneurship encompassing very early-stage funding, training and cultural change activities, scholarships for academic entrepreneurs and more.

In practice, the government support programmes can use two approaches to close these gaps and promote the commercialisation of research. First, initiatives can promote institutional changes with the long-term view to create structures and build competence for the commercialisation of research. This approach might be seen as an attempt to correct systemic failure which inhibits the ability of universities and private actors to develop viable opportunities into concrete entrepreneurship. This can be done by inducing changes in the culture, attitudes, legislation, rules, and incentives; by networking and training; and by establishing organisational structures such as technology transfer offices (TTOs), incubators, and entrepreneurship centres within the universities to support the entrepreneurs (Klofsten and Jones-Evans, 2000; Rasmussen et al., 2008). These initiatives could also be developed in boundary organisations (Hellström and Jacob, 2003) operating in the intersection between the university and the business sector, such as incubators, science parks, network organisations and consultants. This is a way for governments to support changes in the university sector helping the institutions to change and develop into entrepreneurial universities (Clark, 1998).

Second, government initiatives can provide direct support to specific commercialisation projects. The rationale for this approach is to mitigate market failure by stimulating the supply and demand side for research-based technologies. Examples of such support could be direct financial support (grants, loans, equity), direct 'soft' support (training, counselling, infrastructure), and efforts to stimulate private sector investments (networking, co-funding). The financial support will often be specialized towards certain activities or phases in the commercialisation process.

European programmes often seek to emulate the perceived US capacity for commercialising research results (Mustar et al., 2008). Many US universities and their TTOs take an active role in promoting research commercialisation, and national initiatives such as the SBIR programme have successfully contributed to fostering academic entrepreneurship (Toole and Czarnitzki, 2007). Although regional and multinational authorities (e.g. the European Union) are increasingly more involved in innovation policy issues, the policies to support academic entrepreneurship have generally been implemented at the national level (Mustar et al., 2008).

Government support to promote science-based entrepreneurship is usually delegated to separate programmes, such as TULI in Finland (Salo et al., 2006), the NSERC Idea to Innovation (I2I) programme in Canada (Rasmussen, 2008), and the University Challenge Funds in the UK (Wright et al., 2007). These programmes are usually organized within a larger government body, such as a research council or development agency. The programmes act on behalf of the

government and typically provide funding to activities executed by agents such as research institutions, TTOs, or individual researchers.

3.4 Examples of successful research institutions

Most of the research commercialisation literature is related to universities, and more than half of the studies on university commercialisation are conducted in the US context (Rothaermel et al., 2007; Shane, 2004). Recently, more studies have been conducted in other countries, predominantly in Europe (Rasmussen et al., 2006b; Wright et al., 2007).

Successful cases of research commercialisation seem to be based on two different models. One is a strong commitment to technology transfer from the research institution and the academics. The other model is based on a strong commitment to entrepreneurship and regional development in collaboration between key stakeholders in the region. Some examples of each model and a comparison will be given in the following sections.

3.4.1 The technology transfer model

The technology transfer model is based on a strong commitment to the exploitation of research from the research institution. Many of the most successful US universities such as MIT and Stanford have policies, a culture within the research departments, and a well established infrastructure that promotes technology transfer. Another successful example is the University of British Columbia (UBC) in Canada, which has managed both to create significant revenue and to follow a rather broad model of technology transfer (See Box 3)

Box 3: University of British Columbia (UBC), Canada

UBC is highly ranked internationally, and graduates about 7000 undergraduate and 2000 graduate students annually and have more than 12 000 staff and total revenue of more than CAD 1.5 billions. The research budget is about CAD 500 millions, about 10% industry funded. UBC ranks in the top 10 universities in North America in commercialising research and for its patent activity in the Life Sciences. Over the period of the last ten years, UBC has formed more spin-off companies per research dollar than MIT and Stanford (www.ubc.ca).

The UBC University–Industry Liaison Office (UBC UILO)

UBC UILO has been in operation since 1984. The UILO core activities are within sponsored research and technology transfer. In 2007/2008 the UILO administered CAD 469 million of sponsored research to more than 7000 projects, received 171 invention disclosures, filed 173 patents, completed 32 licensing agreements, and created 5 spin-offs (reaching a total of 130 to date). The licensing revenue was CAD 6.6 million and the equity portfolio stood at CAD 6.1 million (UBC UILO, 2008).

The technology transfer operation at UBC is considered to be much broader than merely patenting and licensing. The benefits and outputs from the activity are stated to be in ranked order: academic, economic, social, and financial. Academic benefits can be achieved by attracting better and more entrepreneurial faculty and students. Economic and social outputs are achieved to the benefit of Canada and Canadians. The financial goal was important in the early days of TTO activity, but in Canada just as in the US the trend is moving towards a broader set of objectives than just the financial (Langford et al., 2006; Rasmussen, 2006). According to the managing director, there has been a discussion for more than 10 years about whether the ILO was business or service, but now there is more and more support that the ILO is a service activity within the university. The UBC IP

policy is flexible and it is considered as important to use a wide array of work methods to find the right solution for each project.

Among the staff of 40, there are 8 PhDs, 5 MBAs, 10 MScs, 2 lawyers, and 2 accountants. According to the managing director, it takes 2–3 years to get a new employee confident in using the different tools and to have a creative approach instead of a bureaucratic one. Industry experience is sometimes found to be counterproductive, due to difficulties in understanding the academic community. An important initiative at the UILO is the Prototype Development Programme.

UBC Prototype Development Programme (PDP)

The Prototype Development Programme (PDP) at UBC is regarded a one of the most successful commercialisation initiatives in Canada and provides an example of how government support is implemented at university level. The 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 commercialisation of early-stage inventions with scarce resources by providing the management and funding necessary to validate and realize the commercial potential of the technologies (UBC UILO, 2005a). Between 1988 and 2005, the UILO received 1835 invention disclosures, of which 138 (7.5%) received PDP support. A total of CAD 4.7 million was invested in prototype development projects at UBC, of which CAD 0.9 million was funded directly from the UILO's PDP budget.

As a result of these activities, 57 of the funded projects were licensed or assigned to a commercial partner and 34 new spin-off companies have been formed (UBC UILO, 2005a). These 34 spin-off companies rose over CAD 436 million in private equity financing. The funding sources for the PDP have changed throughout the program's existence. In recent years, the UILO, in partnership with UBC researchers, has been highly successful at attracting funding from Federal proof of concept programmes. These funds are claimed to fill a gap. Internal funds, primarily granted from the province, are also significant and important due to the flexibility allowed with these funds.

UBC Spin-off portfolio

The following criteria are used to define a UBC spin-off. The company must have been formed to either: 1) license UBC technology, 2) fund research at UBC in order to develop technology that will be licensed by the technology, or 3) provide a service which was originally offered through an existing UBC department or unit (UBC UILO, 2005b). In 2005, the UBC UILO made a report on the status of the spin-off created, counting 117 firms. 41% were inactive, 39% active, 11% merged or acquired, while 9% still were in early stage. Half of the active firms were in life science, one third in physical science, and one sixth in information technology. The number of jobs in these firms were over 1900 and almost all firms (96%) were located in British Columbia. 17 of the firms are publicly traded with a market value of CAD 3.2 billion. UBC has invested CAD 17 millions in the technologies, government support to the companies sum up to CAD 82 millions and private investment to CAD 1.8 billions. The return to the university is calculated as CAD 41 millions in research funding, 32 millions in royalties, and 4.5 millions in equity value from the spin-offs.

Source: Based on Rasmussen (2008) and internet search

On the background of the growing focus on commercialisation from universities, relatively few studies have looked at this activity within public research institutes. An exemption is IMEC in Belgium (See Box 4), which has successfully promoted the creation of spin-offs as a part of their technology transfer strategy.

Box 4: IMEC, Belgium

IMEC is a non-profit independent research center in nano-electronics and nano-technology with more than 1600 employees and revenue of EUR 244 millions. IMEC's research is applied in better health-care, smart electronics, sustainable energy, and safer transport (www.imec.be).

IMEC spin-offs

IMEC has listed 22 spin-off companies created over the last 20 years on their web-page. Moray and Clarysse (2005) studied the technology transfer practises related to spinning out new ventures in IMEC. They found that the policies and support structure developed over time and this impacted the resource-endowments of the spin-offs. For instance, the companies started in 1999-2002 had more founding capital (mean EUR 1.6 million), raised more capital the first year (EUR 3 million), had more experienced founders (mean 41 years), more employees at founding (median 4.5), and more IMEC researchers involved (median 4) compared to the companies started earlier. Of the 23 spin-offs included in the study, 3 went bankrupt and 5 were acquired. In total EUR 121 millions have been invested in the spin-off firms and the active firms employ about 450 full time employees.

Among the challenges met by IMEC was the need to finance the spin-off firms. IMEC participated in a venture capital fund, but learnt that the seed phase was not interesting for venture capital (Moray and Clarysse, 2005). A seed-capital fund was set up, but the shareholders had similar expectations as venture capitalists. As a result IMEC decided to finance the pre-seed and even seed phase itself, and only approach VCs in a later phase. IMEC has also developed formal business plan support and gradually built a formal team of coaches within the organisation that are at the disposal of potential spin-offs during their incubation period.

Source: Based on Moray and Clarysse (2005) and internet search

3.4.2 The entrepreneurial university model

The other model for creating value from the investments in public research is based on efforts to stimulate entrepreneurship in the regional context of the university. This approach includes both the creation of spin-off emanating directly from the academic research and the creation of other start-ups where the university could assist in the start-up process. The Proton Survey of Knowledge Transfer Offices in Europe showed that while the average number of spin-offs based on formal transfer of university technology was 1.6, the average number of start-ups assisted by the university was more than 5. A classic example on the development of a regional high-tech cluster around a university is from Cambridge, UK (see Box 5).

Box 5: Cambridge University, UK

Cambridge is widely known for the high-tech cluster partly based on the science base of Cambridge University, often referred to as the 'Cambridge phenomenon'. In 1985, it was found that 25% of the high-tech firms in the Cambridge area had a founder originating from the university or a research establishment. The University of Cambridge Entrepreneurship Center keeps a database containing 184 spin-off companies from University of Cambridge started in the period 1979-2002. Druilhe and Garnsey (2004) found that 109 of these companies were direct spin-offs. In only 42 of these cases, the university formally participated in firm formation by owning IPR or taking an equity stake in the company. At the end of the 1990s, Cambridge University started several new schemes to encourage and assist academic entrepreneurs. These included a student organisation, the University of Cambridge Entrepreneurship Center, the University Challenge Fund, and a better resourced TTO. The number of spin-offs increased from an average of 4 to 5 from 1989 to 1998, to more than twice this number the following years (11 in 1998, 16 in 1999, 8 in 2000, 15 in 2001, and 8 in 2002).

In their analysis, Druilhe and Garnsey (2004) classified the 109 Cambridge spin-offs into the following

categories, 20 consulting/services companies, 37 development companies, 23 product-based companies, and 29 software companies. The study concludes that the resource requirements needed to start a spin-off company significantly differ between the categories of firms.

Other frequently mentioned cases are the many start-ups around the University of Twente in the Netherlands and the Swedish success stories from the University of Linköping and Chalmers University of Technology (see Box 6).

Box 6: Universities with successful involvement in start-up creation

University of Twente's TOP program

The TOP-programme (Temporary Entrepreneurial Position programme) was established in 1984 by the University in/for the region of Twente. The objective of TOP was to encourage graduates of the university to start their own knowledge-based companies. Gradually the objective was extended to staff members of the university, graduates from other universities and polytechnics, and people from industry. During the first year the company is located in the university, later they have to move on (www.utwente.nl/top). From 1984 to 1997 there were 230 TOP positions (people) and 170 new companies created. 135 existed by medio 1997 and had created 1400 new jobs in the region (van der Sijde and Tilburg, 2000).

University of Linköping and Chalmers University of Technology

Two of the most successful Swedish examples of commercialisation of research can be found at University of Linköping and Chalmers University of Technology in Gothenburg. Both these universities are characterised by a rather extensive support system for entrepreneurship, comprising entrepreneurship training, student involvement, and close links with other actors in the region. For example, the support structure connected to the University of Linköping comprises the following organisations:

- LIU Innovation: Idea and business coaching for employees, i.e. on valuation and patenting
- Venture Zone: Supplying students with inspiration and help to take new steps in their ideas and businesses
- CIE (Centre for Innovation and Entrepreneurship): Training for entrepreneurship through the Entrepreneurship programme, for students and researchers with ideas.
- PIE (Project, Innovation, Entrepreneurship): Offers courses on entrepreneurship and commercialisation
- LEAD: Business incubator, offering coaching and financing services, knowledge and networks for high tech spin-offs from research.

In both cases focus is not merely on science-based ventures, but to support all kinds of innovative start-ups.

To summarise, this section argues that institutions known for successful commercialisation performance have not targeted commercialisation in a narrow sense, but pursued a technology transfer or entrepreneurship strategy. Some cases, such as MIT (See Box 2) seem to be based on a dual structure promoting both technology transfer and entrepreneurship. Some of the main characteristics of each model are outlined in Table 3.3.

Table 3.3 Two models for commercialisation of research from public research institutions.

Model	Technology transfer	Entrepreneurial university
Main goal	Dissemination of research results	Promote all types of knowledge-based start-ups
Outcome	Innovation	Jobs and regional development
'Bottom up' driving force	Researchers and research institutions	Individuals (entrepreneurs) and regional context
Implications for spin-off and licensing activity	Small number of start-ups and licenses with high potential	Higher number of start-ups
Contextual factors	Strength of research base	Industry structure, regional innovation system

3.5 Conclusion

The most successful examples of high impact from commercialisation of research seem to be based on bottom-up processes. Moreover, the regional conditions differ highly, making it unlikely that a 'one size fits all' structure will be successful. Thus, a key challenge is to identify the 'driving factors' behind successful commercialisation processes at university and regional level. Two main approaches seem to characterize successful examples of value creation from the commercialisation of research. One is a strong dedication from the university or research institution to promote technology transfer to achieve academic, economic, social, and financial benefits. The other is a strong regional commitment to promote the start-up and growth of knowledge or technology-based new ventures. The strongest potential is released if both these 'driving factors' are well established and linked together.

4 Organisation and implementation of the FORNY programme

This chapter provides an overview of the technology transfer offices (TTO) participating in the FORNY programme. It presents and analyses results from a web survey of the TTOs on how they are organised, their competencies, their strategies, network and collaboration and their portfolio. The final section concludes and illuminates issues for further discussion in the final chapter of this evaluation report.

4.1 The TTOs in the FORNY-programme

The main target group of FORNY is researchers working in universities, university colleges, research institutes or university hospitals that have ideas originating from their research which can be developed into commercial activity. FORNY funds activities organised by the research institutions themselves and by the local TTOs that are either owned by the universities or other institutions.

FORNY is organised with a small secretariat within the Research Council of Norway (RCN). The main task of the secretariat is to allocate resources to organisations which are approved for participating in the programme, and to serve as a coordinating body for information exchange and strategic development of the programme. An important aspect of the programme is thus how it organises the commercial activities through the TTOs, characteristics of the TTOs and their strategies for working with the research institutions they are serving.

In order to achieve a status as a TTO in the FORNY programme the TTO must serve research institutions with potentials of generating high-quality ideas and projects for commercialisation. This implies that the TTO must have a formal agreement with one or more research institution which have researchers that generate deal flow for the TTO. When the FORNY programme was established in 1995, there were six TTOs participating in the programme. Four represented the universities existing at that time (Oslo, Bergen, Trondheim and Tromsø) and two represented, respectively, the research institutes co-located at Kjeller and the specialised university and related research institutes located at Aas. Later, a number of other TTOs have been included in the programme, and for the time being there are 14 actors participating. An overview is provided in Table 4.1.

Table 4.1 Overview of TTOs participating in FORNY by 2008

Region/TTO	Provide TTO-services for	Main disciplines / R&D man years[*)]	Participation in FORNY
Oslo region			
Campus Kjeller	All research institutes located on Campus Kjeller	Technology, Natural sciences (900)	Since the start in 1995.
The Innovation Centre at Aas	The Norwegian University of Life Sciences and other research institutes located on campus	Agriculture and fish related (900)	Since the start in 1995
Oslo Innovation Centre	Originally the University of Oslo. Now: Oslo University College, Østfold University College and Norwegian Institute for Water Research	Natural sciences (150)	Since the start in 1995; phased out 2008
Birkeland Innovation	University of Oslo, Norwegian School of Sport Sciences and Oslo School of Architecture and Design	All disciplines (2000)	Since 2004
Medinnova	Originally for Rikshopitalet University Hospital, now all hospitals in Eastern and Southern Norway (Helse Sør-Øst)	Medical and health (1250)	Since 2002
Simula	Simula Research Laboratory	ICT (50-100[***)])	Since 2005
Southern and Western Norway			
Coventure	Originally the regional hospital and local businesses. Now University of Agder	All disciplines (150)	Since 2000
Prekubator	University of Stavanger, Stavanger University Hospital and two research institutes	All disciplines (350)	Since 2003
Bergen Technology Transfer	University of Bergen, Haukeland University Hospital, Bergen University College and other research institutes in the region	All disciplines (1750)	Since 2004 when it took over the role of the previous Forinnova
Mid-Norway (Trøndelag)			
Leiv Eiriksson Innovation (LEN)	Originally the Norwegian University of Science and Technology, now mainly the university colleges in the region.	All disciplines (200)	Since the start in 1995, restructured in 2004
NTNU Technology Transfer	Norwegian University of Technology and Science, St. Olav University Hospital	All disciplines (1500)	Since 2005 when it took over the role of LEN
Sinvent	All research divisions in the SINTEF Group	Technology (900[**)])	Since 2005
Northern Norway			
Norinnova	Traditionally for the University of Tromsø. Now: Norut and University College of Narvik. Close collaboration with TTO Nord	Technology	Since the start in 1995
TTO Nord	University of Troms, University hospital of Northern Norway; University colleges in Northern Norway	All disciplines (900)	Since 2005. Close collaboration with Norinnova

[*)] Data for man years are for 2007, all figures rounded off to the nearest 50.
[**)] Data refer to the SINTEF divisions located in Trondheim.
[***)] More precise data cannot be given due to confidentiality.

There TTOs currently participating in FORNY represent a diversified structure. An overview of the TTOs is presented in Table 4.1. The majority of the TTOs serve a local university and in most cases other research institutions located in the same area. Three of the TTOs serve larger universities (i.e. Birkeland Innovation, Bergen Technology Transfer and NTNU Technology Transfer), two TTOs serve medium sized universities (i.e. the Innovation Centre at Aas and TTO Nord/Norinnova), and two serve smaller universities (i.e. Coventure and Prekubator).

Among the remaining seven, there is one TTO specialised on university hospitals (Medinnova) and three on specific research institutes (Campus Kjeller, Sinvent and Simula). Moreover, there are two TTOs that traditionally served as university TTOs, i.e. Oslo Innovation Centre and Leiv Eiriksson Innovation (LEN). However, in both cases their roles have been taken over by new TTOs set up by the respective universities, and they have been left to work with smaller institutions and industry. One of the two TTOs, Oslo Innovation Centre, was phased out of the FORNY programme in the end of 2008.

It appears from the table that there is a mixed pattern of specialisations among the TTOs; partly they are organised according to a regional pattern, partly there are tendencies of specialisation towards institutions. We find the most specialised structure in the Oslo region, where there is one TTO specialised for the university hospital, three TTOs serving specific research institutes and one university, and one TTO basically serving as a university TTO. Furthermore, there is also some specialisation in Mid-Norway, with three TTOs serving different parts of the institutions in the region. In the other regions, the TTOs are mostly serving all relevant research institutions, including the university hospitals.

In an analysis of the "biopharma landscape" in Norway provided by the Boston Consulting Group[1], the structure of the Norwegian TTOs has been divided into regional TTOs, university TTOs, institute TTOs and specialised TTOs. In line with what we have said above, the structure is characterised as complex and geographically oriented, and the Oslo region is the only region with specialised TTOs. Moreover, the report concludes that there is a lack of focus on biotechnology at the national level, and, as far as this sector is concerned, the report comments that there "are reasons to believe that the particular nature of biopharma requires a more focused effort to succeed – in particular to build necessary scale and capabilities".

A report on European TTOs[2] have categorised the TTOs according to their attachment to the research institutions; department-type, wholly-owned and independent. The department-type is localised within the university or research institute as one department and the personnel is untenured university staff. The wholly-owned is owned by the university or institute, but func-

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[1] The Boston Consulting Group 2007: The Biopharma Landscape in Norway: Current Status and Future Commercialization Opportunities. Report prepared for the Norwegian Association of Pharmaceutical Manufacturers (LMI).

[2] ITTE (2004), European Commission, DG Enterprise, 'Institutions for Technology Transfer from Science to Enterprises in Europe, *Technology Transfer Institutions in Europe*. Final Report June 2004

tions as an independent non-profit unit. And the independent TTOs serve usually more than one research organisation, and are normally created as a separate private venture extension. The Norwegian TTOs can be categorised as mainly belonging to the two last groups, however, there are also some that do not fit into these categories.

It is difficult to group the heterogeneous Norwegian TTOs into categories that are useful for an analysis of the organisation of the FORNY programme. This is especially due to the fact that the structure of the TTOs, i.e, the number of TTOs participating in FORNY; their size, their geographical locations, their functions etc, is under continuous development. For instance, the number of TTOs in the programme has doubled from 2000 to 2008, and while some have been included others have been excluded. Hence, the structure of the TTOs will be an important issue for the future organisation of the FORNY programme. This will be further discussed in the summary section of this chapter.

4.2 Funding

As has been outlined in Chapter 2, the main approach of the FORNY programme is to provide funding for working with commercialisation at the local level. By 2008 there are five types of funding (see Chapter 2 for more details):

- *Infrastructure funds* for stimulating activities that enhance knowledge and builds positive attitudes toward commercialisation. Both research institutions and the TTOs may apply for the means which may cover up to 50 percent of the costs.
- *Commercialisation funds* which can be characterised as a block grant for the TTOs. The funds are directed towards development of ideas and projects as well as competence building among the TTO staff. FORNY funds 50 percent of the total costs.
- *Proof of concept funds* which are directed towards specific commercialisation projects for proof of concept and verification of the technology. The TTOs are responsible for the application, and all the costs are covered.
- *Leave of absence grants* which are provided for researchers to enable them to focus on their commercialisation projects.
- *Incentive funds* the TTOs may obtain bonuses for approved commercialisations based on the quality of the commercialisation. The main quality criteria for spin-offs are the potential for economic growth and external financing, while the criteria for licenses are guaranteed royalties and coverage of future expenses for development and patenting.

A significant share of the total FORNY budget is allocated to the TTOs, and an overview of the funding obtained by the TTOs is provided in Table 4.2.

Table 4.2 Funding from FORNY to the TTOs (million NOK)

TTO	2000	2001	2002	2003	2004	2005	2006	2007	2008
Campus Kjeller	5,5	6,9	5,8	4,9	5,7	5,4	9,7	11,5	12,2
The Innovation Centre at Aas	3,9	4,9	4,2	4,1	2,7	2,9	5,2	6,2	9,7
Oslo Innovation Centre	7,0	6,2	6,8	5,7	3,8	3,2	1,2	3,6	1,3
Birkeland Innovation					1,8	5,4	6,8	10,2	12,8
Medinnova			1,0	2,0	0,0	2,7	11,3	11,2	16,5
Biomedisinsk Innovasjon[1)]					1,8	1,5	2,9	2,1	
Simula Innovation						0,6	1,4	1,6	1,9
Coventure	1,0	1,9	2,8	3,1	3,4	2,9	5,2	4,8	4,6
Prekubator				2,9	3,2	3,4	6,0	6,2	5,8
Bergen Technology Transfer/ Forinnova/Sarsia[2)]	7,5	7,8	7,8	5,6	4,4	5,9	13,1	13,5	15,2
Leiv Eiriksson Innovation	7,7	13,5	10,3	9,4	6,7	4,9	5,1	5,9	4,7
NTNU Technology Transfer					2,8	4,3	11,9	10,8	10,3
Sinvent						3,1	7,1	8,7	9,5
NorInnova/TTO Nord[3)]	4,6	3,5	3,5	4,3	4,1	3,3	4,0	4,5	3,4
Total	37,2	44,7	42,0	41,7	40,2	49,4	90,8	100,6	107,8

[1)]Bio-medisinsk Innovasjon (BMI) was involved as a TTO in the FORNY program for some years. Its role has later been changed to focus on projects in later stages of commercialisation.
[2)]Bergen Technology Transfer was formally established in 2004 when it took over the role of the previous Forinnova. Also Sarsia worked for a shorter period as a TTO in the region, but has now changed its role into a later stage commercialisation company.
[3)]NorInnova and TTO Nord are separate organisations, but are collaborating closely and have the same dominant owner.

The data in Table 4.2 to some extent reflect the diversity of the TTOs, as the amounts of funding vary significantly between the TTOs. Moreover, the data reflect the evolving structure of the TTOs. As mentioned in section 4.1, two of the main actors in the early years of FORNY, Oslo Innovation Centre and Leiv Eiriksson Innovation, have been replaced by new TTOs set up by the respective universities. From 2000 to 2008 the number of TTOs in the FORNY-programme has doubled. During the years some have been included in the program, while others have been left out.

As may be seen from Table 4.2, there are five TTOs that obtained more than ten million NOK per year in 2007 and 2008. Three of these are serving as TTOs for the three largest universities in Norway, i.e. Birkeland Innovation for the University of Oslo, Bergen Technology Transfer for the University of Bergen, and NTNU Technology Transfer for the Norwegian University of Science and Technology. The other two 'large' TTOs are Campus Kjeller which serves a group of research institutes co-located in Kjeller north of Oslo, while Medinnova is serving as TTO for the university hospitals in the eastern and southern region.

What is characteristic for these TTOs is that they all serve research institutions which have a high number of research staff (see table 4.1), and thus there is a greater potential for generating high-quality ideas for commercialisation. The large increase in funds should also be seen in relation to the increase of the budget of FORNY, as presented in Chapter 2, Table 2.1-2.2. It

may further be noticed that some of the TTOs like Medinnova and Bergen Technology Transfer have also experienced an increase in the number of institutions they serve.

4.3 Organisation of the TTOs

In order to obtain an overview of how the TTOs are organised, what strategies they employ, who they collaborate with and their portfolios, we organised a web survey to all TTOs participating in FORNY in 2008 (cf. Table 4.1). The questionnaire can be found in appendix.

Owners and boards of directors

In most cases, the TTOs are owned by the institutions they are providing TTO-functions for. This is actually the case for all the TTOs except Coventure and Norinnova. In the case of Norinnova the University of Tromsø is an indirect owner through its ownership in the mother company of Norinnova. The lack of ownership in Coventure might be explained by that Coventure serves the local industries and has a more regional role.

In six of the cases, major national or local companies are important owners. This is the case for Campus Kjeller, The Innovation Centre at Aas, Oslo Innovation Centre, Coventure, Leiv Eiriksson Innovation and Norinnova. All these TTOs manage other services like science parks and incubators, and in all these the national innovation agency SIVA participates as owner and contributes with funding of the incubator activity. Moreover, in most of these cases local or regional authorities are also owners.

An important concern regarding the organisation of the TTOs is to what extent the owner is actively involved in the TTO. The owners' direct involvement can be indicated through their funding of the TTOs' activities and whether they are represented in the board of directors. These may be important indicators of to what extent the TTOs are embedded in their mother institutions and if commercialisation is an integrated part of their strategies. The funding pattern is fairly mixed. On the one hand the three TTOs of the largest universities receive substantial funding from their owners. This is also the case for the TTOs serving specific research institutes. These TTOs may be regarded as being well embedded in their mother institutions. On the other hand, there are other TTOs where the mother institutions are less involved in the funding of the TTO activities. This may reflect that commercialisation and technology transfer is of less importance to their strategies.

The owners' involvement through and the composition of the respective TTOs' boards of directors can be seen in Table 4.3. As a main rule, the board of directors have representatives from the owners, and for nine of the TTOs the owners also have the chair of the board. Other representatives are from sectors of strategic interest to the activity of the TTO. This is particularly reflected by the fact that all the boards have members from research institutions, and generally from the disciplines most relevant for commercialisation as well as representatives from the business sector.

Representatives from the public sector are involved in seven TTOs. These are from SIVA and local or regional authorities. The latter group is represented in four of the TTOs and two have the same representative. The few representatives from local and regional authorities might indicate a lack of commitment towards commercialisation activities from this group or a lack of collaboration. However, it might also be explained by the role of the TTO which we will discuss towards the end of this section.

Table 4.3 Composition of the TTO boards of directors

		Board members representing sectors				
	Owner has the chair	Research	Health	Finance	Business sector	Public administration
Campus Kjeller	x	x			x	x
The Innovation Centre at Aas	x	x				x
Oslo Innovation Centre		x	x	x	x	x
Birkeland Innovation	x	x		x	x	x
Medinnova		x	x	x	x	
Simula	x	x				
Coventure		x		x	x	x
Prekubator	x	x	x	x	x	
Bergen Technology Transfer	x	x	x			
Leiv Eiriksson Innovation (LEN)		x		x	x	x
NTNU Technology Transfer	x	x	x	x	x	
Sinvent	x	x	x			
Norinnova	x	x		x	x	x
TTO Nord		x	x		x	

Staff

Table 4.4 provides an overview of the total number of staff employed by the TTOs for working with commercialisation projects. In total, there are about 100 full time equivalents employed by the TTOs, among which the permanently employed staff accounts for around 90. In addition the TTOs hire consultants on a temporary basis, in total there are around 25 consultants occasionally used by the TTOs, and they account for around 10-11 full time equivalents. There are mostly men working with commercialisation of research results, in three of the TTOs no women are represented.

Some of the TTOs perceive themselves as understaffed for performing their commercialisation activities. These are especially the TTOs who serve several research institutions. Most of the other TTOs are fairly satisfied with their staffing situation, wishing for one or two more employees.

Table 4.4 Existing and optimal number of staff (full time equivalents)

TTO	Existing number of staff working with commercialisations	Number of women	TTO's estimate of optimal number of staff
Campus Kjeller	11	6	15
The Innovation Centre at Aas	7	3	7-8
Oslo Innovation Centre	8	0	10
Birkeland Innovation	10	4	12-14
Medinnova	6	0	7
Simula Innovation	2	0	4
Coventure	2	1	3
Prekubator	6	3	12
Bergen Technology Transfer	10	3	15-20
Leiv Eiriksson Innovation	3	1	4
NTNU Technology Transfer	19	6	20
Sinvent	5	1	6
NorInnova	10	4	10
TTO Nord	5	2	7
Total	102	34	125-130

In comparison, a survey of European TTOs reveals that the average of staffing in a European TTO is 10.8 employees. Seven of the Norwegian TTOs are of this size or larger. However, some of the TTOs, like those managing research parks and incubators, have staff working with other tasks than commercialisation of research results. They have thus a larger number of employees than stated in this survey. Nevertheless, some of the Norwegian TTOs are rather small compared to the European average.

Competence

Based on the survey data, an overview of the disciplinary competence of the TTO staff is provided in Table 4.5. Among the total reported staff of 136[3], the largest groups are engineering, natural sciences, economics and business studies, and these four disciplines groups account for more than 70 per cent of all staff. There are just three employees with competence in medicine and four with a background in law, while there are as many as 12 with background in entrepreneurship studies. There is no clear evidence of disciplinary specialisation of the TTOs with the exception of NTNU Technology Transfer, where 14 out of 20 have a background in engineering.

According to international research, there is a tendency among TTOs to recruit staff with extensive disciplinary knowledge and with PhDs, while less priority is given to marketing and negotiation skills (Siegel et al 2003). However, this does not seem to be the case for the Norwegian TTOs. Only nine of the TTOs have staff with a PhD, and in total there are 13 with PhD

[3] The discrepancy between the total number in Table 4.4 and 4.5 is due to that some of the staff have interdisciplinary competence and are listed in two categories

degrees. The majority of these (8) have degrees in natural science, while the rest are in ICT, engineering, medicine and entrepreneurship studies.

Table 4.5 Disciplinary competence of TTO staff

TTO	Social sci.	Engi-neering	Eco-nomy	MBA	Medi-cine	Law	Nat. sci.	ICT	Huma-nities	Entr-studies	Other	Total
Campus Kjeller	1	4	2							2		9
The Innovation Centre at Aas		1	2	2	1	1	4			1	1	13
Oslo Innovation Centre	1	4	3	4			4	4		1		21
Birkeland Innovation		2	1	1			4	1				9
Medinnova		2	1		1		2					6
Simula Innovation								1		1		2
Coventure								2	1			3
Prekubator	1	1	2			1	2	1		2		10
Bergen Technology Transfer			1	1		1	4	1		5	1	14
Leiv Eiriksson Innovation		4	2	3			1					10
NTNU Technology Transfer		14	3			1		1			1	20
Sinvent		1		3							1	5
NorInnova		2	2	1			3					8
TTO Nord			1		1		3	1				6
Total	3	35	20	15	3	4	27	12	1	12	4	136

Another important aspect of competence is the experience-based knowledge of the staff. Figure 4.1 shows the average number of employees at the TTOs with experience in respectively entrepreneurship, industry, commercialisation, research and business law.

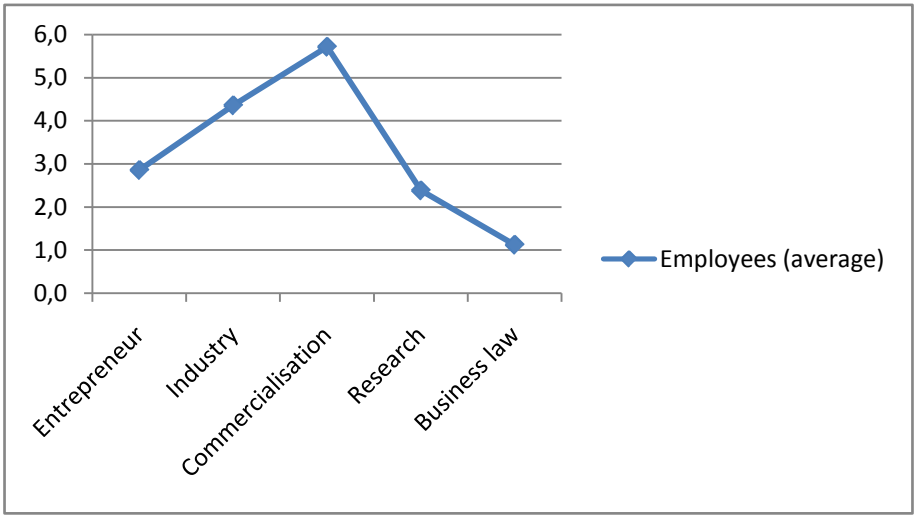


Figure 4.1 Experience-based competence.
Average number of employees with experience in the respective areas.

Most of the staff in the TTOs has experience from working with commercialisation activities and to some extent they also have industrial experience. The TTOs were also asked to indicate the total years of experience within the different fields for all the staff. It turns out that the distribution of years of experience follow the same pattern as shown in Figure 4.1. Thus the TTOs both in terms of number of employees and total years of experience have most competence from industry and commercialisation. To some extent they also have staff with experiences from research and entrepreneurship, while few have staff with business law expertise. In this field, the majority of TTOs engage external experts.

An important issue regarding the competence of the TTOs may be the balance between specialist disciplinary competences necessary for communicating with the researchers and for understanding the scientific basis for their business ideas, and the more generalist type of competences necessary for understanding the business potential of the ideas. Information obtained from case studies[4] of TTOs reveal that there are different perceptions of what competencies that are important for staffing the TTOs. In one of the cases it is claimed that the staff must have disciplinary competence in order to communicate with the researchers. In another case it is claimed that the TTO only need generalist competence. Yet another claims that the ultimate competence is a combination of great scientific and technological knowledge and industrial experience.

The different perceptions may be explained by the institutional environment the TTOs serve. In general one may presume that TTOs serving institutions mainly characterised by basic research perceive that they need to have disciplinary knowledge within the fields they serve in order to obtain relations with the researchers, while this is less important for the TTOs that serve institutes characterised by more applied research.

Another issue is to what extent the competence of TTOs is on a sufficiently high level to work adequately with their commercialisation projects. The TTOs own evaluation of their competencies (Figure 4.2) indicates that they generally consider their competence within the different fields as rather good. In particular, they all consider themselves to have a high level of technical and disciplinary competence as well as having competence and experience for being board members. Moreover, their negotiation competence and knowledge on market and sales are also rated as good.

Business law is the area where the TTOs perceive that they have the least competence. There are few employees with this kind of experience, as shown in Figure 4.2. This is also the field, together with IPR, where the TTOs employ external consultants the most.

[4] Cf. Branstad, A 2009 (forthcoming). Betydningen av TTO-enheter og deres kompetanse for kommersialisering av forskning. En studie av fire norske TTO-enheter. Notat, Høgskolen i Vestfold

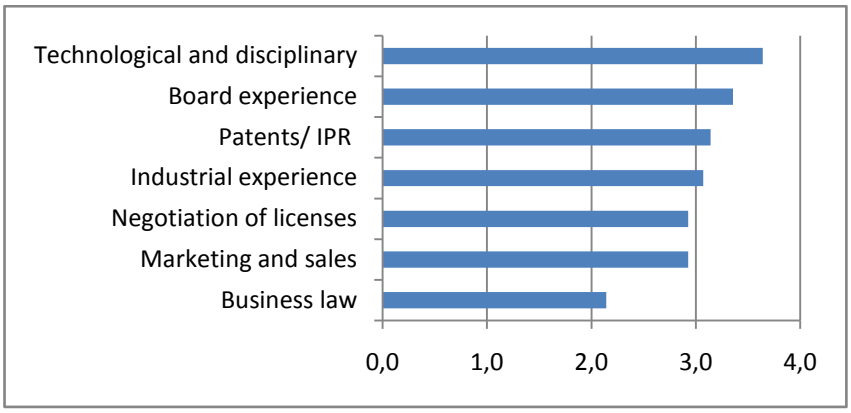


Figure 4.2 Evaluation of own competence
Scale: 0: No competence – 4: Very good competence

Summary

The TTOs pursue different strategies for staffing, and the differences may be understood, at least partly, on the background of the different institutional environments the TTOs are operating in. Some of the TTOs are relatively small in size while others have a higher number of staff. The question is thus if size and disciplinary competence have an effect on the quality of commercialisations. These are important measures for a discussion on the future organisation of the TTOs in the FORNY programme.

Moreover, the majority of the TTOs have a high level of experience from industry and commercialisation activities in general. Staff with these experiences and skills is assumed to be important as they can engage in boundary spanning roles as facilitators and negotiators of university-industry technology transfer. Given the high level of experience and the TTOs being content with their competencies, one might expect that the output of the TTOs will be of relative high quality. However, one must keep in mind that several of the TTOs are serving institutions with ideas mainly of an embryonic nature and which it takes a long time to commercialise.

4.4 Strategies and networks

The core activity of the TTOs is to stimulate the development of research based commercialisations with a high market potential. As university technologies are embryonic in nature and associated with high uncertainty, the TTOs' strategies for selecting and working with commercialisation projects are most crucial. Should they pursue a broad strategy stimulating the generation of a large number of ideas, or should they rather pursue a narrow and focused strategy and apply strict selection criteria? Furthermore, how should the ideas be evaluated, and what types of projects should be given priority? A number of issues have to be addressed when the TTOs are developing their strategies for commercialisation, and in the following sections we focus on some of these.

Selection and termination of ideas

How do the TTOs organise their strategies for generating ideas? The picture is not very clear, as the TTOs report different strategies. The majority reports that they direct the search for ideas towards high quality research groups. However, there is also a tendency that many TTOs have a broad approach towards all relevant disciplines, and there are many that prefer a great number of DOFIs (disclosure of inventions). Hence, the overall picture is fairly complex – some are quite focused and selective in their search strategies, while others pursue broad strategies.

A second issue is how the TTOs evaluate the registered ideas. The main criteria for selecting an idea for further development is its market potential and the quality of the idea, and virtually all TTOs emphasise these criteria. Somewhat unexpected, is that several of the TTOs do not perceive an engaged researcher as a critical element for developing the idea. Here, the TTOs seem to be split into two groups; those considering an engaged researcher as very important, and those which do not perceive this as important at all. The latter opinion is held by the TTOs that are directed towards industry and manage several functions. This may reflect that the TTOs have quite different strategies for how to follow up ideas.

Most of the TTOs rely on their own competence for evaluating ideas. Only one has responded that they do not evaluate the ideas themselves but is dependent upon disciplinary competence in the institutions. However, many TTOs occasionally consult researchers when the ideas are evaluated, and to some extent also industry contacts are consulted. The majority of the TTOs have developed systematic routines for their evaluation processes and apply a formal checklist for evaluating ideas. One of the TTOs has even developed an evaluation system that has been ISO-certified. Only three of the TTOs have no formal checklist for evaluating ideas.

A third issue is the criteria for rejecting ideas or for terminating the development of ideas. An overview of the responses from the TTOs is given in Figure 4.3. Mainly, ideas are terminated due to insufficient market potential. Other causes are the unclear potential of the idea and lack of financial resources. To some extent ideas are terminated because they are too far from commercialisation and the risk is regarded as too high. Moreover, four TTOs perceive their lack of expertise as a factor that contributes to termination. And in some cases previous experiences with the actual researcher may be a reason for terminating an idea. In general, the main reason for terminating ideas is related to the potential of the ideas and not to expertise.

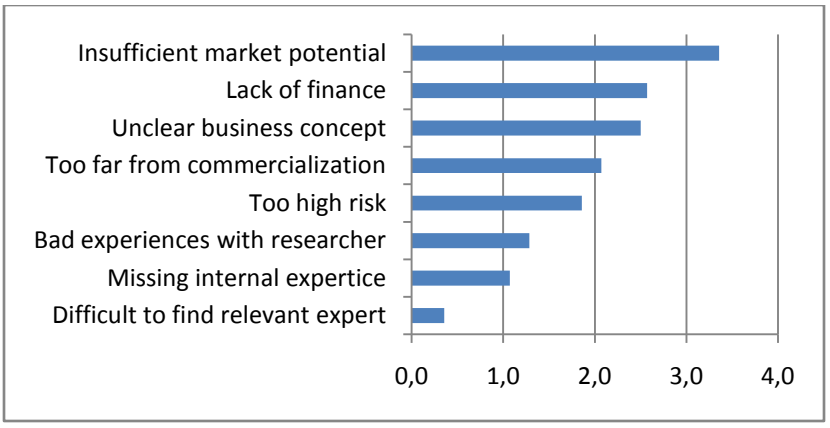


Figure 4.3 Reasons for terminating ideas
Scale: 0: Not important at all – 4: Very important

Spin-offs, incentives and involvement of the board

Establishing spin-offs is one of the main activities of the TTO, and working with spin-offs is the activity that occupies most of the TTO's time. In the following we summarise some data about their strategies in this field (Table 4.6).

Table 4.6 Spin-off strategies (N=14).

	Yes, usually	Yes, sometimes	No, never
Can TTO hold equity in the spin-offs?	**9**	5	0
Is payment for services converted into equity?	1	4	**9**
Has TTO financial means to invest in spin-offs?	**7**	6	1
Has TTO financial means to offer spin-offs loans?	4	**6**	4
Has TTO the possibility to follow up established spin-offs with financial means?	**6**	**6**	2
Has TTO the possibility to follow up established spin-offs with competence resources?	**10**	3	1
Has TTO staff the possibility to invest in the spin-offs?	1	1	**12**
Has TTO staff board positions in the spin-offs?	**10**	4	0

From Table 4.7 it is evident that the majority of the TTOs usually hold equity in the spin-offs they are involved in and that they have the possibility to invest in the ventures. Most of them can also support the further development of the established ventures by offering competence resources. All allow their staff to hold positions in the board of the spin-off, but only two of the TTOs allow staff to invest personally in the spin-offs.

Some of the TTOs have financial resources to offer the spin-offs loans, while the majority only do this in some cases and some never. Nine of the TTOs do not accept equity as imbursement for their services at all, and it is only one that does this frequently.

We further asked the TTOs whether the employees could obtain bonuses. Some studies emphasise that such a system will improve the effectiveness of the TTOs (Siegel et al 2003). In Norway 10 of the 14 surveyed TTOs have bonus systems for the staff and 9 have bonuses for the TTO manager. They have rather diverse bonus systems: collective, individual and combined. None of them are identical. Some of those who have not established a bonus system are considering implementing a system in the future. There is one TTO that has brought the arrangement to an end, as it perceived the system to not have a positive effect on the results.

Another issue is to what extent the TTOs involve the board in decisions regarding projects and investments. The majority did only involve the boards in decisions regarding investments in spin-offs and exit. Four of them also involved the board to some extent in selection of projects, resource allocation to projects and decisions on termination of project. Only one TTO does not involve the board at all, but uses instead an advisory board regarding investments in start-ups and a competence board for advice on projects. Five of the TTOs have a separate advisory board for decisions on commercialisations. Hence, the board of directors is used as a resource for some of the TTOs in regards to major financial decisions.

Perception of the TTO's role

Establishing spin-offs is rated as the main activity by most the TTOs – especially by the TTOs characterised by managing functions such as an incubator, financial funds and managing research parks. Another group of the TTOs spend most of their time on infrastructure activities. These are characterised by serving research insitutes and universities. Establishing spin-offs and infrastructure activities are the two most important activities of the Norwegian TTO. In general the TTOs do not devote much time to license activities, there are only three that allocate equal amount of time to license and spin-off activities.

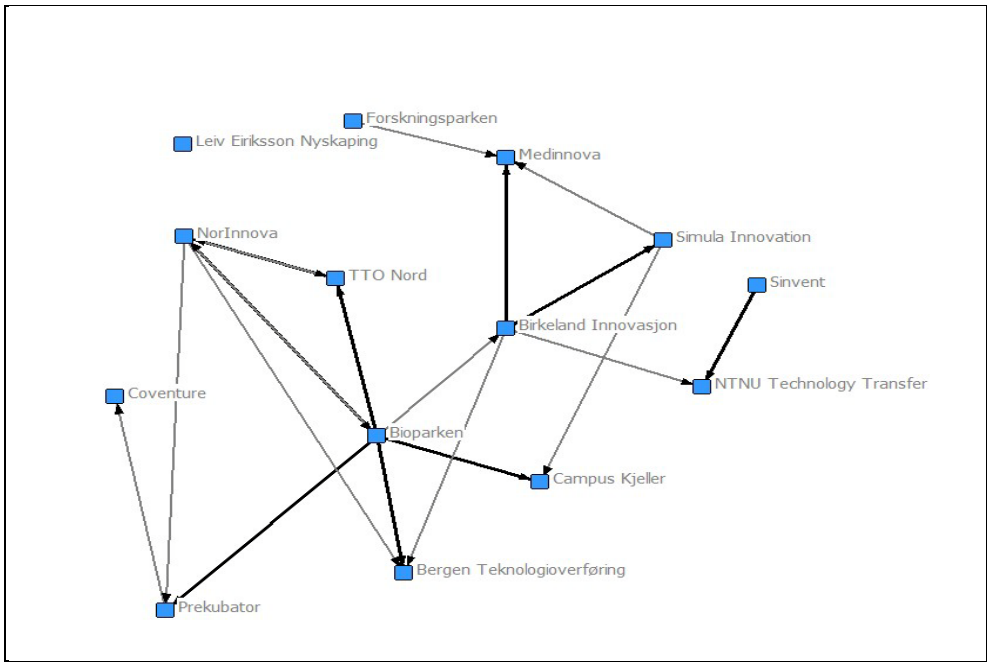
This is also reflected in responses on how the TTO percieve their role. The majority of the TTOs perceive themselves as an actor that promotes national economic development. The TTOs that manage several functions are more inclined to see themselves as promoting local economic development, while the TTOs that serve several research institutions perceive their role as an actor which diffuses scientific knowledge and technology to the rest of society. In comparison, European TTOs (CEMI 2008) perceive that their most important objectives were to promote diffusion of scientific knowledge and technology, and to generate revenues. The latter is not perceived as that important by the Norwegian TTOs.

Thus, one might claim that some of the TTOs are more inclined towards a entrepreneurial university model as described in chapter 3, while others are directed towards technology transfer, but all together there are no clear directions.

However, in general, the Norwegian TTOs are to a certain extent pre-occupied with contributing to national economic growth through the establishment of spin-offs. The emphasis on the latter might reflect the previous focus of the FORNY-programme which was establishment of spin-offs and this may indicate a certain path-dependency of the programme.

Network and collaboration

The TTOs have different competencies in terms of disciplinary background as well as industrial experience. The TTO managers gather regularly through meetings organised by the FORNY-programme and they have good knowledge about each other's activities and competencies. Hence, one might expect that there is some collaboration between the TTOs. In the survey we asked each TTO to indicate to what extent they collaborate with each of the other TTOs, and the results are displayed in Figure 4.3. The figure only shows the relations that where rated to a very large and large extent. Most of the TTOs reported that they collaborated with the others to some extent.



→ = collaboration to a very large extent → = collaboration to a large extent

Figure 4.4 The TTOs perception of whom they collaborate with

What is evident from the figure is that there are few TTOs that have close collaboration, and there is none of the TTOs that serve as a central node in the system. In this sense the system of TTOs may be regarded as less integrated. Interestingly, it seems like that the pair wise relationships between the TTOs are perceived differently. This may be explained by the respondent's perception of his/her personal work relations and not the whole TTO as such. It might also be explained by size; i.e. that a small TTO may perceive a relation as very close as opposed to a large TTO with many relations.

It may be observed that the relations are not dependent upon geographical proximity. For instance, there is little collaboration between the TTOs in Mid-Norway. There is some collaboration between the actors in the Oslo region and the actors in the southern part of the coun-

try, but it is not a strong relationship. The lack of collaboration within the regions might be related to the competition for funding among the TTOs. They are all competing for the same funds. Thus, even though FORNY reward collaboration between the TTOs to some extent, there appear to be few incentives for collaboration.

Another important issue related to the strategies of the TTOs, is how they interact with other actors in the commercialisation system, like national innovation agencies, local and regional authorities and industrial companies. An overview of the survey results is provided in Figure 4.5.

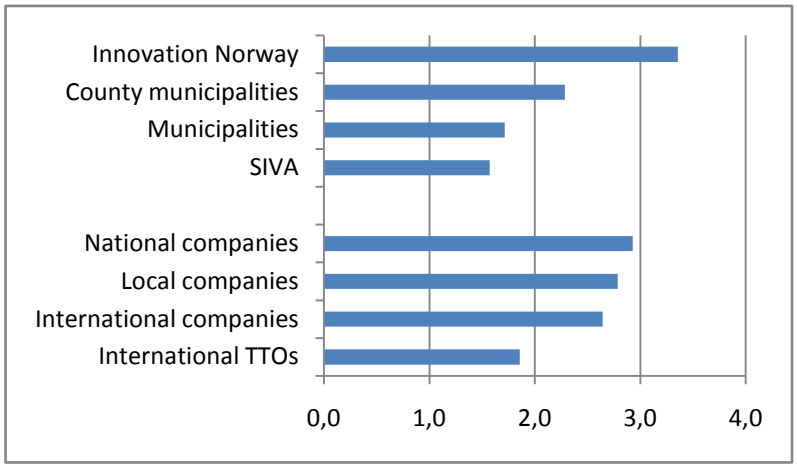


Figure 4.5 Collaboration with public and private actors
Scale: 0: Of no importance – 4: Very important

Among the innovation agencies and local and regional authorities, Innovation Norway is by far the most important actor the TTOs collaborate with. All but one reports that they collaborate, and among these, virtually all rate the collaboration as very important. This is not surprising since Innovation Norway manages schemes that are of great importance for the development of the start-ups (see Chapter 2) and the TTOs assist the researchers in these processes and have knowledge on different schemes that might provide additional funding. The other national innovation agency, SIVA, has obtained the lowest score. The reason for this is that SIVA only provides funding for running incubator facilities, and do not otherwise manage measures of direct relevance to the FORNY programme.

Contacts with local and regional authorities seem to be of less importance to most of the TTOs. In particular, the relation towards the municipalities appears to be rather weak and this might imply that local authorities are generally not committed towards commercialisation of research results. On the other hand, some of the TTOs have county municipality representatives on their boards, and these TTOs have naturally rated this collaboration as more important. It is the county municipalities of Akershus and Southern-Trøndelag which are most active in this respect.

Most of the TTOs report that they regularly collaborate with local, national or international companies, and in general the collaboration is regarded as important. This is not surprising, as industrial contacts are of importance for exploring the commercial potential of new ideas, and external companies may be important customers. In many cases also contacts with TTOs abroad are important. Ten of the TTOs report that they collaborate with international TTOs, and the majority of these regard their contacts as fairly important.

Financial actors are of great importance for further development of the commercialisation projects the TTOs are working on. In the different phases the start-ups are dependent upon financial funding from several sources. Thus, one might expect that the TTOs collaborate closely with different financial actors.

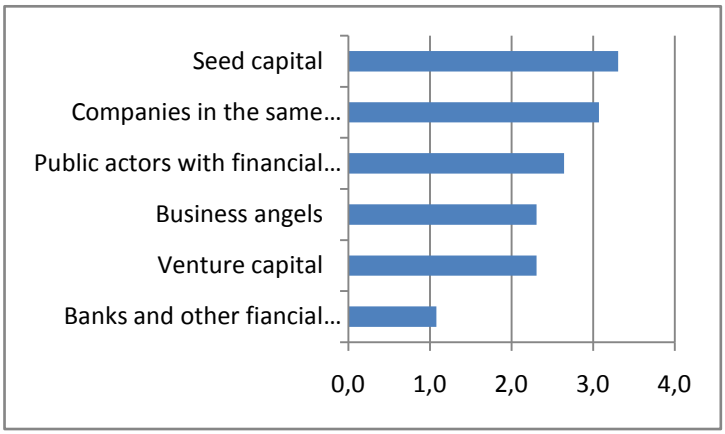


Figure 4.6 Collaboration with financial actors
Scale: 0: Of no importance – 4: Very important

It appears that seed capital funds are the most important financial actors (Figure 4.6). All but three TTOs report that collaboration with seed capital is important. The second most important actor type is other companies with activities in the same field as the spin-off. There are only four of the TTOs that do not report to collaborate with such actors.

Contacts with business angels and venture capital are on average assessed to be of medium importance. The responses are highly diverse. The TTOs managing several functions rate contact with venture capital as very important. Business angels are to a certain extent more important for the TTOs which serve research institutes than the others. On the other hand there are also cases in which contact with both parties are regarded as very important.

Not surprisingly, the actors with the lowest score are banks and other financial institutions. The majority of TTOs (11) respond that they have no or very little contact with these institutions, while there are just two that report these contacts as very or fairly important.

There appear to be one tendency in the responses: the TTOs which serve the universities and manage few functions are more directed towards public actors like Innovation Norway, while

the TTOs that also function as research parks have stronger relations towards venture capital. This might be related to the fact that the first group deal with ideas that are embryonic in nature and thus demand more development in the initial phases before the project may be relevant for venture capitalists.

The TTOs actual relations toward the actors above can be assessed from Table 4.7 which gives an overview of the sources where the TTOs have derived external capital to the start-ups.

Table 4.7 External capital provided by private investors and public agencies to FORNY start-ups, 2006 to spring 2008

TTO	Public agencies	Business angels	Other investors (firms)	Bank loan	Seed capital	Venture capital	Total
Campus Kjeller	9,2		25,9				35,1
The innovation Centre at Aas	7,4	0,1	1,5		4,3		13,2
Oslo Innovation Centre	6,3	1,7	3,0	2,0	1,7		14,6
Birkeland Innovation	6,8	4,5	2,0		8,3		21,5
Medinnova			1,0				1,0
Simula	6,3	6,0	0,5				12,8
Coventure	4,1						4,1
Prekubator	28,2	4,8	30,5				63,4
Bergen Technology Transfer	3,3	2,9	1,1			2,0	9,3
Leiv Eiriksson Innovation	8,5	5,2	17,3			4,0	35,0
NTNU TTO	29,7		17,0			13,1	59,7
Sinvent	9,0				2,4	8,0	19,4
Norinnova	8,8				0,1		8,9
TTO Nord							0,0
Total	129,8	39,3	100,7	2,0	16,6	27,1	315,6

From the table it is evident that public agencies have a major role in the development of start-ups. This is consistent with the results displayed in Figure 4.5. Other important actors are firms within similar sector as the start-ups. Seed capital, which was rated as very important by the TTOs, and venture capital have only been obtained by a minority of the TTOs. This might indicate that few of the start-ups are developed to this stage. This will be further discussed in Chapter 5.

The general picture emerging from this section is that there are few TTOs that collaborate with one another. This gives an impression that they do not make use of the other TTOs' competences and experiences, and it may be asked if there is an unexploited potential for coordinating the efforts of the TTOs. Furthermore, the TTOs are dependent upon other public actors, like Innovation Norway, in order to develop the start-ups. Some of the TTOs also take advantage of contacts with "Other investors", while the amounts of external capital provided by the other types of financial actors generally are smaller. These will be important issues for the discussion of the future organisation of FORNY.

4.5 Portfolios

As discussed above, most of the TTOs have a strategy of investing and holding equity in their projects. Thus, an important indicator of the TTOs' success is the value of their portfolios, and to what extent they have succeeded in developing a good exit strategy. In the following we give an overview of their portfolios and discuss issues related to this.

Patents, licenses and owner shares

All but two TTOs pursue an active patent strategy, see Table 4.8. On an annual basis, it is estimated that the TTOs apply for more than 150 patents. In total they hold more than 300 patent families[5], and about 100 patents were licensed out by the end of 2008.

Table 4.8 Patent activity and number of assigned patents and patents licensed out by end of 2008

TTO	Patent applications per year	Number of issued patent families	Patents licensed out	Licence income 2008 (KNOK)
Campus Kjeller	No patenting			70
The Innovation Centre Aas	4	0	0	0
Oslo Innovation Centre	4	n.a.	12	50
Birkeland Innovation	15	0	0	188
Medinnova	15	22	16	6 000
Simula	2	3	0	0
Coventure	2	0	0	0
Prekubator	5	0	0	0
Bergen Technology Transfer	10	3	2	1 060
Leiv Eiriksson Innovation	5	48	40	3
NTNU Technology Transfer	39	2	1	886
Sinvent	60*)	123*)	30*)	7 000*)
Norinnova	No patenting			0
TTO Nord	2	1	0	0
Total	163	202	101	15 257

*) Approximately 50 percent of the patent portfolio of Sinvent may be attributed to the FORNY programme.

However, the scale of patenting varies a lot. Sinvent by far shows the highest level of patenting activity; but it should be commented that not all of Sinvent's activity can be attributed to FORNY, as patenting and commercialisation are integrated parts of the strategy of the SINTEF Group (the mother institution of Sinvent). It is estimated that approximately fifty percent of Sinvent's patents may be attributed to the FORNY programme. There are three other TTOs which also hold a high number of patents, i.e. Oslo Innovation Centre, Medinnova and Leiv

[5] A patent family is all the patents and patent applications resulting from a specific patent application. A patent application for an invention is originally filed in one country. Sometimes this application is the basis for filing patent applications in several other countries, which in turn can be the basis subsequent applications. All of the patents and applications associated with the original patent application is called a patent family.

Eiriksson Innovation. Approximately one third of the patents are licensed out. As there may be other license agreements in addition to those based on patents, we have collected information about the total number of active licensed agreements. In total, the TTOs in 2008 had about 80 active license agreements that can be attributed to the FORNY programme, and the total revenues generated by these agreements amounted to around 15 million NOK. Again, the distribution across the TTOs is highly skewed. In fact, there are only four TTOs generating revenues of some significance; Medinnova and Sinvent generated the most with around four to six million, while NTNU Technology Transfer and Bergen Technology Transfer generated around one million each. These four TTOs were responsible for around 95 percent of the total reported revenues.

In addition to the patents and license agreements, the value of the TTOs' equity in the start-up firms is of importance. By the end of 2008, the fourteen TTOs active in the FORNY programme held equity in 147 firms which can be attributed to the FORNY programme, and the estimated value of these was slightly more than 100 million NOK (Table 4.9). The estimate is based on data obtained from the TTOs' balance sheet, and represents a high level of uncertainty. Generally, the estimates will be conservative and may underestimate the future values of the firms; nevertheless the data give some indications of the value of the TTOs portfolio of firms.

Table 4.9 TTO portfolio of firms which have been supported by FORNY by end of 2008

TTO	Firms 2008	Estimated value (mill NOK)	No of exits since 2001	Total value of exits since 2001 (mill NOK)
Campus Kjeller	20	11,6	0	0
The Innovation Centre at Aas	10	0,0	8	4
Oslo Innovation Centre	13	0,2	3	20[*)]
Birkeland Innovation	13	2,1	0	0
Medinnova	4	20,0	2	n.a.
Simula	3	2,4	0	0
Coventure/STS	13	5,5	2	0
Prekubator	14	0,0	2	4
Bergen Technology Transfer	5	0,2	0	0
LEN	11	4,5	3	2
NTNU Tech Trans	16	2,3	4	13
Sinvent	10	17,5	37	50
Norinnova	14	39,4	4	10
TTO Nord	1	0,0	1	3
	147	105,7	66	102

[*)]Net profit from exits since 2001.

It appears from the table that the distribution of values across the TTOs is highly skewed. There are four TTOs accounting for the lion's share of the total value of the portfolio firms with more than 80 per cent. These four are Campus Kjeller, Medinnova, Sinvent and Norinnova. However, also in the specific portfolios there are much skewed distributions, as a few companies generally account for significant shares of the total values. For instance in the case Norinnova with a portfolio of 14 firms, three of the firms account for more than fifty per cent

of the total estimated value. Thus, the success of the TTOs to build high value portfolios depends much on their ability to include the most successful companies in their portfolios.

However, the main objective of the TTOs is not to build portfolios of great value per se, but to generate revenues that may be channelled back for further commercialisation activities and for strengthening the research activities of the institutions that provide ideas for commercialisation. Thus, exit strategies are important, and the ultimate success criterion is to what extent the TTOs succeed in their exit strategies and create returns on their investments.

It appears from the table (4.9) that apart from Sinvent, the TTOs so far have not had many exits. In fact, during a period of eight years, there have been no more than around thirty exits (when Sinvent is not included), i.e. three or four per year. However, it should be kept in mind that some of the TTOs are quite young organisations and cannot be expected to have exits during such a short period of operation. Moreover, it is worthwhile noticing that the total value of all the reported exits amounts to around 100 million NOK, and again we have the pattern of a skewed distribution. By far, Sinvent is the TTO with the best performance in terms of the value of exits, in fact, Sinvent is accounting for half of the total values generated by exits. Also Oslo Innovation Centre, NTNU Technology Transfer and Norinnova have succeeded in generating some revenues on exits.

We also asked the TTOs to what extent they had developed an exit strategy and if they perceived any problems related to exits. Apart from Sinvent and possibly one or two other TTOs, the remaining had not developed a systematic exit strategy, and the majority report significant problems related to exits. Generally, the time from investment to a potential exit is rather long. One group estimate the average time to be four to six years, while another group claim that the average will be more than six years.

The TTOs generally perceive it as difficult to carry out an exit in the early years of a new firm, as it might create problems for its further development. Continued involvement by the TTO may be a precondition for getting access to seed capital or other investors, and an early exit by the TTO may give a negative signal to other investors. Moreover it is argued that 'second order' investors are missing, thus it is generally difficult for the TTOs to carry out exits.

Summarising the situation, the TTOs spend most of their resources on projects that give small opportunities for exits. Rather than creating good opportunities for returns on their investments, the investments seem to be tied up in projects in which the prospects for exits are rather modest. This may also be regarded as a result of the lacking supply of ideas with high potential for commercialisation, and it may also reflect the results of inadequate selection strategies by the TTOs.

4.6 Conclusions

Here we will summarise the following important issues related to the organisation of the programme and the strategies of the TTOs.

- The present organisation of FORNY is characterised by being a decentralised and loosely coupled system. The programme has a small secretariat with limited resources, and its main task is to coordinate activities and allocate resources to the participating TTOs. The secretariat has limited capacity for a more active involvement in developing the strategies of the programme, like being more actively involved in the coordination of the efforts of the individual TTOs. Thus, a question for further discussion is if the present organisation of the programme is optimal, or if it rather should be organised with a stronger coordinating body.
- The present system of TTOs is fairly fragmented. There is no clear structure of organisation and specialisation, the most important principle of organisation is that of regionalisation; to a lesser extent the TTOs are specialised on disciplines or types of commercialisations. The collaboration between the TTOs is not well developed. Thus, an important issue for the future is how a more specialised and coordinated structure of the TTOs can be developed.
- While some of the TTOs are well embedded in the strategies of their mother institutions, like most of the TTOs that are directed towards the institutes and some of those serving the universities, others are not. Although the mechanisms of commercialisation are complicated, an important factor that may explain the good performance of some of the TTOs is how the mother institution has adopted commercialisation as part of its main strategy, and that working with commercialisation projects is regarded as an integral part of the activity of the institution.
- The working conditions for TTOs are quite diverse. While the TTOs serving research institutes may specialise in specific technologies and thus easily can be integrated in the activities of their mother institutions, the situation of the TTOs serving the universities are more complex; they deal with researchers from different disciplines, the incentives for researchers to commercialise are limited, and it is often unclear to what extent the university actually prioritise commercialisation activities.
- The TTOs have so far not succeeded in bringing up a sufficient number of projects with a great potential for commercialisation. Although there might be several explanations for this, which will be discussed in the final chapter, the strategy of the TTOs for searching and selecting ideas are important factors. The strategies pursued so far by many of the TTOs have not been successful as their resources to a significant extent have been tied up in projects with limited prospects for exits. Consequently, in the future it should be considered to direct the FORNY programme towards more selective strategies. An important aspect of this is how the TTOs can learn from the experiences of the most successful TTOs, and how the FORNY programme should be organised in the future in order to facilitate such learning processes.

- The TTOs that generate substantial results seem to have staff with more generic disciplinary competence and industrial experience. This leads us to a discussion of what types of competence the TTOs should have and what role a TTO should have. As described in Chapter 3 a TTO might move in two directions; technology transfer or towards an entrepreneurial university model. The latter has to some extent served as the original model of the FORNY-programme with the programme's focus on developing spin-offs. Defined broadly, the role of the TTO is to facilitate technology transfer and to engage in boundary spanning activities between the research institutions and industry. The results in this chapter indicate that especially the latter part is difficult. Thus, a point for discussion is whether the TTOs are staffed with the necessary competence to execute their tasks.

5 FORNY start-ups, commercialisations and firm performance

The most important output measure for the FORNY program is the number and quality of commercialisations. A commercialisation is realised either if a project leads to a firm start-up (from here we use the term "FORNY start-up") or a licensing agreement. In this chapter, we focus on FORNY start-ups. The FORNY program operates with a set of requirement that have to be met before a TTO can register a commercialisation. Below, we list the most relevant requirements[6]:

1. A commercialisation is realised through a licensing or a firm start-up. The commercialisation may relate to the development of products, processes or methods/ solutions.
2. The commercialisation must show a potential for operational profitability. A feasible business plan must be presented, together with a realistic plan for financing the venture before the firm is fully up and running.
3. The business plan must be based on knowledge or research developed in a Norwegian university, college, research institute or university hospital.
4. Intellectual property rights relating to the business plan must be settled in due legal agreements.
5. The commercialisation must bring forward a potential for value creation in Norway.

In this chapter, we take a closer look at the firms that have been categorized as a commercialisation. It is outside the scope of this report to evaluate the quality of the business and financing plans and the IPR agreements that form the basis for the commercialisations in points two and four above. We are particularly concerned with the economic performance of the start-ups over time. We specifically focus on output growth and the factors that have to be in place to facilitate growth in knowledge and research based start-ups. The most central factor here is access to capital in order to finance a relatively long period of costly product development and marketing. We also attempt to enrich the concept of commercialisations by categorizing the start-ups according to the degree of commercial success. This is important since the FORNY start-ups display a wide variety of development paths. Most firms remain small, unprofitable and without signs of growth, but a few appear as successful ventures. The main question to be answered is whether the successful cases are sufficiently many in number and whether they are sufficiently successful to fulfil the objectives of the FORNY-programme.

It is important to notice that the role of the TTOs ideally ends when the start-up is established and the commercialization is successfully registered. An evaluation of the economic performance of the FORNY start-ups must be based on the fact that the TTOs and the FORNY program is (at least in principal) not really a part of the firm during the period that we map. Yet, in reality, the TTOs must follow FORNY start-ups for a long time, supporting them with several kinds of services. One reason for this prolonged relationship between the TTOs and the FORNY

[6] The requirement list is based on the RCN letter on Specification of obtained commercialisations. Some requirements with minor relevance for start-ups are left out.

start-ups relates to ownership. As shown in chapter 4.5, The TTOs hold ownership in 147 FORNY start-ups. If the TTO holds an ownership share in the company, the TTO has a clear incentive to follow up the firm until new owners take over. Most often, new owners are hard to find.

Nevertheless, even though the TTOs and the FORNY programme are detached from the FORNY start-ups at an early stage, the economic performance must be regarded as an important indicator on the ability of the FORNY programme to develop ventures that eventually grow into sustainable and fast growing firms that contribute to national welfare.

5.1 An overview of the portfolio of FORNY start-ups

In this chapter we study the characteristics and performance of FORNY start-ups using register data, covering all start-ups. In chapter 6, we present the survey which was returned by a sample of the start-ups (72 respondents). In some sections of this chapter, we have also used information from the survey. In that case, we consistently inform that the results are based on survey material and not register data.

In table 5.1 we present the total number of FORNY start-ups since 1996, and an estimated number of exits. The figures in this table are larger than what is reported in table 4.9. The reason for this is that table 4.9 is solely focusing on start-ups where the TTOs have ownership. Since 1996, the FORNY programme has facilitated close to 300 FORNY start-ups. On average, each year 23 firms have been established and 8 firms have closed down. Notice that the figures for 2008 are highly preliminary and capture only a small proportion of actual start-ups that year.

Table 5.1 The FORNY start-up portfolio: Number of new firms, entry and exit.

Year	Accumulated number of firms	Number of firms in portfolio	New firms entering	Firm exit/Closure
1996	9	9	9	
1997	34	29	25	5
1998	54	47	20	2
1999	80	63	26	10
2000	109	88	29	4
2001	139	111	30	7
2002	172	133	33	11
2003	197	144	25	14
2004	211	149	14	9
2005	250	170	39	18
2006	275	176	25	19
2007	295	195	20	1
2008	297	197	2	
Sum			297	100

During the period 1996-2008, we have registered 100 firm closures, representing one third of the total number of start-ups.[7] This represents a relatively low exit rate as compared to the rest of the population of start-ups in Norway. According to Klette and Mathiassen (1995), the annual exit rate for these firms is approximately 10 percent. With 300 start-ups and 100 exits, the 2008 portfolio of FORNY start-ups covered approximately 200 firms. Information and communication technology is by far the most dominant industry among the FORNY firms. It counts for 1/3 of all firms followed by other services and medtech/healthcare. Energy & environment, marine/aquaculture, biotech/food industry and maritime/offshore industries are all about the same size.

The large Norwegian industrial clusters of the maritime/offshore and energy sectors are weakly represented in the FORNY start-up portfolio. Commercialisation in these industries is often demanding in terms of required early stage capital investments. Also, early stage projects in these industries are more often picked up by large industrial incumbents and are therefore not in the scope of the FORNY programme.

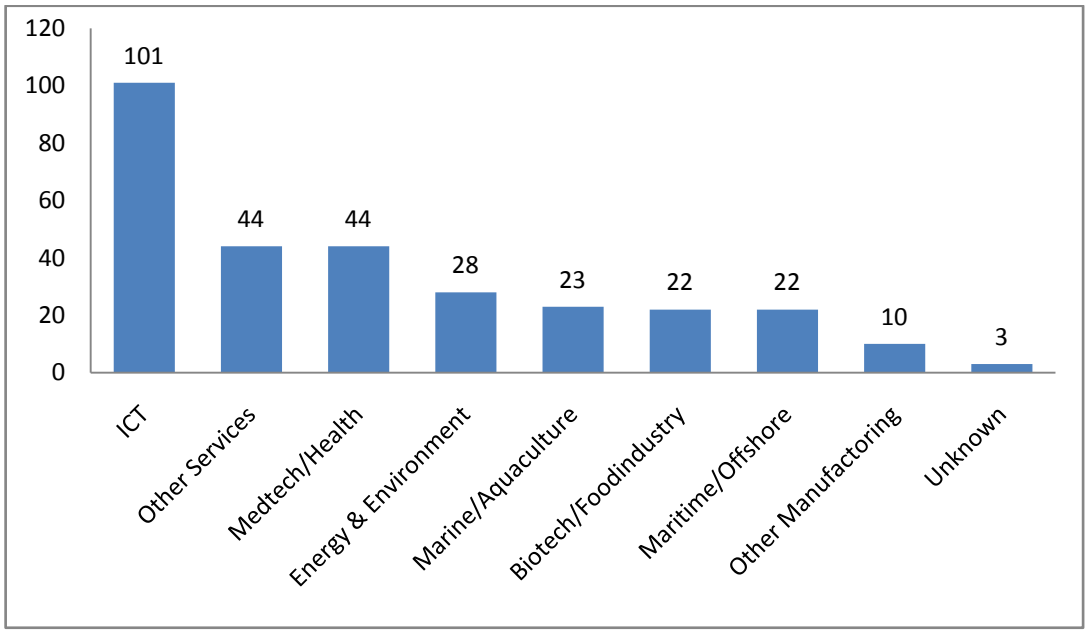


Figure 5.1 FORNY firms by industry

There are 12 different TTOs in the FORNY programme. They differ widely with respect to the number of FORNY start-ups. Leiv Eiriksson Innovation in Trondheim is clearly the TTO with most firms in their portfolio, followed by Oslo Innovation Center and the Innovation Center at Aas.

7 A closure is registered either if the FORNY-program or the Norwegian firm registry reports a close down or if the firm is registered without operational income for two consecutive years after a year with positive turnover.

Table 5.2 FORNY start-ups by TTO.

TTO	Number of start-ups	Existing start-ups
Leiv Eiriksson Innovation	59	43
Oslo Innovation Center	42	24
The Innovation centre at Aas	40	16
Campus Kjeller	36	29
Bergen Tech Transfer	28	15
Norinnova	28	18
Prekubator-Rogaland	23	17
NTNU Technology Transfer	14	13
Conventure-Sørlandet	11	8
Birkeland Innovation	6	5
Medinnova-BMI-RF	6	5
Sinvent	4	4
Sum	297	197

The distribution of FORNY-start by TTOs is strongly driven by the age of the TTOs. For instance, Birkeland was started as late as 2004, while LEN was awarded funds all the way back to 1995.

5.2 Growth and Commercialisation

A study of commercialisation in technology and research intensive early stage firms must take into consideration that the first 3-10 years (depending on technology) are investment intensive, driving up costs. Growth and commercialisation should thus not be studied from the perspective of operating result and profits, but rather from the perspective of sales revenues and turnover.

Table 5.3 gives an overview of number of firms and development in sales revenues for each year after the FORNY programme got involved in the firms through the TTOs.[8] As shown in the table, the number of firms falls rapidly with the number of years after entrance of FORNY. This is explained by the fact that many start-ups have been established lately. Moreover, as time goes by more firms are forced to close down.

[8] Turnover is not including transfers from public sector funds (soft money).

Table 5.3 Turnover by years after entrance of FORNY (1000 NOK).

Years after FORNY involvement	Number of firms	Total turnover	Average turnover	Median turnover	Top 25 % turnover	Top 10 % turnover
0	290	194021	669	242	728	1843
1	269	319914	1189	455	1323	3021
2	230	379686	1651	551	1997	4221
3	190	302004	1589	533	2030	4466
4	163	383939	2355	596	2752	5585
5	135	329892	2444	646	2985	6565
6	100	311561	3116	984	3613	8329
7	70	360111	5144	1258	4727	13356
8	51	343713	6739	671	3748	8402
9	33	245697	7445	607	2667	9056
10	20	275156	13758	748	3470	20884

Turnover is expected to grow as firms mature. The average turnover increases from 670 000 NOK the first year to nearly 14 million NOK after 10 years. But average figures do not tell the true story about the FORNY portfolio. The figures are strongly affected by a few out-layers that pull the average figures up over time. Consequently, we have also reported turnover for the median firm, the top 25 percent firm and the top 10 percent firm. Neither the median firm nor the top 25 percent firm show any growth of significance. We have to move all the way up to the top 10 percent firm to identify a strong growth pattern. However, notice that after 10 years where turnover makes a big jump, the top 10 percent firm is actually the second largest firm, since there are only 20 firms representing this cohort.

Some of the FORNY start-ups have caught the attention from other firms who eventually have acquired them (e.g. Secustream), leading to a profitable closedown as the activity is merged into the acquiring firm. This exit route leads to a potential downward bias in the turnover growth pattern. However, the number of FORNY start-up acquisitions is low and the overall acquisition price (signalling future revenues) is limited. Moreover, experience from such transactions in the seed and venture capital segments shows that most firms continue to exist after being acquired. In other words, we do not expect that this downward bias affects the overall patterns.

Turnover revenues may not necessarily stem from innovations that the FORNY start-up was based on. Results from the survey indicate that turnover is either strongly related to the firm's commercialisation, or only marginally related. 18 percent of the firms reported that all sales revenues were related to the commercialisation. More than half of the firms reported that only 0-10 percent of the turnover was related to the commercialisation.

Table 5.5 Share of the turnover in 2008 which is related to commercialisation.

Share of turnover related to the commercialisation	Share of the firms
0 % - 10 %	55 %
11 % - 99 %	27 %
100 %	18 %

Source: The FORNY start-up survey

Most firms are likely to be in a development phase were the commercialisation so far has not brought any significant income. Hence, turnover is not related to commercialisation but something else, for instance financial support from public funds. Several firms have moved into the commercialisation of a different product. Hence, they have commercial revenues, but not relating directly to the FORNY commercialisation.18 percent of the firms in the survey report that the entire turnover is related to the commercialisation. This is likely to be firms which have made it through the development phase where the commercialisation now gives return in terms of turnover.

5.2.1 Degrees of commercialisation

So far, we have not conducted normative valuations of FORNY-portfolio firm performance in terms of successful commercialisations. There are a large number of different definitions of commercialisation in the literature. One view of commercialisation previously used in the FORNY programme is when a firm has a product or a service which *may be* introduced commercially. This is a wide definition with focus on potential performance and no requirement of actual achieved commercial success. Our data material allows for backward looking studies, hence, definitions of commercialization can be based on figures describing the development of actual commercial revenues. In the following we have defined two simple degrees of commercialisation and a profitability criterion:

Lower degree commercialisation: turnover higher than 500 000 NOK at least once over the period 2000-2007.

Higher degree commercialisation*:* turnover higher than 5 mill NOK at least once over the period 2000–2007, and growth in turnover over the last three years higher than 75 percent.

Profitability*:* operating result plus write-offs (EBITDA) greater than zero at least once during the period 2000–07.

A lower degree commercialisation confirms that there is or has been some demand for the product. On the other hand, the firm is not a high growth case with a potential for significant future value creation and employment.

A higher degree commercialisation signals that the firm is able to move into a high growth path with large potential future revenues and employment. The objective of the FORNY programme is to contribute to long term value creation and employment. Hence it is the

group of higher degree commercialising firms that should be in focus. Notice though that a higher degree commercialisation not necessarily implies a fully successful enterprise, only a potential one.

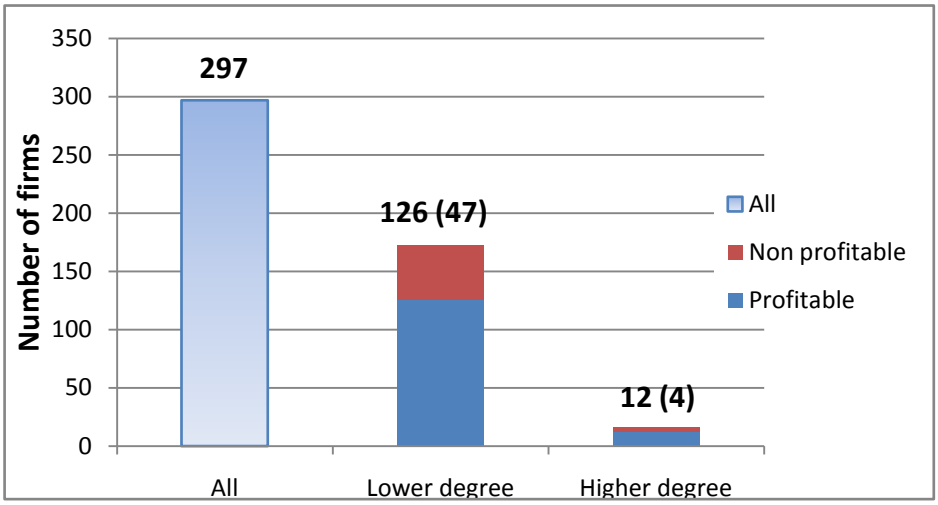


Figure 5.2 Number of commercialisation among the 297 FORNY firms. Number of non-profitable firms n brackets.

Figure 5.2 illustrates that there is a small number of firms, about five percent, which fulfil the criteria for commercialisation of a higher degree, while almost half of the firms fulfil the criteria for commercialisation of a lower degree. This pattern fits well into the overall pattern for start-up firms in Norway. Somewhat less than five percent of start-ups transform into firms that grow fast over a long period.[9] The vast majority of firms (technology intensive as well as others) remain small with modest or no growth. They serve the purpose of employing a few persons.

In chapter 3.2 and 3.3, we have presented the spin-off activity of TTOs in other countries. A direct comparison with the surveyed institutions is not easy, however, it appears that the number of spin-offs with strong employment and output growth is larger in many of the cases. Also, the number of firms going public or being acquires by other firms appears to be higher in those foreign TTOs that we presented.

TTOs clearly operate with different approaches to the start-up process. Figure 5.3 displays the number of commercialisations in the different TTOs.

[9] See e.g. Grünfeld et al. (2009), Kolvereid, Bullvåg and Åmo (2007), Sørheim and Isaksen (2008)

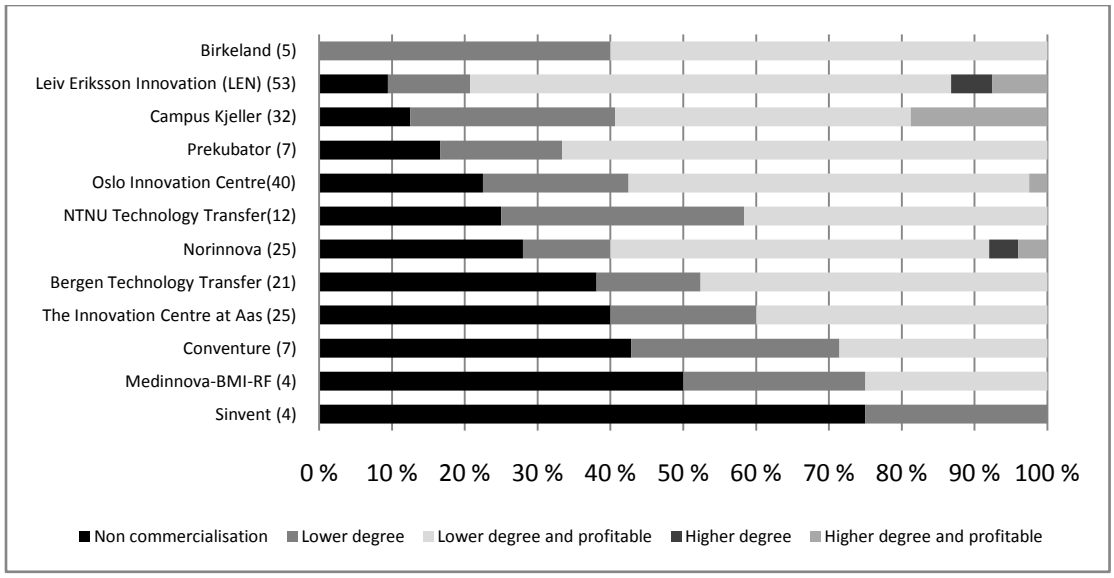


Figure 5.3 Commercialisations by TTOs.

It is not straightforward to compare the different TTO portfolios since the portfolios differ much in size, age and underlying strategy. Higher degree commercialisations have mostly taken place in the TTOs where there have been a large number of FORNY start-ups. Those TTOs which are newer have a smaller number of FORNY start-ups and no higher degree commercialisations. Some of the TTOs are focusing heavily on start-ups in the fields of biotech/ medtech/food industry. In these sectors, the road to commercialisation is often two or three times longer than in other industries. Hence, the number of higher degree commercialisations will be capped.

Notice also that some of the newer TTOs are strongly dominated by lower degree commercialisations (very few start-ups with no revenues). This indicates that firms have had a relatively short road from establishment to commercial revenues.

5.3 Value added, the J-curve and the need for capital

As mentioned earlier in this chapter, it is important to keep in mind the fact that we are studying immature firms where it is expected to take several years before the start-ups reach satisfactory turnover and profits. These firms normally face a challenge which is named the **J-curve.** The development in the firm's operating result follows a certain J-curve pattern: Operating costs increase gradually, but after some years the growth in costs is curbed as the development phase comes to an end. Turnover may be low or equal to 0 a number of years before marketing and commercialisation take place. Subsequently the turnover starts moving. Consequently, there will be a period with significant and growing deficits. First after a significant number of years will the firm manage to cut the deficit by increased sales and finally

reach positive operating results. Hence we are facing a J-curve pattern when studying the progress in operating results as well as value added.

Since the portfolio of FORNY-firms is constantly changed and rejuvenated as new start-ups enter, one cannot evaluate the FORNY programme based on a study of overall value added and operating results in a given year. Due to the J-curve pattern, one should actually expect weak overall figures for value added. In Table 5.5, we get the impression that total value added in the portfolio of FORNY start-ups is high (NOK 233 mill. in 2007). However, a closer look at value added in the median firm shows a completely different picture, where figures are closer to zero. The total figures are strongly affected by a few large firms like Opera Software.

Table 5.5 Central accounting figures (2007).

	Number of firms	Sum	Mean	Median
Turnover (1000 NOK)	203	910 720	4 490	930
Value added (1000 NOK)	203	233 130	1 150	10
Employment	203	822	3	1

Value added growth has previously been viewed as one of the most central indicators for success in the FORNY programme. Yet, as we argue above, most of these firms are in an early stage where value added is and should be low or negative. As long as a large proportion of the FORNY- portfolio consists of young start-ups with a growing need for sliding down the J-curve, aggregated value added figures will hardly tell a story about success or failure. In the very long term, however, value added may be a relevant indicator as the portfolio matures significantly. But even the long term figures must be adjusted for the age composition of the portfolio. [10] On this background, we have chosen to direct our attention to the sales revenues of the FORNY start-ups as the most relevant indicator of success.

Table 5.6 shows developments in operating results as firms grow older. With respect to the J-curve, it is desirable that operating result get sufficiently negative, indicating a willingness to invest in the development process, leading to a successful commercialisation. We only find signs of a J-curve among the bottom 10 percent performers, with respect to operating result. 90 percent of the start-ups have no clear signs of an initial phase where costs propel in order to achieve new development stages.

[10] The value added figures in the FORNY portfolio are also strongly dominated be one firm. Hence total value added figures do not say much about the value added growth of the typical FORNY start-up. Our figures show that as the FORNY start-ups grow older, median value added remains low, indicating that average figures are not representative.

Table 5.6 Operating results by years after entrance of FORNY. Numbers are in 1 000 NOK.

Years after FORNY involvement	Number of firms	Average operating result	Median	Bottom 25 %	Bottom 10 %
0	290	-301	-60	-278	-946
1	269	-532	-68	-568	-2033
2	230	-682	-55	-624	-2684
3	190	-1066	-51	-663	-2794
4	163	-869	-37	-599	-3730
5	135	-1645	-30	-826	-4120
6	100	-1320	-31	-872	-4028
7	70	-1163	-30	-433	-4451
8	51	864	-58	-856	-3885
9	33	-850	0	-141	-3113
10	20	-1142	-16	-368	-1674

If the J-curve argument is relevant, one would expect that those start-ups that reach a higher degree commercialisation, also reports a deep J-curve in the past. In the table below, we show that this is in fact the case. Here we present the most weak operating result (EBIT) for each FORNY start-up during their lifetime. The J-curve bottomed close to 15 times deeper for those with a higher degree than for those with no commercialisation (see Table 5.5b). The difference between lower and higher degree commercialisations is also striking.

Table 5.6b: Degrees of commercialisation and the J-curve

	Minimum operating result among the FORNY start-ups	
	Average	Median
No commercialisation	-568	-116
Lower degree	-2906	-807
Higher degree	-4176	-1678

A deep J-curve indicates strong willingness to invest. In the survey, firms were asked to which extent they needed capital in five different stages. According to the survey on start-ups discussed in the next chapter, the firms reported a strongest need for capital in early stages where development and testing is in focus. In the later stages focusing on marketing and production firms did not report an equally strong need for capital. We find this pattern somewhat surprising, since the marketing and production phase often is viewed as very resource demanding. We believe that the response may be a result of the fact that very few FORNY start-ups have actually reached the later stages, and thus do not emphasise the need for capital in these phases.

Table 5.7 The FORNY firms need for capital in different stages

The firms need for capital injection (1-7; 1:No extent, 7: Great extent)	
Related to development of technology/products/concepts/services	5,7
Related to testing of technology/products/concepts/services	5,0
Related to patenting/licensing/copyright etc.	3,8
Related to marketing of products/services	4,1
Related to production commence	3,6

Source: Start-up survey

5.4 Access to capital and ownership

In order for firms to make it through the development phase, it is required that they bring in adequate amounts of capital. There are essentially three forms of capital available: equity capital, loan financing and government transfers. Figure 5.4 gives an overview of the injection of capital over the period 2000-2007. In chapter 7, we go into more detail on public sector programmes that constitute a significant share of the available capital. For purposes of comparison, we have also listed the approximately NOK 700 mill channelled through the FORNY programme during the same period. Notice though that the FORNY funds are not channelled directly to the FORNY start-ups.

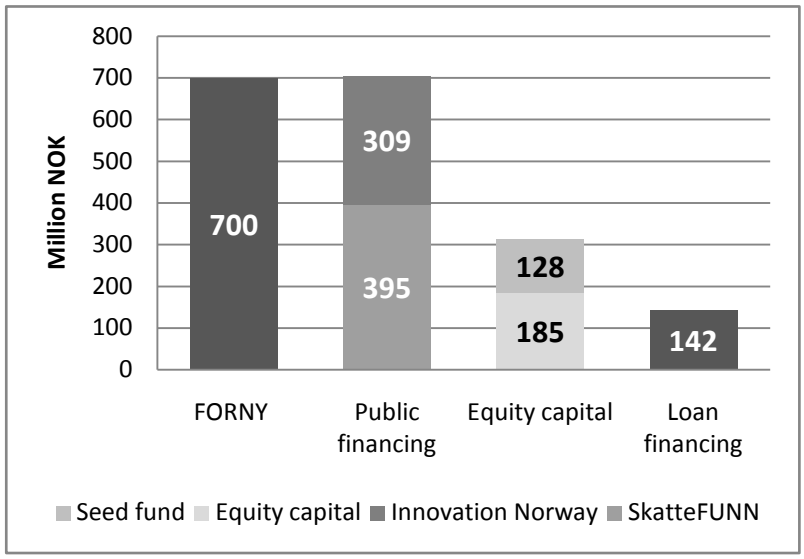


Figure 5.4 Capital made available for FORNY start-ups 2000-2007 (million NOK). (Public financing is divided into seed fund and funding from Innovation Norway. Equity capital is divided into Seed fund and Equity capital)

In total, the FORNY start-ups have received 1.1 billion NOK through alternative capital sources (excluding FORNY funds). Below we present the role of these capital forms for the FORNY start-ups.

5.4.1 Equity capital and Ownership

According to our estimates, flow of equity capital during the period 2000-2007 amounts to 313 million NOK, out of which 128 million NOK has been channelled through Norwegian seed capital funds.[11]

In Table 5.8 we show the development of accumulated equity capital as the FORNY-firms mature. Notice that we report the stock of equity capital in each year. Changes in equity capital from one year to another are found by looking at the difference between two years. As discussed earlier, average numbers are believed to be misguiding, since they are strongly influenced by a few large firms. It is therefore more relevant to study the median, and top 25 and 10 percent firms.

The median firm as well as the top 25 percent firm have significant less equity capital than the average firm two years and after start-up. Consequently, there are a few firms which have large amount of equity capital compared to the rest of the FORNY-firms. The top 10 percent firm has significant more equity capital than the average, which signals that a few firms actually receive a substantial amount of equity capital over time. For the top 10 percent firm, equity capital is clearly growing over time.

Table 5.8 Accumulated equity capital as FORNY start-ups mature (1000 NOK).

Years after FORNY involvement	Number of firms	Average equity capital	Median	Upper 75 %	Upper 90 %
0	290	442	124	446	1123
1	269	622	173	652	2444
2	230	1621	243.5	1077	4346
3	190	2661	282	1400	3799
4	163	3832	409	2011	5367
5	135	3368	447	2725	7447
6	100	3264	531	2723	6828
7	70	4855	1007.5	4750	13235
8	51	7964	616	4110	8137
9	33	12863	440	3414	12539
10	20	27398	1290.5	3456	13650

Table 5.9 summarises the survey response on ownership composition. The entrepreneurs are by far the largest owners, followed by the TTOs. Investment funds (venture and seed funds) also play a relatively important role when it comes to equity capital and ownership, while the role of other firms and universities/institutes etc. Play a more modest role. Interestingly, the firm management as well as friends and family hold an equity share in many companies, but

11 Figures on seed capital flows come from the recent seed fund evaluation conducted by MENON Business Economics and Nordlandsforskning (Grünfeld et al. 2009), where FORNY start-ups that enter the seed fund portfolios are identified.

the share is normally small. Banks and financial institutions are practically not present as owners.

Table 5.9 Ownership

Owners	No share	1 - 25 %	26 - 50 %	> 50%
Entrepreneurs	16 %	26 %	24 %	34 %
TTOs	41 %	43 %	7 %	9 %
Active ownership fund (Seed fund / Venture fund)	65 %	16 %	12 %	7 %
Other firms (ex fund and financial actors)	78 %	10 %	4 %	7 %
University /collage /institute/hospital/health firm	84 %	7 %	4 %	4 %
Management (ex entrepreneurs)	71 %	28 %	1 %	0 %
Friends/acquaintances/family (ex management)	78 %	18 %	4 %	0 %
Banks and financial institutions	99 %	1 %	0 %	0 %

Source: Start-up survey

About two thirds of the firms reported in the survey that new owners have entered after the start-up. The most common entrance for new owners is through issue of new shares. Taking over existing shares is less common.

5.4.2 Loan financing

Loan financing amounts to a small share of the total capital injection in the FORNY start-ups. Long term debt in 2007 amounted to only 142 million NOK. These figures are based on the firms' balance sheets. Information from the survey supports the limited role of loan financing. It is important to notice that a few firms hold most of the debt. The five firms with most debt accounted for 50 percent of all long term debt among the start-ups.

Public institutions play an important role among providers of loans. The firms report public institutions, like Innovation Norway, as the most common loan financer, followed by the entrepreneurs, active ownership funds and the TTOs. Two out of the four most important loan providers are government institutions.

Table 5.10 Firms that have received debt funding from alternative sources (Share of firms)

Issuer of loan	Share of firms (%)
Public institutions (Innovation Norway, etc)	33
Entrepreneurs	28
Active ownership funds (Seed fund / Venture fund)	28
TTO	25
Other firms (ex fund and financial actors)	22
Banks and financial institutions	17
Others	8
Friends/acquaintances/family (ex management)	3
University /college /research institutes/hospitals	0

5.4.3 Public financing

A more thorough and detailed discussion of public financing is delayed to Chapter 7, dealing with public sector instruments directed towards innovations and commercialisation from

universities etc. Here, we briefly comment on the total figures as outlined in figure 5.4. In our mapping of capital supply, we have covered capital transfers from the R&D incentive scheme skatteFUNN and alternative capital instruments transferred through Innovation Norway. In addition, some smaller funds are channelled to these firms through other public sector agencies, like SIVA, the municipalities and counties. In total, the FORNY start-ups have received public sector transfers amounting to 700 million NOK during the period 2000-2007. This accounts for more than 60 percent of all capital supply. If we add the fact that the FORNY-funding to a certain degree works as a subsidy to the start-ups by supplying them with valuable support function, it becomes clear that public sector funding plays a major role in the financing of start-ups with a background from universities, colleges, institutes, hospitals etc.

5.5 Active ownership

Early stage companies often lack important resources which are necessary in order to develop and commercialise their product. More specifically, such firms often do not have competencies on matters like finance, business strategy, IPR-protection, marketing, industrial networking etc. One way to solve this shortage of competence is to bring in active owners with such complementary resources. Such owners (e.g. like industrial players, venture capital and seed funds) normally take a significant ownership share and involve themselves in the firm through board representation and direct interaction with the management.

A closer look at the board composition in FORNY start-ups (see Table 5.11), the entrepreneurs are by far the most represented stakeholder in the board of FORNY start-ups, followed by the TTO and private investors (business angles). In addition to the TTO, the list of board members is dominated by typically active owners. More than 30 percent of the start-ups have private investors on the board. Moreover, around 20 percent have venture and seed funds on the board.

Table 5.11 Representatives in the FORNY-firms board

Represents in the firm's board	%
Entrepreneurs	76
TTO	40
Private investors (business angels)	31
Other companies	26
Venture capital funds	21
Seed funds	18
Management consultants / Lawyers	15
Family and friends	13
Customers	7
Governmental financing system	6
Suppliers	1

As many as 57 percent of the FORNY start-ups reported that active owners have bought shares in the firm since after the start-up. However, most other owners also enter early. of these new owners enter the firms at an early stage. Table 5.10 gives an overview of the entry time for different owners. Naturally, entrepreneurs and the TTOs take ownership first. But other owners also enter early. To a certain degree, Friends and family in addition to the management appear to enter as owners at later stages. The more institutional players seem more reluctant to take ownership in later stages.

Table 5.12 Entrance of owners by years after FORNY.

	No	Number of years after FORNY			
Owners	**owner**	**0-1**	**2-3**	**3-5**	**> 5**
Entrepreneurs	21 %	62 %	7 %	9 %	1 %
TTO	62 %	29 %	6 %	3 %	0 %
Management (ex entrepreneurs)	69 %	24 %	3 %	4 %	0 %
Active ownership fund (Seed/Venture funds)	74 %	22 %	0 %	4 %	0 %
Others	79 %	15 %	1 %	3 %	1 %
Other firms (ex fund and financial actors)	82 %	15 %	1 %	1 %	0 %
Friends/acquaintances/family	79 %	10 %	4 %	6 %	0 %
University /collage /institute/hospital/	88 %	7 %	0 %	3 %	1 %
Banks and financial institutions	96 %	4 %	0 %	0 %	0 %

Source: Start-up survey and register data

5.6 Concluding remarks

Since 1996, the FORNY programme has generated approximately 300 start-ups. Today, these firms report a total of 900 MNOK in turnover and an employment of approximately 700. Yet these figures are strongly dominated by a few large companies like Opera Software. The median firm turnover is around one million and its value added and employment is close to zero NOK and one employee respectively.

We have shown that approximately five percent of the firms display patterns that are consistent with a high growth path and a strong future potential for employment and value added contribution (so called higher degree commercialisations). Notice, that these higher degree commercialisations do not represent successful cases per se, but rather potential cases. In this perspective, the figures are low. This is especially so if we compare the figures on start-ups produced in TTOs in other countries, as outlined in chapters 3.2 and 3.3.

This does however not imply that the number of firm closures is high among these start-ups. On the contrary, the survival rate is over 90 percent each year. We find reason to claim that this pattern is driven by the fact that the vast majority of these start-ups remain small firms with limited or no activity. One should thus ask whether this development is consistent with the objectives of the FORNY-programme.

A closer look at commercialisations at the TTO level reveals that the successful start-ups are found in the older TTOs that have a large number of start-ups. This comes as no surprise as commercialisation takes time. However, we also find that the newer TTOs tend to have a

smaller share of start-ups with no commercial revenues at all. This may signal a strategy shift where start-ups are related to projects with a shorter road to commercialization. This is probably not the case for the TTOs focusing on the biotech and life science industries.

Technology and R&D intensive start-ups face a long period of high and climbing costs before reaching a phase where commercialization yields revenues and finally profits. In light of this pattern, using value added as a success criterion is inappropriate. FORNY start-ups should actually not report too high value added figures as that may signal low willingness to invest during the first years. The most relevant performance measure when studying early stage firms is sales or output growth.

We have shown that the vast majority of FORNY start-ups have received very limited amounts of capital. Clearly, many of the start-ups should not receive capital as the projects turn out to be commercially unsuccessful, yet the share of firms that actually receive significant amounts of capital to enable large early stage investments is surprisingly low. This may indicate that some of the potentially successful start-ups receive insufficient capital flows.

This picture is further enriched when we look at what kind of capital firms are supplied with. More than 60 percent of the capital comes through public sector channels, mostly in the form of transfers. Not surprisingly, loan capital plays a moderate role in financing early stage firms like the FORNY start-ups. Supply of equity capital is surprisingly limited when we look at the start-ups after some years. Most capital is raised in the very first years after establishment. The need for additional capital is rather growing over time. Hence a pattern with low capital supply in the later stages may constitute a problem. We return to results that support this finding in chapter 7.

6 Results from a survey of FORNY start-ups and licence agreements

This chapter provides an insight into the role of the FORNY programme based on survey data collected from spin-off firms, developers of licensed technology and firms purchasing the licensed technology. The chapter describes the different actors in terms of firm and entrepreneur characteristics and it analyzes the FORNY programme's additionality in facilitating the entrepreneurial activities.

6.1 The sample

The evaluation focuses on firms and license agreements registered from 2001 and onwards which were described in the previous chapter. Three questionnaires were sent by e-mail to the respective groups of respondents in January 2009.

Table 6.1 lists the population, number of firms and licenses where we had contact information and number of respective responses. In the last columns response rates are calculated from the population number and number of contacts. In addition, it should be noted that some licensers had issued several licenses, and also that some firms held several licenses. This made fewer unique contacts, and calculated from these, the surveys received 53, 50 and 47 per cent responses.

Table 6.1 Population number, contact information and response rates.

				Responses as % of		
	Popula-tion	Contact information	Responses	Population	Reached sample	Unique contacts
Survey spin-off firms	158	138	72	45,6%	52,2 %	53,3 %
Survey licensers	79	56	21	26,6%	37,5 %	50,0 %
Survey licensees	79	48	16	20,3%	33,3 %	47,1 %

The entire population of firms, licensers and licensees were registered by FORNY. However, the lists were not complete in terms of e-mail addresses, and consequently, the questionnaire did not reach out to the entire population. The analysis of differences between responding and non-responding firms showed that responding firms are significantly younger than non-responding firms. This may partly be a result of difficulties in finding relevant contact information to respondents in firms established several years ago. Further, it is tested for differences concerning industrial sector, size of the firms in terms of invested capital, total sale, or number of employees. No significant differences were found on these variables.

Table 6.2 presents the population numbers and responses in the respective surveys. The table is specified for each technology transfer office (TTO). The total number of start-ups and licensing agreements summarized by TTOs were presented in Table 5.2.

Table 6.2 Total number of firms and licenses. Response rate calculations by TTO.

TTO	Spin-off firms			Licensers			Licensees	
	Sample size	Responded	Response rate (%)	Sample size	Responded	Response rate (%)	Responded	Response rate (%)
Bioparken	15	3	20	10	2	20	-	0
Birkeland	5	5	100	10	4	40	3	30
Campus Kjeller	22	14	63	15	2	13	-	0
Coventure	11	7	63	-	-	-	-	-
FORNY Rogaland	16	4	25	2	-	0	-	0
FORNY West	14	5	36	14	5	36	4	29
Oslo Innovation Centre	13	3	23	3	-	0	-	0
LEN	30	9	30	11	4	36	3	27
Medinnova/BMI	4	2	50	4	3	75	3	75
Norinnova	14	10	71	4	1	25	2	50
NTNU Technology transfer	11	9	82	6	-	0	1	17
Sinvent	3	1	33	-	--	-	-	-
Sum	158	72	46	79	21	27	16	20

Table 6.2 shows the number of listed FORNY firms and licenses started or registered since 2001. LEN and Campus Kjeller were the TTOs that have contributed to most spin-off firms, while Campus Kjeller together with FORNY West had produced most licenses. The number of survey responses partly corresponded to the population although discrepancies were found. All firms from Birkeland have answered the questionnaire, while only a small percentage of firms from Bioparken, FORNY Rogaland and Oslo Innovation Centre have answered. Together it produced an unequal distribution of responding firms, licensers and licensees from the different TTOs.

The following sections are devoted to spin-off firms, licensers and licensees. Each section starts with a brief description of the respondents. Then, spin-off firms and technologies behind the licences are depicted. Each section contains also an analysis of additionality. The sections conclude with a short summary. The conclusions on the overall role of TTOs are presented in the end of the chapter.

6.2 Spin-off firms

The survey to spin-off firms was directed to the founder of the business, or its present leader. It was not always possible to reach the founder or present CEO, and others as well have answered the questionnaire. Figure 6.1 gives an overview of the respondents'roles in the business in question.

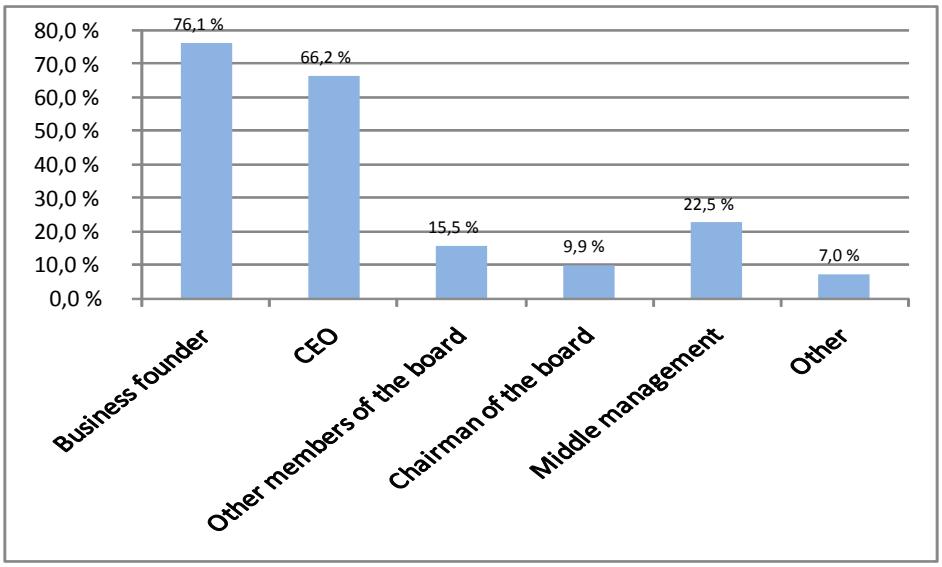


Figure 6.1 The role of a respondent in a spin-off firm. Multiple responses permitted (n=71).

The respondent was in most cases the business founder (76 per cent) and/or the present CEO (66 per cent). This shows that the founder and present CEO is one and the same person in a large number of firms (42 per cent). Others who have answered the questionnaire are middle managers, chairman of the board, or other members of the board.

Table 6.3 gives more information about the respondents. Most respondents were men (90 per cent). Male in the sample reported more entrepreneurial experience than female. While the amount of total labour experience was almost identical for male and female respondents, the former reported relatively long experience in the private sector. These data accord to the concept of gendered labour market where females are mostly occupied outside the private sector.

Table 6.3 Male and female respondents' characteristics.

	Male	Female
Have previous start-up experience	54 %	29 %
Have previously closed down a business	28 %	14 %
Mean total labour experience (years)	21,1	20,3
Mean labour experience in private sector	7,6	13,2

Since there were only 7 female respondents, further analysis was conducted without dividing the sample into two groups according to gender. Most respondents reported higher education in the technical (84 per cent) and economic (23 per cent) fields, while some had education in humanitarian (10 per cent) and/or sociological fields (4 per cent). The average respondent reported 21 years of general work experience, while average work experience in the private sector was 13 years (Table 6.4).

Table 6.4 Further respondent characteristics.

Gender	90 % men
Major types of education	Technical 84 % Economic 23 %
Average years of work experience	In total 21 years In the private sector 13 years
Previous business start-up experience	51 %
Previously closed down a business	27 %
Took part in the R&D that led to the start-up	76 %

Interestingly, we found that a majority of 51 per cent of the respondents had previous business start-up experience. A closer look at the subcategories showed that 53 per cent of those reporting themselves as founders of the business had previous start-up experience. This indicates at least serial entrepreneurs and possibly portfolio entrepreneurs. A follow up question showed that 27 per cent (24 per cent of founders) had previously closed down a business. Although the latter did not include those who had sold the business, the data indicates that we find several portfolio entrepreneurs in our sample.

6.2.1 Technology and industries

The spin-off firms are as expected placed within knowledge intensive industries. Spin-offs within information and communication technology is most frequent (43,7 per cent). Then follows biotechnology and energy/environment (both 16,9 per cent), and maritime and medtech/biomedicine (both 15,5 per cent). These results should however be seen in relation to the number of responses from the respective TTOs. The units are linked to universities and major R&D institutions which predominately produce technologies related to specific industries. This point is also shown by the firms' strong technological linkage to the research community the firms have spun out of (see Figure 6.2).

The far most important sources of the technological ideas behind the spin-offs were the research in the institutions where the spin-off was initiated. 63 per cent of the respondents reported that the firm's technology to a large extent has originated from this source. Next, the founder's industrial experience is important. This can also be seen in relation to the founders' previous start-up experience (reported in Table 6.2), although only 12 per cent of the respondents reported that previous start-up experience itself had major importance.

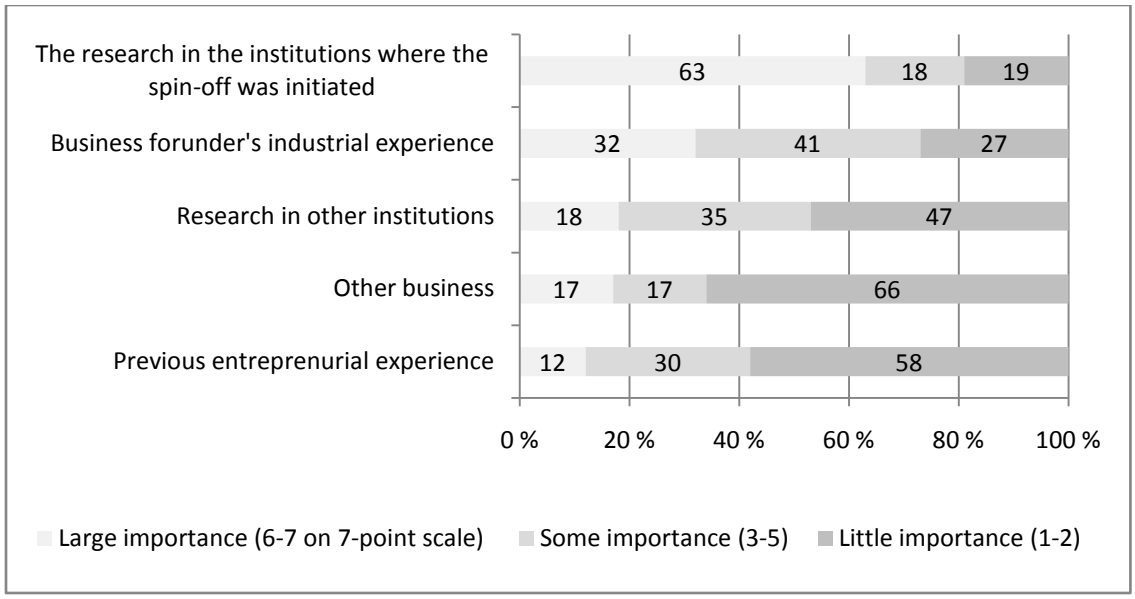


Figure 6.2 The source to the firm's technology.

6.2.2 Innovation

The firms under scrutiny demonstrated highly innovative orientation. 80 per cent of the firms have invested in R&D the last 24 months. This is also expected due to the category of start-ups in question. The R&D investments have mainly been channelled to product development as shown in Figure 6.3.

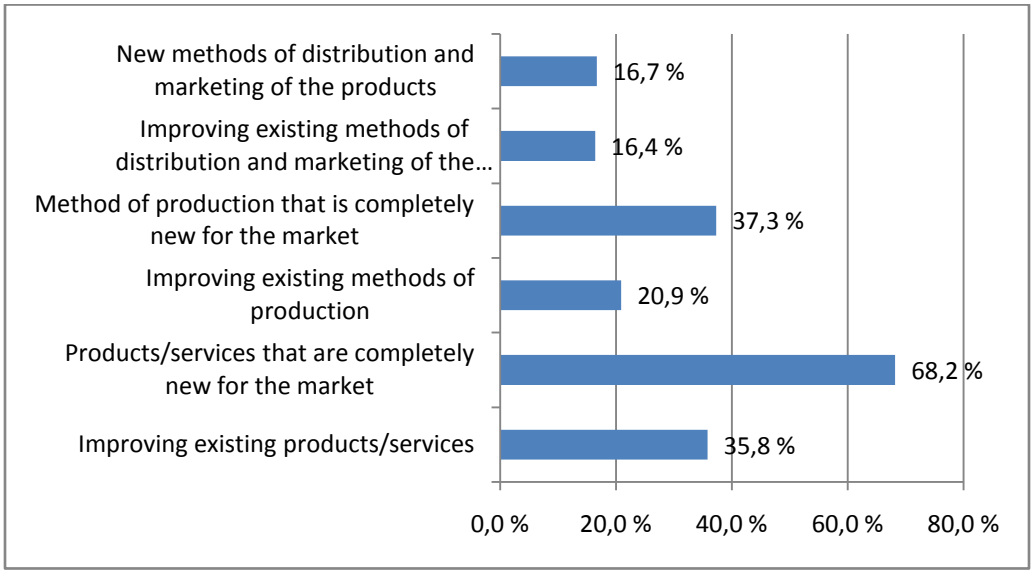


Figure 6.3 Areas of innovation.

The surveyed firms introduced products/services that were completely new to the market (68,2 per cent), completely new methods of production (37,3 per cent) or improved existing

products (35,8 per cent). To a less extent the firms focused on innovations in distribution and marketing of the products.

Commercialisation of R&D results is promoted because it is expected to bring innovations into markets and thereby to contribute importantly to economic wealth creation. This is due to the expected high degree of innovativeness in R&D spin-offs. As demonstrated by Figure 6.4, the technologies behind the spin-offs were described by respondents as highly innovative. 80 – 90 per cent agree that their technology is innovative and generates new product ideas that are novel to the industry. 71 per cent agree that their technology is path-breaking and challenges existing technology and competitors.

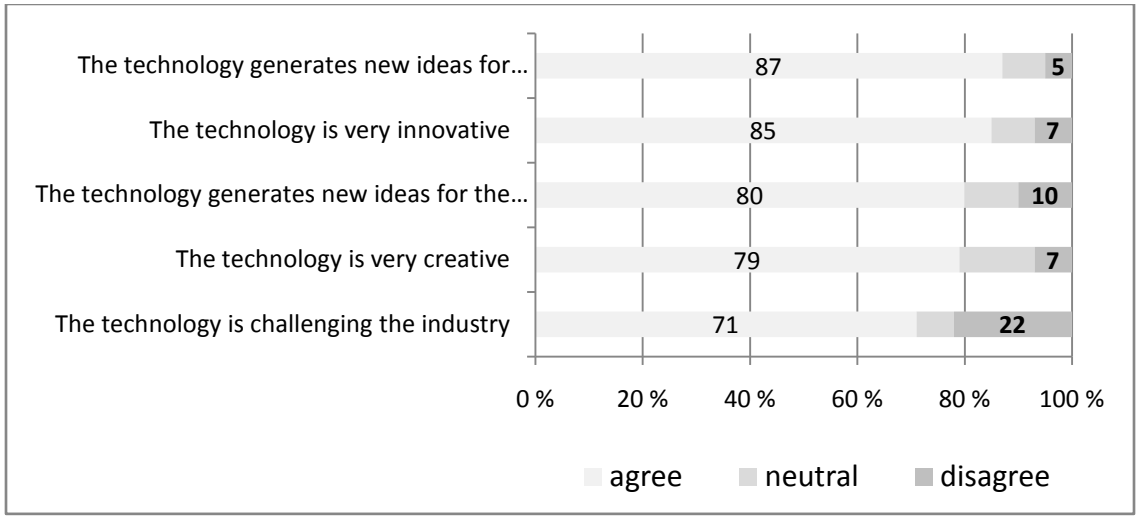


Figure 6.4 Degree of innovation.

Section 5.2.1 categorised the firms according to different degrees of commercialisation defined in terms of turnover. On the expectation that higher degrees of innovation would also result in higher turnover, a comparison of the degree of innovation is made between lower degree commercialisations and remaining firms (which never exceeded 500 000 NOK in annual turnover). This shows that lower degree commercialisations are not significantly different from the remaining firms in perceived degree of innovation. Concerning the higher degree commercialisations, the survey received only 4 responses from this group. Hence, no statistical calculations are possible to compare this group of firms with the other.

In order to protect their competitive edge, 70 per cent of the firms reported that they tried to keep their innovation secret from competitors. About 65 per cent have applied for patent protection, or think that being ahead of competitors contribute to maintain their competitiveness. 40 per cent reported that complexity helped to protect their technology form being copied. As we know that the ability to profit on innovations is an important motivation, and it is necessity for R&D investments, the means to protect innovations become crucial. Out of the means reported above, only patenting represents a legal protection, while the others are

mere market mechanisms. On the other hand, when asked if the firm's products or services had been exposed to copying, only 10 per cent confirmed to this and reported only small economic damage as a consequence of the copying.

6.2.3 Organising the venture

In this subsection we look into who contributed to technology development, and who is presently involved in the firm's management team and board. Table 6.5 compares different actors with respect to their contribution to the development of the spin-off firm. In the questionnaire the development of a firm was presented as activities related to recruitment, market analysis, financing etc. This analysis encompasses more than purely financial contribution demonstrated in the Figure 5.4 which is based on the register data.

Table 6.5 Contribution of different actors to the development of spin-off firms.

	not contributed (% of all answers)	% of those who contributed		
		little contribution (1-2)	some contribution (3-5)	very large contribution (6-7)
Business founder	3	1	13	86
Employees	11	8	21	71
TTO	16	20	37	43
Venture funds	47	26	42	32
Board of directors	14	7	62	31
Clients	33	28	40	31
Industry partners	36	34	34	31
Public support programmes	25	16	55	29
Research unit (source of technology)	24	33	39	28
Suppliers	47	55	34	11
Students	52	54	35	10
International research milieu	58	62	31	7
Other national research milieu	52	63	31	6

Among those actors who had at least some contribution to the firm development, the founder was considered to be the most important one, which to a large degree represents the respondent himself. Then follow the firm's employees. This is an expected result as the founder and possible employees are those engaged and hired to develop the firm. In addition comes the board where 86 per cent reported at least some contributions. Among external actors the TTO, public support programmes and the spin-off's research unit contributed at least to some degree (under 30 per cent in the categories of not contributing). For instance did 84 per cent of the respondents ascribe at least somewhat important role to the TTO. Of less importance were clients, industry partners and venture funds that were reported to contribute only to some extent.

Among the actors which were involved into the firm development, business founders and employees played the most important role. The third most important actor was a TTO with the count of 43 per cent in the category of very large contribution.

Focusing on the same actors it was also asked how these contributed to promote the firm's trustworthiness to investors, customers, business partners etc. The results are shown in Table 6.6.

Table 6.6 The importance of different actors for achieving trust in relationships with potential clients, investors, suppliers and industrial partners.

	Not contributed (% of all answers)	% of those who contributed		
		Little importance (1-2)	Some importance (3-5)	Large importance (6-7)
Business founder	1	2	15	83
Employees	9	5	27	67
Research milieu (source of technology)	16	7	37	56
Industrial partners	27	15	37	48
TTO	17	14	46	40
Board of directors	14	3	57	40
Clients	24	11	53	37
Public support	32	15	54	31
Venture founds	48	21	60	19
Suppliers	46	28	54	19
Other national research milieu	49	49	39	12
International research milieu	53	55	38	6
Students	52	42	54	4

Again the founder and employees are the most important. In this table the actors placed higher both play more important role and are more often involved into the process of trust establishing. The industrial partners are an exception. They are relatively rare used for gaining trust, but whenever involved, they play a very important role. Beyond that, the scientific community and the TTO are reported to play an important role. 83 per cent of the respondents considered a TTO to play at least some role for achieving trust in relationships with stakeholders, while 40 considered this role to be very important. This demonstrates an important function of the TTO, i.e. to connect and recommend the business to potential investors, customers and business partners. Being a young firm the liability of newness can be severe, in particular to this category of firms which invest heavily in R&D. Willing investors and possible business agreements with future customers are crucial to the firm's ability to invest and willingness to take the risk involved. These data suggest that the TTOs are used by the spin-off firms in order to gain additional legitimacy when dealing with other stakeholders.

Accounts of today's organisation of the ventures show that 75 per cent of the firms have management teams of more than one person, while the respondent is the sole manager in the remaining 25 per cent. There is also a continuation form the original founder or founding team to the present leadership team of the firm. Only in 6 per cent of the firms were none of the present leaders involved in starting the business. 30 per cent of the firms had all team mem-

bers continued from start-up to the present, while in the remaining firms a respondent or some other in today's leadership had been involved in the start-up.

Linked to the continuation of leadership, we have assessed the original position of those in the present leadership who were involved in the start-up. This shows to what extent the FORNY programme aid academics into a business career. Figure 6.5 shows the percentage of present management team who held different academic positions prior to the business start-up.

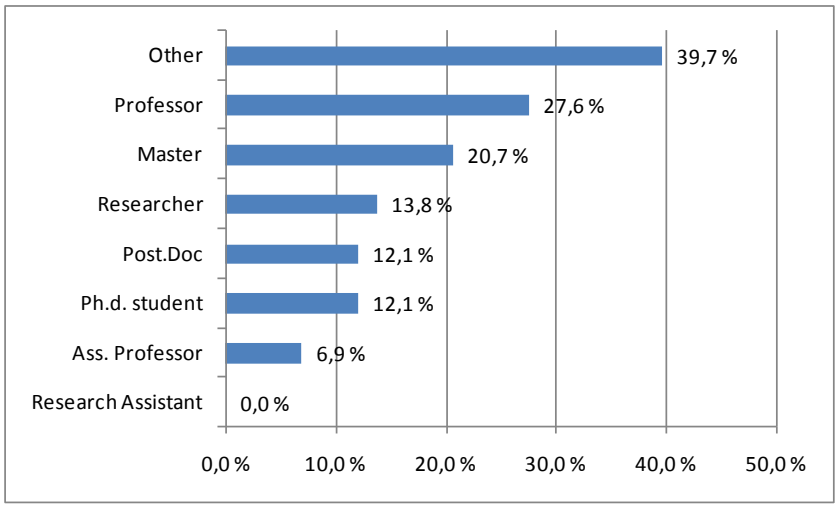


Figure 6.5 Previous academic positions among the firm's present management team. Multiple responses allowed (n=58).

The figure demonstrates some shift in career from the academic to the business sector. 43 per cent of the respondents reported that nether them no anyone in the present management team had a scientific occupation (professor, associate professor, Ph.D. student, post.doc, researcher) when the firm was started. However, "other" represents the most frequent category and shows that other than academics are pulled into the new business.

Concerning other qualifications, 91 per cent of the management teams are represented by education at master level in technical fields, while 45 per cent are represented with similar economic qualifications. 97 per cent of the firms have experienced entrepreneurs in their team.

6.2.4 Additionality

Additionality of the FORNY programme can be defined as a measure of the extent to which this public support programme has stimulated R&D commercialisation activity beyond what would have been undertaken anyway (Buisseret, Cameron, & Georghiou, 1995). Table 6.7 shows a large degree of additionality. Only 18 per cent respondents reported that the TTO had no effect on starting the firm. A moderate additionality is found for 26 per cent of the firms, while 56 per cent of the firms would not have been established or indeterminately delayed without the contribution from the TTO. The latter represents a high degree of additionality.

Table 6.7 Additionality concerning spin-off firms (n=70).

Degree of additionality	**Without the TTO, would the firm have been:**	%
Low additionality	Established with no changes; same scale and time frame	18,3
	Established in the same scale, but at a later point in time	11,3
Some degree of additionality	Established, but at a limited scale	5,6
	Established, but at a limited scale and at a later point in time	8,5
High additionality	Establishing the firm would have been indeterminately delayed	18,3
	The firm would not have been established	38,0

Spin-offs started in the Energy and Environment area revealed somewhat higher additionality compared to other industries. The respondents who had never started a business were more likely to report high degree of additionality compared to those with previous start-up experience (Table 6.8).

Table 6.8 Additionality analysed by industry and respondents' entrepreneurial experience.

	N	Degree of additionality (% of the respondents)		
		low	some	high
Industry				
Energy and Environment	11	9	27	64
Medtech/Biomedicine	11	37	18	45
Information and Communication	30	40	7	53
Maritime/Offshore	11	46	9	45
Biotechnology	12	50	8	42
Entrepreneurial experience				
Has previously started a business	36	31	22	47
Never stared a business	33	30	6	64
All respondents	70	30	14	56

As the intention with the FORNY programme is to add to the number of commercialisations, but also enhance the firms' ability to exploit their innovation and growth potential, it may be expected that a higher degree of commercialisation is followed by higher reported additionality. However, no such difference is found, which indicates that firms that obtain high growth are no more inclined to attribute this to the FORNY programme compared to firms with less growth. (This is only tested for the low degree group versus the remaining due to the low number in the high degree group.)

In addition to additionality measured for the actual start-up, scale and timeframe, it should be noted that the TTOs contribute in a number of ways. For instance, providing network contacts and legitimacy indirectly is an important contribution. The results indicate that the TTOs played an important role for the development of spin-offs.

Beyond the overall importance of the TTOs, the survey provides data on the firms' satisfaction with particular means of assistance which the TTO can provide (Figure 6.6).

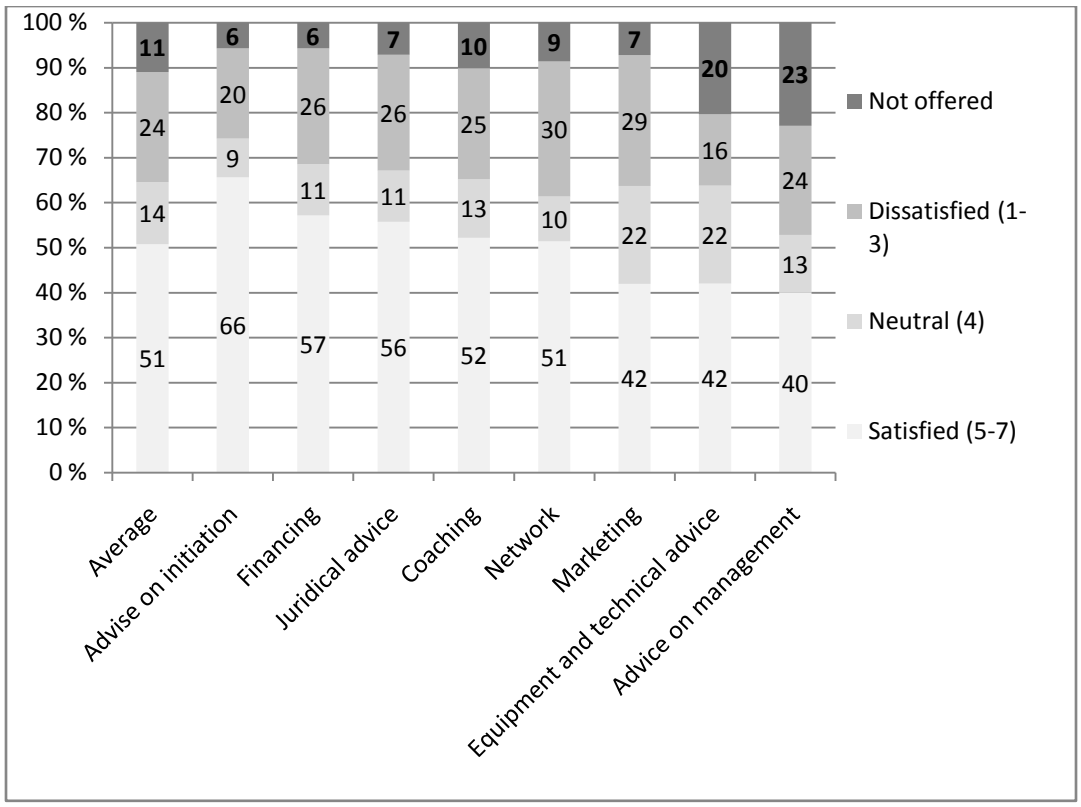


Figure 6.6 Satisfaction with a TTO: To what extent are you satisfied with different forms of support provided by the TTO?

The spin-off firms were most satisfied with advises on the early stages of the start-up process, for example business-planning and accounting. Support (or absent of support) regarding marketing and networking led to most dissatisfaction among respondents. On average 51 per cent of respondents expressed their satisfaction with the services provided by the TTOs (5-7 on the 7-point scale).

Also the questions about satisfaction with the TTOs where compared between groups with different degree of commercialisation. Neither here was it found any significant differences between the groups. This corresponds to the equal evaluation of additionality and shows that the firms perceive the TTOs' services as equally valuable to the firm independent of its degree of commercialisation.

6.3 Licensing

Data on the licensing of technologies developed with support from the FORNY programme were collected via specially designed questionnaire. The response rate was 50 per cent (21 of 42 respondents responded). This part of the report should be considered with reservations

relating to the relatively small sample size. The respondents had mainly technical education (95 per cent). Relatively large proportion of the respondents had previous entrepreneurial experience (48 per cent had previously started and 24 per cent had previously dissolved a business). The respondents reported on average 29 years of general labour experience (12 years in private sector) and 27 years of experience with research. The majority (19 of 21) respondents were men. The respondents' characteristics are reported in Table 6.9.

Table 6.9 The respondents' characteristics.

Gender	90 % men
Major types of education	Technical 95 %
Average years of work experience	In total 29 years In the private sector 12 years Research experience 27 years
Previous business start-up experience	48 %
Previously closed down a business	24 %

The characteristics of the respondents described here were to a large degree like the characteristics of the respondents from the survey on spin-offs. However, the later reported slightly less technical education and total labour experience. The significant proportion of the respondents reported some start-up experience (48 per cent) and experience with closing a business down (24 per cent).

6.3.1 Technologies behind the licenses

Seven TTOs have contributed to the development and licensing of technologies in the sample (see Table 6.2). The total number of start-ups and licensing agreements summarized by TTOs were presented in Table 5.2. 52 per cent of respondents established contact with a TTO when the technology was already fully developed. In four cases the respondents had relationships to more than one institution while developing the technology.

The technologies behind the licenses were related to the fields of medicine and biomedicine, information and communication technologies, biotechnology, materials, and energy/environment (the proportions are illustrated on Figure 6.7).

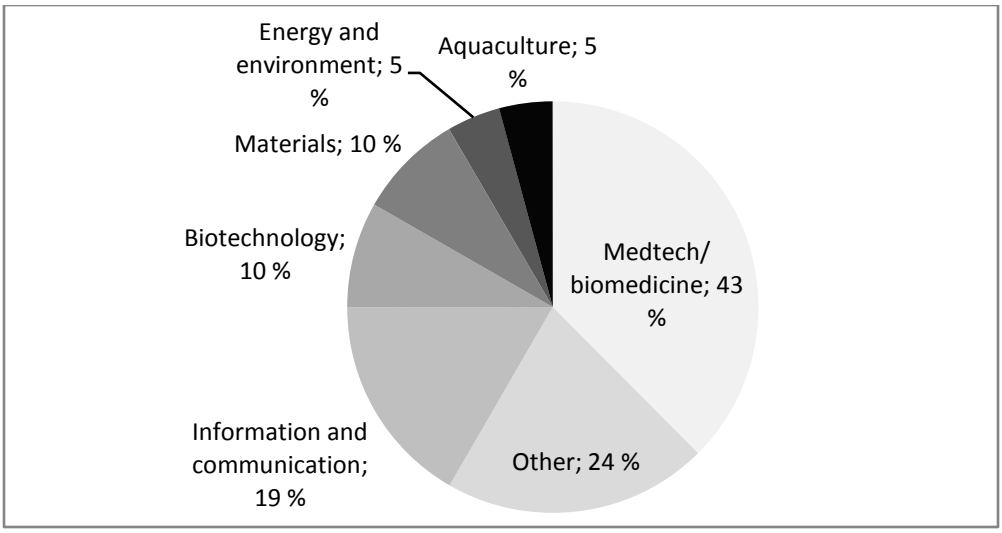


Figure 6.7 The industries relevant to the technologies behind the licenses (n=21).

Four of five technologies were reported to be the improvements of the existing technologies. 42 per cent of the technologies were categorised as being completely new for the market. Moreover, the majority of respondents describe their technologies as very innovative, challenging the existing technologies in the industry, and generating new ideas (see Figure 6.8).

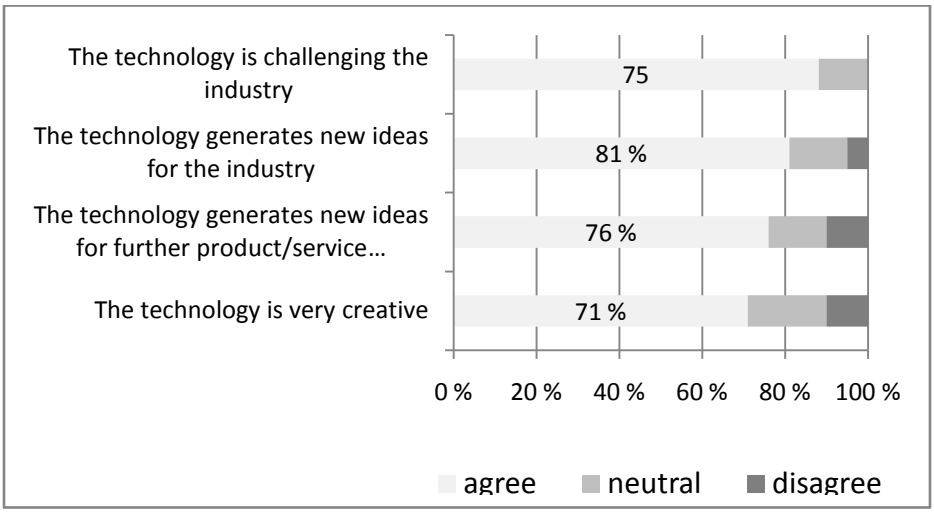


Figure 6.8 Degree of innovation for the technologies licensed.

6.3.2 The role of TTOs

80 per cent of the respondents reported that without the support form TTOs the technology would not be developed or would be developed with serious limitations (Figure 6.9). This result may be interpreted as the evidence of the important role which TTOs played.

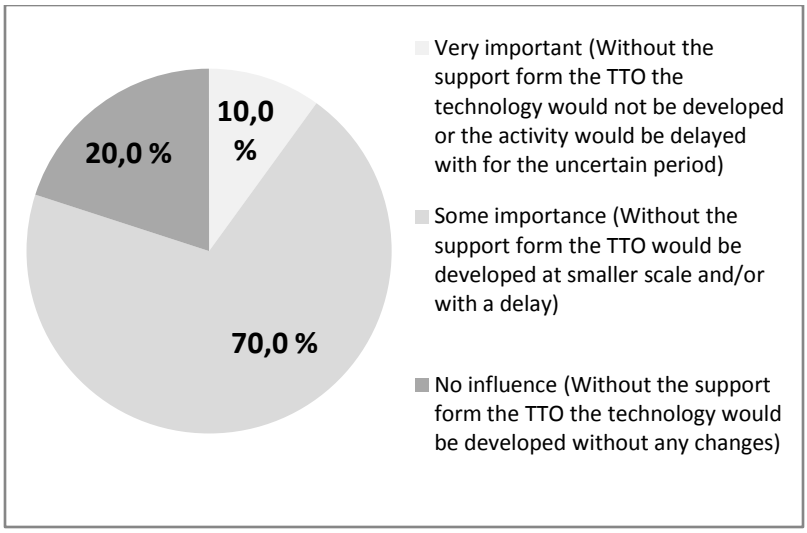


Figure 6.9 The importance of the TTO for the development of technology.

However, there are data which may cast doubt on the conclusion about the positive role of TTOs for technology development. When compared to other actors, TTOs were reported to provide very little contribution to the development of technology (see Table 6.10).

Table 6.10 The importance of different actors for the development of technology.

	Not contributed (%)	% of those who contributed		
		Of little importance	Of some importance	Very important
Business founder	0	0	0	100
Researcher's Scientific community/institution	5	22	28	49
International scientific communities	40	50	17	33
Industry partners	32	38	38	24
Other national scientific communities	44	59	21	20
Students	53	45	45	11
TTO	39	80	10	10

Scale: Little importance 1-2; Some importance 3-5; Very important 6-7.

When considering the process of licensing, 43 per cent of the respondents reported that the TTOs had no positive influence. At the same time, 28,5 per cent of the licenses would not be accomplished (at least in the foreseeable future) without the support from TTOs.

6.4 Purchasing technology

16 of 34 buyers of technologies developed with the support from a TTO responded to the questionnaire e-mailed (47 per cent response rate). The modest number of cases does not allow conducting any profound quantitative analysis. However, this section presents some trends that were observed.

One of four firms purchasing technologies was foreign-owned. Four of five firms have been currently using a technology developed with the support from a TTO. A relatively large proportion of respondents reported that the technology was important (31 per cent) or very important (38 per cent) for the firm's R&D. Over half of the respondents considered the technology to play an important role for the development of the firm's most important products/services. One of three respondents reported that the technology constituted a major part of the company's sale. The technology was usually purchased in order to introduce a new product/service on the market or to improve the existing product/service. It was relatively seldom used in order to introduce and improve production, storage or distribution methods. 31 per cent of the respondents evaluated the TTO's role as "extremely important". Moreover, 75 per cent of the respondents assigned scores of four or higher (on 7-point scale) to the role of a TTO. The survey also reviled that the firms purchasing technology often had relationships with the research unit both before and after the purchase. The majority of the firms would even recommend other companies to develop licence agreements with the research unit known to them.

6.5 Conclusions

The survey data suggest that the firms and licenses which were developed with support from the FORNY programme were research-based and innovative. The spin-off firms and licenses were mostly related to such knowledge-intensive industries as information and communication, medicine and biotechnology. Moreover, the surveyed firms demonstrated highly innovative orientation. The majority of these firms were involved into R&D activities. The licensees described the relevant technologies as highly innovative, challenging the existing technologies in the industry, and generating new ideas. Thus, the FORNY programme contributed to the activities which it was intended to add to.

The scope of the FORNY program's contribution may be assessed in terms of additionality. The majority of the spin-off firms surveyed stated that their firm would not be started or the establishment would be delayed for uncertain period without support from a TTO. Moreover, TTOs added significantly to the scale and efficiency of the spin-off activities. These data suggest the high level of project additionality.

The data also suggest that the impact of a TTO is largest at the beginning stage of the spin-off process. The TTO successfully contribute to bridging the gap between academic research and start-up. However, the satisfaction with TTO's role decreases when the spin-off firm gains momentum. Different technical questions, practical marketing and management are the areas where TTOs provided most disappointing advices.

The positive role of TTOs is not restricted with the direct impact on the start-up process. It is also observed that a TTO provides additional trust in relationships between the parts involved in to the commercialisation process.

When considering the role of TTOs for licensing, the results are mixed. On one hand, both sellers and buyers of licenses indicated the important role which TTOs played. Without this support, the majority of licences would not be developed within any foreseeable time frames. On the other hand, when compared to other actors, TTOs were reported to provide very little contribution to the development of technology. This ambiguity may be an artefact of the questionnaire design. There is also an alternative explanation. The respondents may over-emphasise the effects of a TTO because they are generally interested in the continuation of public support. However, when comparing the effect of a TTO to one's own contribution, the respondents may over-emphasise their own role in the process of technology development.

7 The FORNY programme in interaction with other policy programmes

This chapter provides an overview of public policy programmes designed to aid the process leading to new business formation. This includes new business based on R&D results, i.e. commercialisation of R&D either within existing firms or by new start-ups. Among earlier reports focusing on the interaction between policy programmes supporting business start-up and early growth we find Clausen et al. (2007) and Rasmussen et al. (2007). The FORNY programme is one in a line of policy measures available to entrepreneurs. First, we demonstrate the FORNY programme's interaction with other programmes by picturing the entrepreneurial process and linking each programme to its target phase in this process. Second, data is presented that shows the extent of support that firms, which are supported by the FORNY-programme, also receive from other support programmes. This has been calculated in particular for funding through Innovation Norway's programmes and Skattefunn, while no data is available for the FORNY firms' allowances from research programmes in the RCN. Based on these findings we finally discuss the FORNY-programme in relation to other programmes. We also discuss challenges to the entire policy regime in effectively adding to entrepreneurial intentions, innovations, firm formations and growth.

7.1 Actors and programmes supporting the entrepreneurial process

In Norway, there is a large number of policy programmes designed to support innovation and entrepreneurship. These are operated by several actors, are directed towards different phases in the entrepreneurial process, and serve different functions such as providing infrastructure, entrepreneurial education or financial support. The overview here is not complete, with respect to the entire range of policy programmes, but presents major programmes which in particular target R&D based start-ups and entrepreneurs.

7.1.1 Policies throughout the entrepreneurial process

An active policy for enhancing entrepreneurship needs to pay attention to the entire chain of events leading a person or a firm to start and develop new business activity. This chain of events includes the entrepreneurial process, which starts with the identification of an entrepreneurial opportunity, and ends with a going business. However, a policy scheme also needs to consider the phase prior to opportunity identification. How can more people be mobilized to attend entrepreneurial activity? Likewise, there might be a need for policies to increase survival chances and exploit growth potentials of new firms.

Mobilisation for entrepreneurial activity may be a prerequisite for the effect of other policy programmes. In general, entrepreneurship is seen as the combination of an entrepreneurial opportunity and an enterprising individual (Eckhardt & Shane, 2003). Hence, policies for increasing peoples' intentions of becoming entrepreneurs can produce more enterprising individuals. Next, policy programmes may aid nascent entrepreneurs to discover new business ideas. Also social resources may be mobilized, i.e. to create a social environment that is more ready to receive entrepreneurs and new ideas, and are willing to support their activities. Pro-

grammes designed to mobilize for more entrepreneurship are often broad and general in its aim in order to hit yet unidentified entrepreneurs and facilitate an entrepreneurial environment.

Policies aimed at the business start-up stage may identify and target nascent entrepreneurs, and provide them with deficient resources. Nascent entrepreneurs can be hampered by lack of knowledge and experience, network contacts and financial resources. Hence, training programmes, developing infrastructure that gives the entrepreneur access to networks, and providing financial support, are emphasized at this stage.

Policies to support development and growth of new businesses may increase the chance that the business survive and create future value. As such, policies at this stage may increase the value of all policy programmes supporting entrepreneurship. A large number of start-ups fail within the first years of operation, and a number of factors influence survival chances (Brüderl, Preisendörfer, & Ziegler, 1992). Policies that target this stage attempts to increase the chance that new firms survive by mitigating liabilities of smallness and newness. To provide financial resources is particularly important in order to exploit the firm's growth potential.

A process perspective can be useful in order to review policy programmes and interactions between programmes. This may identify whether the overall policy scheme covers the crucial areas where public support is beneficial, or whether there are gaps that make barriers to entrepreneurs and reduce the effect of other policy programmes.

7.1.2 National actors' domains

There are in particular three public actors engaged as operators of policy programmes targeting the entrepreneurial process. These actors are specialized in different domains, although some overlap exists.

Innovation Norway (IN). INs basic domain is provision of entrepreneur and firm-specific support. This includes programmes for entrepreneurial training, financial support and networking activities. IN also targets special groups such as women entrepreneurs and young entrepreneurs.

The Industrial Development Corporation of Norway (SIVA). SIVAs special domain is development of infrastructure that can support entrepreneurs and new firms. Historically SIVA established hard infrastructure where buildings were the major asset, and the organization has interests in a number of science- and industrial parks around the country. Now, SIVA has moved more towards providing soft infrastructure, which is knowledge networks linked to their physical infrastructure.

The Research council of Norway (RCN). RCNs interest in the entrepreneurial process is predominately linked to promoting R&D based commercialization. A large proportion of publicly

funded research in Norway is channelled through the RCN. One objective is to connect the research domain with the business domain in order to see more business-driven research as well as research-driven business development. Linked to this objective RCN both support development of infrastructure and provide firm-specific support to start-ups based on R&D results, as is the case with the FORNY programme. In addition the RCN fund research initiated and driven by existing firms, either undertaken by the firm itself or by R&D institutions in partnership with the firm. Finally, there is funding of research initiated and driven by research institutions while business partners are involved to enhance the usefulness of the research to the business sector.

Figure 7.1 below presents a number of policy programmes for entrepreneurship. It is distinguished between three phases: mobilisation, start-up and growth. Innovation Norway operates a large number of programmes. These are listed to the left in the figure, while other programmes are listed to the right. In the subsections that follow the most important programmes which interacts with the FORNY programme are described.

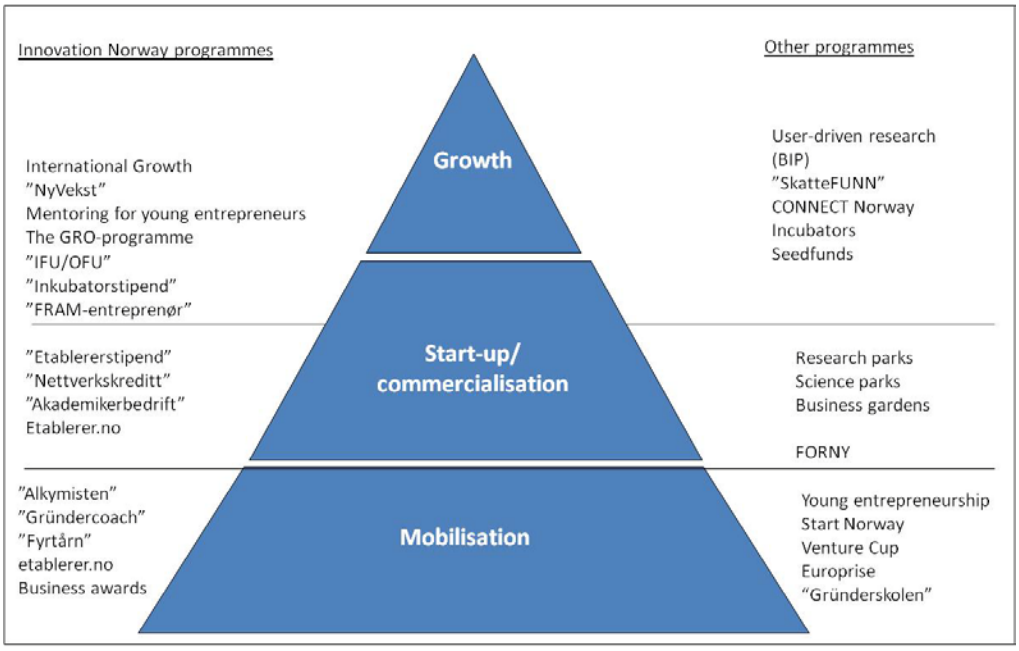


Figure 7.1 Policy programmes for entrepreneurial mobilisation, start-up and growth.

7.1.3 Policy programmes for mobilisation

There are a number of activities and programmes designed to mobilize for increased entrepreneurial activity. Many programmes target special groups, and to inspire young people towards and entrepreneurial career is emphasized in several programmes. "Ungt entreprenørskap" is a foundation based on the principles of the international JA-YE (Junior Achievement – Young Enterprise), and support entrepreneurial education and training at all educational levels from

elementary school to universities. Pedagogical programmes are provided where students learn about the business sector and become engaged in activities of starting new business.

Another initiative is “Start Norway”, which is a non-profit student organization that promotes the entrepreneurial mindset among students. The organization has branches in 15 universities and university colleges around the country. Start Norway manages the Venture Cup, which is a competition among students in making the best business plan. This is a process where students are inspired to develop business ideas into ready business plans under the supervision of experienced entrepreneurs or public agents.

“Gründerskolen” is an educational programme where all universities and several university colleges in Norway cooperate. The University in Oslo is coordinator of the programme that gives 30 study credits for an education in entrepreneurship. The programme includes a study period abroad where the students gain experience by working with business development in a technology-based start-up in addition to university courses.

Innovation Norway also provides several programmes for inspiring an entrepreneurial career. For young people “Alkymisten” offers knowledge-based support in the process of taking an idea towards a business plan and potential start-up. “Fyrtårn” is a programme targeting women entrepreneurs. The programme combines advanced training for successful entrepreneurs with inspiration and mentoring of women on the step into an entrepreneurial career as the experienced entrepreneurs entering the programme also agree to become a mentor. As a resource to anyone interested in becoming an entrepreneur, www.etablerer.no offers online information, training and planning tools. On this web page you can join discussion groups with fellow entrepreneurs, or you can individually go through an online training programme.

The FORNY programme supports the mobilisation phase by its infrastructure means. This is part of the FORNY funding (see table 4.2) which is dedicated to promote an entrepreneurial understanding and culture within academic communities. Hence, this funding is linked to the pre-stage of the commercialization process – its objectives are to promote entrepreneurial intentions, which can later lead to commercialization if and when business opportunities arise.

7.1.4 Policy programmes for start-up

At the stage when an entrepreneur is in the process of developing a business idea and starting a business there are two sets of policy programmes. First, there are programmes supporting the entrepreneur with financial and knowledge resources. Second, there are programmes concerned about establishing an entrepreneurial environment that attracts and support entrepreneurs with network resources.

Programmes operated by Innovation Norway:

“Etablererstipend” is a programme that gives financial support to entrepreneurs in a start-up process. The programme divides the start-up process in a development phase and a start-up

phase. The development phase includes activities prior to a start-up decision, while the start-up phase includes activities between the decision to start a new business and the actual start-up. The programme can support direct costs and the entrepreneur's living expenses.

"Inkubatorstipend" is a stipend IN offers to firms located in an incubator. This can be an incubator financed by SIVA (see below) or other incubators approved by IN. Like the "Etablerer-stipend" this stipend separately finances a development phase and a start-up phase. The programme emphasizes knowledge based start-ups with high innovation and growth potential.

"Akademikerbedrift" is a programme for women entrepreneurs from academic institutions, in particular social sciences, who want to start their own business based on their professional knowledge. The programme provides office facilities and requires that the entrepreneur becomes part of a professional environment. Participants in the programme are given access to microcredit networks and entrepreneurial training programmes.

In addition to microcredit networks Innovation Norway also finances coaching of entrepreneur groups (Gründergrupper). This is an offer to single entrepreneurs who can benefit from networking with other entrepreneurs. The coaches help the groups to function more effectively as a network resource for the participants.

The infrastructure programmes are SIVAs domain. SIVA contributes to the financing of research parks and science parks located by the universities and university colleges. These are innovation companies that facilitate for innovation and entrepreneurship in the realm of the academic institutions. In addition the close linkage to the university colleges, it is emphasized that research and science parks bridge the gap between the academic and business sectors.

In the start-up phase the FORNY programmes for commercialisation and verification are relevant. This funding represent the major part of the FORNY programme, and finances the start-up process of firms based on R&D results. In comparison to other policy programmes supporting this stage, the commercialisation means in FORNY finances the commercialization agents rather than individual entrepreneurs.

7.1.5 Policy programmes for firm growth

A number of policy programmes are designed to support young firms, and a registered business is often a criterion for being considered. The incubator programme operated by SIVA target innovative and growth oriented start-ups. The incubators have a special focus on providing soft infrastructure in order to aid innovation processes and market launch nationally or internationally. The incubators are located at the research and science parks, but do also distribute their services to firms outside the parks, individually or through cooperation with regional business gardens.

IN is responsible for establishing regional seed funds of minimum 250 million NOK that can invest in promising start-ups. R&D based new firms that needs product and market development investments are in particular need for seed money. IN partly finances seed funds by

lending up to 70 percent of the capital, while it is required that private investors invest at least 30 percent of the funds' total capital in terms of equity.

"IFU/OFU" are industrial and public R&D contracts respectively. These are contracts between SMEs as suppliers and large companies or public agencies investing in new technology. The contract implies cooperation which gives the R&D project stable conditions and removes risk from the small, possibly new firm trying to commercialize R&D results. IN, as operator of the programme, helps to establish the contracts, and provide financing in order to take some of the risk involved with the R&D project.

"SkatteFUNN" is a programme for supporting R&D investments. The programme is operated in cooperation between RCN, IN and the Inland Revenue service. Through the programme firms obtain a tax relief worth 20 percent of their R&D costs. Firms without taxable profits receive equal amount as direct payments. The latter is of particular interest to young firms with heavy R&D investments.

User-driven Research based Innovation (BIA) is a RCN programme supporting R&D projects initiated by R&D intensive companies in a broad spectre of industries. It is required high quality research with an international perspective. With its profile the programme contributes to more R&D investments and takes risks in high profile projects.

In addition to user-driven research through the BIA programme, the RCN funds user-driven research in a number of other relevant programmes as "User-driven innovation projects" (BIP). Through BIP projects Norwegian companies can receive support amounting to 50 per cent of project costs. This allow for expenses in the firm's own R&D department or contracts with external R&D partners.

The FORNY programme is not focusing on the growth phase as TTOs are expected to finalise their engagement in the start-ups at this stage. Nevertheless, the nature of commercialisations based on R&D results often requires extensive funding at this stage.

7.2 FORNY start-ups and public sector grants and loans

In chapter 5, we briefly touched upon the role of the government programmes in financing the development of FORNY start-ups, outside the FORNY-programme itself. We showed that more than 60 percent of the capital made available to these firms came from public sector sources. Here, we look closer at the composition of these public sources and how they interact with each other.

The FORNY start-ups have been granted approximately 700 million NOK through support schemes from IN and RCN during the period 2000-2007. As shown in Figure 5.4, around 300 mill. NOK came from IN while close to 400 mill. NOK was channelled through the SkatteFUNN programme of RCN.

We have not been able to collect micro data for the whole FORNY start-up population on RCN R&D grants, support through municipalities and counties as well as grants and loans received from SIVA. On this background, start-ups were asked through the start-up survey to identify their public sector financial sources. Figure 7.2 below shows that only one out of four firms was awarded funds from the municipality and counties. We therefore expect that the role of such funds is limited.

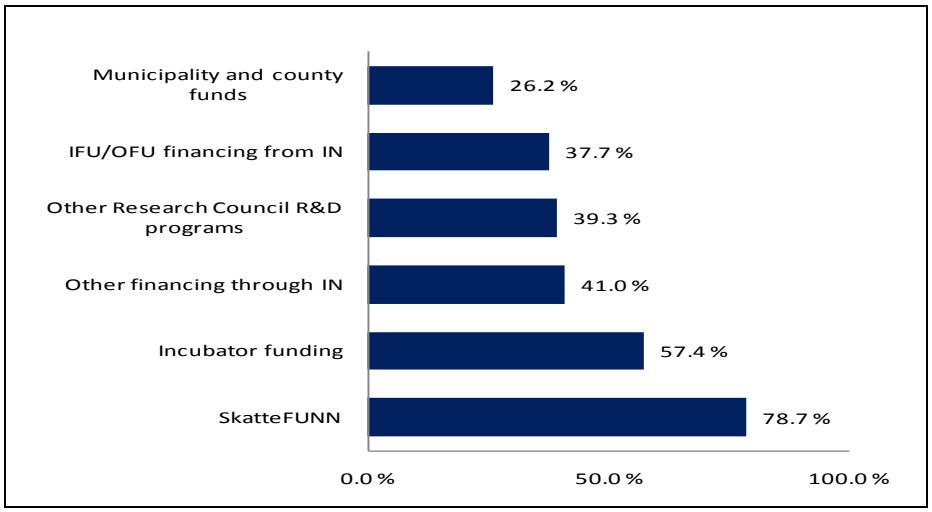


Figure 7.2 Share of FORNY start-ups that report receiving funding from alternative sources

Close to 40 percent of the start-ups have received funding through RCN R&D programmes outside the FORNY programme, through e.g. BIAs and BIPs. Such grants vary widely in size and scope, yet since the start-ups derive from R&D intensive university and college institutions, there is good reason to expect that this source sums to significant amounts. On the other hand, the share of start-ups that have received such funding is relatively low considering that FORNY start-ups are almost exclusively R&D driven projects from universities and colleges.

Close to 80 percent of the start-ups included in the survey reported that they have been granted R&D tax reliefs through the SkatteFUNN scheme. However, in the total population of FORNY start-ups only 65 percent (188 out of 297 in Table 7A) were covered by this scheme. The difference is probably related to the fact that SkatteFUNN was introduced in 2002, and the survey is slightly biased towards including newer start-ups.

When we look at all the programmes administered through IN, approximately 60 percent (180 out of 297) of the FORNY start-ups were awarded such grants and loans. In table 7.1, we also show that 50 percent of the start-ups received support from both IN and skatteFUNN, while 25 percent received no support at all. We come back to this latter group below.

Table 7.1 Number of firms awarded grants, loans and tax reliefs from IN and RCN.

Awarded		Skattefunn		
		Yes	No	Total
Innovation Norway grants and loans	Yes	146	34	180
	No	42	75	117
	Total	188	109	297

There is a clear pattern showing that FORNY start-ups receiving grants from IN are also awarded tax reliefs through SkatteFUNN. The correlation of amounts awarded through these programmes is 0.4 with a 99 percent significance level.

In Figure 7.3, we have classified the grants and loans from IN according to the specific programme. Funding is strongly dominated by the OFU/IFU contracts, where a formal relationship is already established between the FORNY start-up and its industrial or public sector customer (for more on this program, see ECON, 2007). As outlined above, this programme is focusing on the growth phase of the firm. OFU/IFU contracts are one of the largest forms of grants awarded through IN, and some FORNY start-ups have been supported with more than 10 million NOK. In other words, grants through this programme have been strongly concentrated towards a few larger firms where the road to commercial revenues is short.

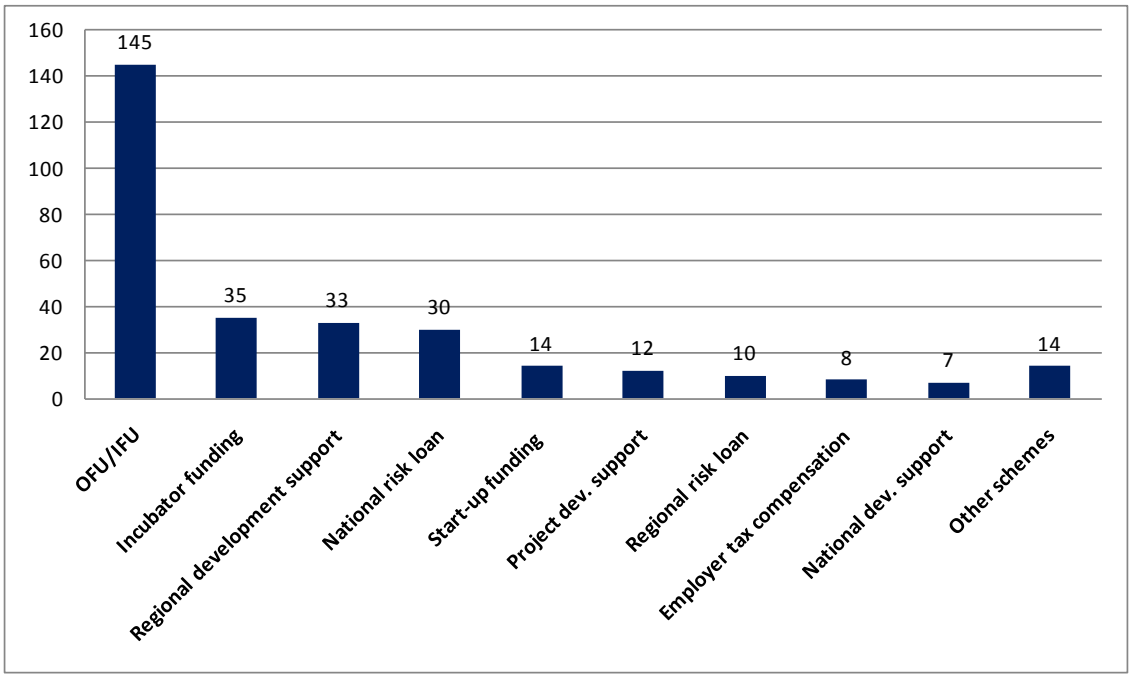


Figure 7.3 Innovation Norway grants and loans awarded to FORNY start-ups (2000-2008)

Another programme of importance is incubator funding. According to the survey, almost 70 percent of the start-ups have received such funding, either from IN or SIVA. As mentioned

above, such programmes are focusing on the early stage of the project, before a firm is set up. Focusing on the same phase, the size of start-up funding (Etablererstipend) and project development support is limited. These are also programmes designed to help firms directly in their early start-up phase, and the funding is scattered relatively evenly among a larger number of firms. Finally, notice that loans as an IN instrument towards such firms play a less important role, representing no more than 10 percent of the financial flows from IN.

7.2.1 Commercialisation and the role of policy programmes

To what extent do these public sector policy programmes promote the commercialisation of projects which run through the FORNY-program? This is an important question, since it points at the very objective of the FORNY-programme and its place among other policy instruments. Naturally, it is a complex task to identify whether grants by themselves play an important. One can easily argue that it is impossible to distinguish between the effects of these grants from the effects of other factors. Nevertheless, we have approached this complex subject, by looking at the distribution of grants and tax reliefs through Innovation Norway and SkatteFUNN among the start-ups, distinguishing between different degrees of commercialisation, as defined and discussed in chapter 5.

Table 7.2 Degrees of commercialization and public sector support

		Innovation Norway Support	*SkatteFUNN*	*Total*
No commercialisation	Average	591	522	**1113**
	Median	168	0	**196**
Lower degree commercialisations	Average	1097	1650	**2747**
	Median	360	800	**1328**
Higher degree commercialisations	Average	3480	3335	**6815**
	Median	1849	2785	**5462**

From Table 7.2, it is clear that a higher degree of commercialisation goes hand in hand with larger transfers from public sector policy schemes. The median FORNY start-up with a higher degree commercialisation has received more than 25 times larger transfers as compared to the median start-up without a commercialisation. The difference between these categories is strongest in terms of resources channelled through the SkatteFUNN program, indicating that the higher degree commercialisations are based on extensive R&D activities which form a basis for R&D tax reliefs. Start-ups with a lower degree commercialisation are also awarded considerably less than those with higher a degree, yet significantly more than those with no commercialisation at all.

Some of this pattern probably relates to the fact that those firms which have reached a higher level of commercialisation are older. As a consequence, they have been able to receive grants

for a longer time. However, on the basis of the composition of grants awarded by IN, we find reason to claim that the most important factor relates to the fact that when the start-ups reach a phase where commercialisation is viable, more solid public funding becomes available (like IFU/OFU). From a normative perspective, it is positive that funding is channelled mostly to those firms that actually do well. However, it is not completely clear whether this correlation is a result of funding driving commercialisation or the other way around.

7.2.2 Financing through seed funds

IN is presently administering public loans that contribute to finance the investments of 15 seed funds in Norway with 3 billion NOK in capital under management. The seed funds have been established in two waves (1998-2000 and 2005-2006), where the second wave is considerably larger when it comes to capital for investment. The government supports the funds through subsidised loans that match private sector equity capital and loans supplied by the owners of the funds. The seed funds are expected to invest in early stage firms, and there is a clear intention from the government that start-ups originating from universities and colleges should be a target group (see Grünfeld et al. 2009 for more on the seed fund objectives and activities).

So far the funds have invested close to 1 billion NOK in 216 firms in Norway. Slightly below 20 percent (51) of the companies come from TTOs, and 42 are related to the FORNY-portfolios. The amount of capital supplied to the FORNY start-ups through these funds is large compared to other policy programmes. The average investment is close to 3.5 million NOK while the median investment amounts to 1 mill NOK. 10 start-ups have received more than 5 million NOK in investments. All together, the funds have invested 128 million NOK in the 42 FORNY start-ups

Notice that the number of seed fund investments after 2003 is rather limited. Only 10 FORNY start-ups have entered the seed fund portfolios during the last 5 years, indicating a shift in the seed fund investment strategy. However, these investments are also significantly larger. Moreover, the more recent funds apparently focus on slightly larger and more mature companies, with a shorter road to full commercialisation. Bearing this in mind, it seems that capital from seed funds now predominantly enters as a relevant capital source for start-ups that have reached relatively far out in the growth phase. Grünfeld et al. (2009) evaluate the seed fund strategies and argue that the funds should not move into earlier stages when they search for potential investment cases. Experience from the older funds shows that the risks become too large and the management requirements too complex.

7.3 Conclusions and potential gaps in the policy schemes

We claim that there are two lessons to be learned from the review of policy programmes with relevance for the FORNY start-ups.

First, a major challenge when it comes to commercialisation of R&D relates to **mobilisation** of entrepreneurial intentions among academics. We find from the overview of policy programmes focused on mobilisation that educational institutions from elementary school to universities are well represented. These programmes are important in order to implement an entrepreneurial mindset at early age. To carry this mindset into an academic career may trigger commercialization of R&D results at some later point. However, there is a question whether these programmes reach the future academics. First, the programmes are focused on generating entrepreneurial human capital, and do first of all engage students who in their future career will leave the university and apply their entrepreneurial capability in the business sector. This linkage of entrepreneurial capability as valuable in the business sector only, disregards how entrepreneurial opportunities may arise in all sectors, and the academic in particular. Secondly, entrepreneurial training at university level is linked to business education programmes, rather than the technical and vocational programmes. Hence, mobilisation in terms of entrepreneurial training programmes is to a very little extent directed towards commercialisation of R&D results in other fields.

To enhance mobilisation of entrepreneurial intentions among academics would require programmes aimed at institutional and cultural change within the research communities. The entrepreneurial mindset needs to be stimulated among academics as well as among the students we want to become future entrepreneurs – academic entrepreneurs. That is, in order to recruit more academics into the FORNY-programme, a broader mobilisation within academic institutions is necessary. A general challenge with such policy intentions is how to reach individuals and communities that do not themselves request the type of knowledge and capabilities which we want them to posit. This is the challenge of proactive policies.

Within the FORNY programme we find funds directed at infrastructure means, cf. section 4.2. These may partly cover the mobilisation phase. There is evidence that these funding add to the number and quality of business ideas which emerge from the academic sector, and the programme has contributed to change the way of thinking in academic communities (Borlaug et al., 2008). Still, to aim for cultural changes requires long term commitment. The very justification of the FORNY-programme, and the present evaluation that the programme has not reached its potential in bringing forward a satisfactory number of business ideas from the academic community, demonstrates the need to continue, and possibly strengthen, the focus on mobilisation for entrepreneurial intentions in academic communities.

As a second lesson, we find that the number of programmes directed towards the very early stages in the start-up process are relatively abundant. Also, the FORNY programme itself is directed towards these phases. Yet, the number of programmes and the amount of financial resources directed towards the phases following directly after the start-up process is more limited. Notice also that this coincides with a period or phase of moderate capital supply through equity capital and loan financing, which was identified in chapter 5. In the later growth stages, this review shows that firms with a higher degree of commercial success tend to be better endowed with public sector financing (e.g. OFU/IFU and seed fund investments).

Hence, if the public sector support programmes contain gaps, we believe that the early growth phase is the most vulnerable period for FORNY start-ups. With the early growth phase, we speak of a period of 1-3 years after the firm has been established.

8 Gender perspectives on FORNY

The objective of this chapter is to discuss the FORNY programme in view of gender perspectives and analyse the programme in order to identify if there are gender issues related to the programme and how these issues should be addressed in the future development of the programme.

Generally, the field of commercialisation and academic entrepreneurship is characterised by significant gender imbalances. Traditionally, this is the men's world, as men have accounted for significant majorities in the research fields which are the most important bases for commercialisation, as well as in the type of firms that we normally will associate with research based commercialisation. On this background, the task of this chapter is to summarise relevant data on gender among staff employed by the universities and research institutes included in the FORNY programme to see how strong the male bias are in the research fields that are initiating projects for commercialisation. Furthermore, we will analyse the projects actually supported by the FORNY programme and analyse to what extent there are differences between the shares of men and women taking part in the commercialisation projects compared to the shares in the institutions the projects have been recruited from. The key question is if the processes of commercialisation imply selection mechanisms that operate in women's disfavour, and if so, how should be addressed when discussing the future organisation of FORNY.

8.1 Gender issues related to academia and academic entrepreneurship

8.1.1 A gender divided system

The research systems are on the whole (i.e. on all levels of the university and college sector) – based on gender divisions. These divisions reflect typical forms of division of labour between the sexes in society as a whole. The main pattern is, as in most western countries, marked by both horizontal and vertical division of the sexes. In the horizontal dimension the humanities represent the general feminine boundary, and the technological field represents the predominantly masculine domain; whereas the vertical dimension is illustrated by the considerably lower participation of women higher in the professional hierarchy, where nearly 80 percent of professoriates are still held by men (Hovdhaugen et al. 2004, European Commission 2008).[12]

However, this being the main pattern, gender divisions may also be thought of as a Chinese box, since different fields are divided differently with regard to the sexes. In the natural sciences, for instance, female researchers are represented to a considerable extent in biology, and in the humanities fields such as philosophy and history has traditionally low participation by women, which also applies to fields such as economics and political science etc.

[12] European Commission 2008 *Mapping the maze. Getting more women to the top in research.* Luxembourg: Office for Official Publications of the European Communities.

8.1.2 Women, family and the welfare state

Research on gender differences in research institutions has been based (since the 1970'ies) on various theoretical perspectives and empirical approaches. Late modern gender research emphasizes social constructivist perspectives, which means a focus on how being a man or a woman is constructed in different institutional contexts and in different social relationships. In the 1970'ies and 1980'ies various characteristics of the female were applied to explanations regarding low and unequal representation of women in professional life. According to this understanding women in academia are interpreted as reluctant to work normal hours and have insecure employment conditions, and to avoid competition and managerial positions. Some researchers emphasize the challenging balance between a position in research and being a mother as an explanation for the lower publication rate of women, the longer time used to finish their PhD's, especially in periods when they have small children (Kyvik 1988, 1991). The issue of women's working conditions, especially the possibilities for day care, was a predominant issue in the debate on equality in academia during the 1980'ies (See for example NOU 1988:28). But the findings are not unambiguous. Studies in Finland show, among other things, that there may be a positive synergy between the research role and family situation (Luukkonen-Gronow 1987).

A typical feature of the Nordic, and particularly the Norwegian, discourse on the welfare state is that the possibility of achieving more equality between the sexes has been considered in relation to political structures and developments. The general participation by women in professional life, level of education, distribution of sexes in the student body, the work market, job opportunities and density (possibilities to hire; resources; retirements) and, as already mentioned, programmes for day care and care of the elderly are important in that respect. Contemporary debates are centred more around the need for more permanent positions in research in general, and also how that may influence the recruitment of more women.

8.1.3 The generation hypothesis

It is commonly believed that the distribution of sexes in the student body over time is the most important explanation for the low share of women. According to this belief generational retirements and increasing share of women among potential candidates/recruits, will solve the problem over time based on the developments in the academic demography. However, Nordic research in political science (such as Karvonen & Selle 1995) indicates empirically that equality between the sexes is developed at a far lower rate than macro-level changes such as material, social, legal and other factors would imply.

8.1.4 Mechanisms related to discrimination and exclusion

In addition to externalist models related to external conditions, and essentialist models that are related to characteristics of the female sex, other models emphasize internal conditions in the research sphere, which may contribute to discriminate or exclude women. Homosocial reproduction is viewed as an essential mechanism, i.e. that professionals tend to choose successors that are similar to themselves, also with regard to sex. The conditions for homo-

social reproduction have been favourable in academic institutions due to the male dominance among professors, who may act, consciously or unconsciously, conservatively, through their influence on evaluations and employment issues (Kanter 1977).

The integration hypothesis has also been predominant. Because women can be excluded from the academic sphere, being fewer and representing the other sex, they are also less integrated in the formal and informal networks that are important to building a research career. Women thus tend to be trapped in a vicious circle, i.e. in a position where they have less access to meritorious activities (Zuckerman, Cole & Bruer 1991, Kyvik & Teigen 1996).

Some feminist approaches state that women are discriminated against because they are marginalized in a masculine field (Sonnert 1985). Some studies of employment cases and evaluation of applications for funding of research have shown that women are treated differently in these cases (Fürst 1988, Wennerås & Wold 1997). Norway is one of the countries where procedures for announcing vacancies and recruiting have been criticized for favouring men (Brandt, Bruen Olsen & Vabø 2002).

8.1.5 Selection mechanisms

There have always been certain preconceptions (conscious or unconscious) concerning the different tasks that women and men are suited to. These preconceptions may lead to a gender based socialisation, which in its turn influences the individual person's ambitions, such as choosing an education and a profession. Considerations of the different fields of study and how they are associated with femininity and masculinity represent a reasonable approach to explaining the reasons why so few women are recruited to professional fields that are "technology transfer intensive". This is primarily represented by the fact that women tend to ignore careers paths within these fields at an early stage in the selection process.

As is shown in many studies, women are traditionally allocated to less prestigious segments in the professional structure (see for example Ellingssæther, Noack & Rønsen 1997). Tendencies of gender divisions between subjects in academia have reflected traditional social divisions of labour between the sexes (such as the male dominance in politics, the sciences, public administration and business). These features are present by the fact that the divisions of gender in fields of study are, to a certain extent, correlated to the informal hierarchy that always exists between fields of study and research areas, and that reflect the various degrees of social and intellectual acknowledgment.

The representation of women among leadership is generally low, also within the higher education system (Ozkanli, Machado, White, Riordan & Neale 2008). Empirical investigations undertaken in Norway finds that informal masculine dominated networks and processes of recruitment are important explanations on why women are underrepresented (Skjeie & Teigen 2003, Teigen 2005, Storvik 2006). Stereotype patterns of division of labor among male and female leaders tend to be reproduced; women are typically well represented within human resource management. It is also reasonable to expect that professional skills needed in

order to master technology transfer processes to a larger extent are associated with stereotype male role.

With some young female faculty in the biosciences as exceptions (Thursby and Thursby 2005), empirical studies show that male scientists more easily move to research rich institutes with focus on patenting and industrial partnerships (Metcalfe and Slaughter 2008). Female researchers tend, to a larger extent to remain in the traditional university department. However, lack of relevant empirical investigations into this topic, leave us, to a far extent, pretty unable to understand the nature of the processes of social selection resulting in low participation of women in technology transfer processes. As concluded by Metcalfe and Slaughter (2008:104):

"To gain a deeper understanding of the individual and collective strategies of women and men, we would need to interview people, look at social networks within organizations, follow individuals and groups over the course of their careers, compare new entrants to fields with more established job holders, and analyze how men and women viewed each other, individually and collectively and how they helped, hindered, or ignored each other."

8.2 Policy for equal opportunities in the research sector

Within the Norwegian research sector, equality in research has been promoted on basis of fairness, democracy, credibility, research relevance and research quality (increase in knowledge resources). According to the strategy on gender equality policy adopted by the Research Council of Norway (RCN) in 2007[13], the Research Council has the ambition of being a central actor for promoting dialogue and actions suitable for the purpose and specific features of the involved research institutions. As a granting body they will expect specific plans for the enhancement of gender equality to be developed within all research programmes. They will ensure 40/60 percent gender representation in all steering boards and committees of the council. Furthermore, the RCN has approved an action plan aiming at more entrepeneurship among women[14]. Among other programmes, the plan also mention the FORNY programme, and points to the need for including the gender perspective when the programme will be reorganised.

Within higher education, various actions have been implemented since the 1980s in order to enhance gender equality (Brandt, Bruen Olsen & Vabø 2002). Institutional strategies have comprised the organisation of committees and launching action plans. In particular, focus has been on recruitment to academic positions, and strategies to encourage women to apply for such positions have been followed.

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[13] Forskningsrådet. Likestilling og kjønnsperspektiver i forskning. 2007.

[14] Forskningsrådet. Mer entreprenørskap blant kvinner. Opptrappingsplan 2008-2013. 2008.

Special actions targeted at qualifying women, such as scholarships and the use of mentors have been carried into effect. In the recent decade, great emphasis has been put on so-called gender mainstreaming initiatives; integration of gender equality issues in human resource management and other relevant policy issues in research and higher education. Examples of mainstreaming activities are the development of gender equality focus in strategic plans, strategies for recruitment and relevant knowledge including gender sensitive statistics.

8.3 Involvement in commercially related research and technology transfer

Before discussing data from the FORNY-program, we will summarise some relevant data from the recently finished survey on the role of men and women in academic professions (Vabø and Ramberg 2009)[15]. A general conclusion deriving from this survey is that women researchers are not, to the same extent as men, integrated neither in the formal or informal networks, nor in disciplines that are important to publish, or get financial and other resources that are important to succeed in a career in research. Similar conclusions were drawn in a recent Danish investigation of women in science (Lützen & Bang Henriksen 2008).

In the survey it was asked questions regarding the emphasis of the primary research of the participants and to what extent they had been involved in different types of research related activities. The first question included "commercially-oriented/intended for technology transfer" as one of its options, while the other included "involved in the process of technology transfer" as an option. The results are displayed in Table 8.1 and 8.2.

Table 8.1 Academic staff with their main activity in commercially oriented research and technology transfer. Share of men and women who have responded "to a high degree" or "to a very high degree" (%).

Discipline	Men (%)	Women (%)	(N)
Humanities and arts, teacher training and education science	3,4	0,0	(104)
Social and behavioural sciences, economics and business administration, law	8,6	4,6	(315)
Life sciences	14,8	12,5	(186)
Physical sciences, mathematics, computer sciences	39,1	34,2	(217)
Engineering, manufacturing and construction, architecture	57,5	63,3	(150)
Medicine, health related sciences, social services	5,3	10,1	(183)
Total	23,7	13,9	(1155)

[15] The data are obtained from the European survey called "Changing Academic Profession" (CAP) in which Norway took part. A total of 1500 academic employees in universities and research institutes participated.

On average 24 percent of men and 14 percent of women are involved in research with emphasis on commercialisation and technology transfer. Thus, there is a significantly higher share of men than women involved in this type of activity. However, the figures are not very surprising as they give average shares for men and women across all disciplines.

When controlling for disciplines, it appears from the table that the differences between men and women virtually are eliminated. Interestingly, women actually score higher than men in engineering as well as medicine and related disciplines. In particular it is interesting to observe that women score higher in engineering, which is the discipline with the highest shares of researchers emphasizing commercialisation and technology transfer. To the extent these data are representative this part of the data may indicate that men and women within the same disciplines are involved to the same extent in research emphasizing commercialization and technology transfer.

While this question addressed what is of the *main emphasis* of the research, the next asked if the researchers have been involved in research activities related to technology transfer.

Table 8.2 Academic staff having been directly involved in technology transfer during the last two years. Share of men and women who have responded "yes".

Discipline	Men	Women
Humanities and arts, teacher training and education science	8,8	3,7
Social and behavioural sciences, economics and business administration, law	6,5	8,3
Life sciences	40,0	23,7
Physical sciences, mathematics, computer sciences	43,9	29,0
Engineering, manufacturing and construction, architecture	60,4	50,0
Medicine, health related sciences, social services	42,6	15,1
Total	36,5	18,9

The picture emerging from Table 8.2 is somewhat different from the previous table. Again, we have the general tendency that the share of men that have been involved in technology transfer is close to two times that of women when we look at the average shares across all disciplines. However, unlike the previous data, when split on the separate disciplines, the share of men is higher than the share of women within all disciplines. In particular, the data for men and women in medicine are noteworthy. While women held a slightly higher share than men in the previous table, the data in Table 8.2 indicate a very strong bias in favour of men, as more than 40 per cent of men have been involved in technology transfer, while the share of women is just 15.

It may be important to reflect about this difference. The first question focuses on research activities emphasizing commercialisation and technology transfer, i.e. research activity that potentially may lead to commercial applications in the future. In contrast, the second question

focus on the actual involvement in processes of technology transfer. And interestingly, while the shares of men and women are fairly at the same level regarding their basic research activity, when it comes to the specific processes of technology transfer, men to a significantly higher extent than women tend to be involved. This may be a support for tendencies discussed in the introductory part of this chapter that selection mechanisms are working in a ways favouring men's participation in technology transfer.

8.4 Gender imbalance in FORNY?

We will now turn to the FORNY programme and analyse to what extent gender imbalances may be observed. The approach taken in our analysis is that we first present an overview of the share of men and women in the research institutions served by the TTOs participating in the FORNY programme. We then follow up by examining data on the FORNY programme to see if there are significant differences between the share of women involved in the FORNY projects and the share of women in the research institutions and disciplines the projects are recruited from.

An overview of the data on researchers is provided in Table 8.3. The data include the total number of researchers by discipline in the research institutions served by the TTOs. For an overview of the research institutions, see table 4.1 (in Chapter 4). Ideally, it might have been interesting to split the data on the different TTO. However, as the number of commercialisations from the FORNY programme is fairly small, particularly if they are split on the TTOs, it may be regarded as sufficient to look at the FORNY portfolio as a whole, and just do rough reflections around the balance between men and women.

In total, the research institutions served by the TTOs employ around 27000 researchers, and on average, there is a 40-60 per cent balance between women and men. However, there is some variation between the different disciplines; the smallest share of women occur in Technology and engineering, where the balance is around 21-79, while it in physical sciences etc is 30-70 and in medicine etc 53-47. As these three groups are the most commercialisation relevant disciplines, these figures may serve as our benchmarks for judgements regarding the gender balance in the FORNY projects.

Table 8.3 The share of men and women by discipline in the research institutions served by the TTOs in the FORNY programme. Data for 2007. Source: NIFU STEP

Discipline	Women (%)	Men (%)	Total (%)	Total number of researchers
Humanistic sciences	45,5	54,5	100,0	3617
Social sciences, economics and business	44,5	55,5	100,0	6447
Physical sciences, mathematics	29,7	70,3	100,0	4125
Technology and engineering	21,3	78,7	100,0	4374
Medicine, health related sciences	52,5	47,5	100,0	6984
Agriculture and fish related	41,8	58,2	100,0	1621
Total	40,5	59,5	100,0	27168

Table 8.4 Reported FORNY projects and the share of women in the teams 2006-2008.

	2006	2007	2008
Total number of ideas under evaluation	853	542	816
Share of ideas with one or more women in the team (%)	12,5	16,8	13,6
Total number of commercialisation projects in work	735	593	644
Share of projects with one or more women in the team (%)	18,1	13,6	21,1
Total number of patents filed (in Norway and abroad)	46	33	24
Total number of filed patents with a woman in the team	6,5	21,2	12,5
Total number of established firms	46	43	40
Firms with one or more women in the team	14,7	10,9	14,0

A first indication of the share of women participating in the FORNY projects is given in Table 8.4. The data, which are based on reports from the TTOs, show the following shares of ideas or projects with at least one woman in the team:

- Ideas under evaluation 13-17%
- Projects in work 14-21%
- Patent applications 7-21%
- Established firms 11-15%

By and large, the tendency is that less than 20 percent of the teams have at least one woman in the teams. And as the data refer to team, the implication is that the share of women as percentage of the total number of people participating in these projects is significantly lower.

Table 8.5 Gender relations in FORNY companies active by the end of 2008. Data source: Brønnøysundregistrene.

	Number	%
Companies active by the end of 2008	212	
Among these:		
- With female chairman of the board	14	7
- With one or more women on the board	76	36
- With only men on the board	136	64
Total number of board members	798	
- Among these women	99	12
Companies with information about the manager	186	
- Among these with female manager	11	6

This tendency is supported by data in Table 8.5 which provide an overview of FORNY companies with women involved as board members or managers. Just six percent of the firms have a female manager, and just seven have boards with a woman as the chairman. Moreover, 36 percent of all the boards have at least one female member, and among the total board members only 12 percent are women.

Table 8.6 Composition of management teams. Source: Survey of FORNY firms.

The management team	%
Women only	1,5
Women and men, women in majority	1,5
Women and men, equal number	9,1
Women and men, men in majority	25,8
Men only	62,1
(N)	(71)

This fairly strong male dominance among the FORNY firms is supported by data from the survey, which indicate that just three percent of the firms have women only or a majority of women in the management team, while 62 percent of these firms only have men in the management team.

Based on these data, and talking about size orders, our rough estimate is that women account for around ten percent of the staff involved in the FORNY commercialisation projects.

On this background it may be concluded that there is a fairly significant underrepresentation of women in commercialisation. Taking technology and engineering as a reference, the share of women should be around 20 percent if women recruit to commercialisation projects to the same extent as men. However, technology and engineering have the lowest share of women. Some projects are stemming from natural sciences and medicine in which the share of women are 30 and above 50, respectively. Although the number of projects recruited from these disciplines is smaller than from technology and engineering, it still may be concluded that the

share of women should be higher than the 20 percent share we find in technology and engineering; maybe up to 25-30 percent if women were recruited to the same extent as men. In contrast, the actual share of women is around ten percent, i.e. less than half of what should be expected given a proportionate recruitment of men and women to commercialisation projects.

8.5 Gender issues in FORNY

The FORNY data confirm the tendency we observed from the CAP data, that the share of women involved in technology transfer is significantly lower than what should be expected if the recruitment to commercialisation projects followed the share of women working in the research fields the projects are stemming from. Thus, the data confirm that there are gender biased selection processes in line with what is discussed in the introduction to this chapter, i.e. that women may be perceived to be less oriented towards market and competition oriented activities than men.

On this background it may be concluded that gender issues are important for the future organisation of FORNY, as the way FORNY is working seems to strengthen the general tendencies of gendered divided structures in academia as well as in the business world. However, a main issue to be considered is if the gender issues related to FORNY is specific enough to justify arrangements organised within the framework of FORNY to stimulate women's participation in commercialisation.

An argument against specific actions in the FORNY programme is that the programme is very specific in promoting commercialisation projects. The main criterion for selecting ideas is the potential of the projects; i.e. it is based on assessments of the market potential, technological and scientific quality, the quality of the team etc. From this perspective is of less relevance if the projects are organised by men or women. It will probably be perceived as very inadequate to implement specific instruments to support women's involvement in commercialization projects, like for instance providing specific grants for women involved in commercialisation projects, or to provide more support for verification in cases the project is initiated by women.

At least as far as the *specific* FORNY instruments are concerned (i.e. commercialisation funds, proof of concept funds and leave of absence grants), it will not make sense to implement specific gender related instruments. Instead, we will recommend that broader and more comprehensive strategies should be pursued independent of FORNY. Actions taken in order to improve the gender balance in academia will also have an impact on the gender balance in commercialisation processes, in particular if the actions also include measures to motivate women in academia for an entrepreneurial career.

As processes of social selection and choices about future careers start at earlier stages. The low proportion of women in technology transfer processes and women in technology in general, illustrates a need to develop actions aimed at motivating women at lower school

levels. And this is followed up in the Governments current action plan for more entrepreneurship among women[16].

In particular, it is important that the action plan addresses issues related to entrepreneurship in higher education. The current plan is very vague regarding its strategy for stimulating entrepreneurship among women in academia, and the issue of commercialization and research based entrepreneurship is hardly discussed (although one of their cases illustrates a successful research based start-up). Thus, there is a great potential to develop a more comprehensive strategy for stimulating entrepreneurship among women in academia, and to relate entrepreneurship to processes of technology transfer.

As part of this, it might also be an opportunity for the FORNY programme to support relevant activities promoting women entrepreneurship. As the objective of the infrastructure funds is to build culture for entrepreneurship, a campaign on women entrepreneurship will fit well into the strategy of FORNY. However, to be efficient, the action strongly depends on coordination with local actors.

[16] Departementa. Handlingsplan for meir entreprenørskap blant kvinner. 2008.

9 Implications for the future development of FORNY

FORNY is about to be redesigned, and in this chapter we sketch some implications of our evaluation and of our discussion of the rationale for and international experiences with public support for commercialisation of research results. In 9.1, we review briefly the results of FORNY as elaborated in the previous chapters, and we put forth some explanations for these results in 9.2. We elaborate on the potential for research-based commercialisation in 9.3, followed by a discussion of the TTOs and the selection mechanisms for ideas in 9.4. In 9.5 we discuss the rationales for organising a programme like FORNY, and 9.6 develops some concrete suggestions for the future.

9.1 The results of FORNY

We have analysed the results of FORNY mainly in chapters 5, 6 and 7, and related to gender differences in chapter 8. One general message is that the programme seems to have focused on ideas and commercialisation projects that fall within its primary target groups: R&D-intensive and highly innovative ones. Furthermore, the survey among the companies in the FORNY portfolio reveals a high reported additionality. It is likely that many of the companies would not have been started without the support they have received from the FORNY programme and its commercialisation actors which we have referred to as TTOs. The people working to facilitate commercialisation are enthusiastic, and there are strong indications of a willingness to learn and change and increase the professionalism in the FORNY system.

Still, we would argue that despite this dynamism, the positive additionality and the successful targeting of high technology commercialisation projects, the overall results of FORNY are *not* very impressive. This is not least the case when considering that the programme has spent around 1 billion NOK alone, and that it has established very ambitious goals related to national value creation. Our argument is based on e.g. the following observations and analyses:

- There are few growth firms in the FORNY portfolio. We expected that there would be a higher proportion of firms that experience high growth.
- There are very few large firms in the portfolio.
- The total number of firms is modest. This means that the tiny number of large firms is not compensated by a huge set of smaller ones.
- There are indications that the firms do not go through beneficial development paths (e.g. the J-curve). As argued mainly in chapter 5, it seems that the level of investment in each firm is fairly modest rather than skewed towards the most interesting or high-growth ones.
- There are no indications that the licenses have done any better than the portfolio of firms, i.e. the data do not indicate that some of them are extremely valuable or that there are many fairly valuable ones.

- Despite these results, the TTOs are pleased with their own expertise and activities as shown in Chapter 4. Few of them state that they need significant increases in competence, and most of them rely on their own competences when evaluating ideas for commercialisation. This is not necessarily a bad sign; it could be an indication that the support structure has undergone a professionalization. Still, given the modest results of FORNY, the TTOs' self-content may also signify causes of worry. Some causes would be a lack of certain types of expertise, some sort of groupthink (the tendency for homogeneity in competences and perspectives in a group) or "Not-Invented-Here" syndrome (where a group believes it has a monopoly on certain tasks due to its self-perceived expertise to an extent that has a negative effect on the larger system or organisation).

As seen in chapter 3, we know that many countries, regions and research institutions struggle in their attempts to create research-based commercialisation. Thus, it should be emphasised that commercialisation in a narrow sense is not easy to accomplish anywhere and that many countries' and universities' results are far below the often unrealistic expectations based on a few select examples from the U.S. However, even when looking only at studies of various (mostly successful) European cases, the results in Norway seem modest. The first cohort of FORNY spin-offs counts 120 firms that were established between 1995 and 2000. In 2006, 80 of these firms still existed with a total of 492 employees. 12 firms had more than 10 employees, only 3 firms more than 20 employees, whereas one firm counted for 230 of the total number of employees. While the number of firms created and the survival rate seems fairly comparable with the spin-off activity in other countries, the growth rate of the FORNY firms is, as mentioned, very modest. 10% of them had more than 10 employees after 6 to 11 years, while UK data indicates that about 30% of university spin-offs had more than 10 employees after 1 to 6 years (Lynskey, 2008). The FORNY spin-offs lag even more behind when looking at the 153 firms that were established between 2001 and 2006. In 2006 only 2 – or just above 1% – had more than 10 employees.

We worry in particular about the lack of firms that have grown large and the generally poor growth rate compared to international cases analysed in Chapter 3. Some of the investigations from other countries have counted spin-offs and other results that are not strictly based on commercialisation but e.g. on ideas among students. Thus, the Norwegian firms may differ from samples related to which types of firms that is included. This is still not enough to remove the impression that the growth rate and the number of firms created in the FORNY programme seem comparably low.

The general picture is therefore that the results of FORNY – also given the substantial funding devoted to the programme over the years – are less than satisfactory. A key issue is the balance between putting a lot of resources into creating a few spin-offs that are expected to have a significant growth potential versus spreading the resources on the creation of many companies. Formally, FORNY has attempted to do both, but it seems neither to have been able to support high-growth ventures nor the creation of a large portfolio of new ventures.

9.2 Explaining the FORNY results

There are obviously many different explanations for these results. We can group them into three categories.

Measurement problems

It may be too early to assess the results of FORNY activities in recent years. We know e.g. that the programme has seen its funding increase significantly the last 5-6 years, we know that a professionalization of the support structure probably has taken place, and we know that many of the TTOs are young and a response to the 2003 legislative changes. All these reasons point to the importance of keeping track of the results of the programme and its TTOs also in the coming years.

The validity of some of our data can be questioned as well, although it is most likely a very minor problem for the evaluation. For example, there may be a few "hidden" positive results when firms and licenses disappear from the databases after mergers and acquisitions. This is most likely not a significant issue, however, as analysed in Chapter 5. A possibly more severe measurement problem is that the main goal of "increased value creation in Norway", can only be measured indirectly, e.g. through the performance of the spin-off firms. Thus, we have not been able to assess whether FORNY has lead to other effects such as cultural change, system changes, networking, competence development and other more indirect ways of promoting value creation. This could be an important point, but where it would be close to impossible to disentangle the impact of FORNY from other developments like the legislative changes in 2003 and possible internally driven changes in the research culture in various institutions.

Framework conditions

It could be that FORNY has done the best possible with the number and quality of ideas available in the Norwegian public research system – and FORNY does not and cannot play a role in all commercialisations. For example, from international investigations we know that TTOs tend to get stuck with the *mediocre* ideas from the run-of-the-mill researchers – the best ideas and researchers most often (are) commercialize(d) directly in collaboration with industry (Jensen et al., 2003). Furthermore, for university staff members in the Norwegian system the "normal" commercialisation route has been through *research institutes* like SINTEF, SI, IFE, CMR, NGI and FFI rather than through patents, licenses and spin-off firms. This does not mean that research institutes are not interesting sources of commercialisable ideas – on the contrary, as the results of the different TTOs reveal. But it means that traditionally the good ideas *have* found ways into industry e.g. through the good networks between universities and research institutes, and that the ideas going through the TTO system are not necessarily the "best ones".

In addition, higher education institutions (HEIs) have *not* been extremely interested in commercialisation, for example evidenced by the fact that no wholly university-owned TTO existed *before* the legislative changes. Finally, there are good reasons to believe that some forms of

university-industry relations are comparatively strong in Norway and that they have been so for a long time. Like the existence of industry-oriented research institutes, this could mean that there are good channels of knowledge and technology transfer in Norway that may not exist in other countries where a more formal emphasis on commercialization may thus be more needed. It could also mean that academics focus on research problems and topics that are highly relevant to the important existing companies, with fewer ideas that need special care outside of the collaborative arrangements. A high volume of industry-oriented collaborative research furthermore means that many of the intellectual property rights are, in fact, held by companies rather than the universities, as shown e.g. by the evaluation of NTNU Technology Transfer AS (Spilling et al. 2006). All in all these factors may reduce the potential in Norway – compared to some other countries – for the type of commercialization that the FORNY programme seeks to support. This will be further discussed in 9.3.

FORNY-related problems

Underperformance may of course also be due to the FORNY programme itself, and many of these choices and actions have already been touched upon in the report and will be elaborated below. Some examples are:

- a narrow emphasis on commercialisation rather than technology transfer or entrepreneurship in a broader sense
- unsatisfactory selection of ideas and projects
- poorly developed expertise and a complicated support structure
- too decentralised, fragmented and loosely coupled system
- FORNY as an isolated rather than integrated actor in national and regional commercialisation systems, and
- lack of important support schemes related to phases of commercialisation.

In the rest of the discussion in this chapter, we will in particular discuss the FORNY-related explanations for the underperformance we have indicated. However, we will also elaborate the potential for commercialisation. This is done in the next part, followed by a discussion of the strategies for organising the TTOs and a discussion of selection and follow-up strategies. Finally, we analyse some main challenges regarding the future design of FORNY.

9.3 What is the potential for commercialisation of public research?

In this section we discuss international comparisons, the structure and development of the Norwegian research system, and external circumstances that may influence the potential for commercialisation of research in Norway.

9.3.1 International comparisons

Chapter 3 showed that commercialisation is a complex and heterogeneous activity demanding specialised expertise and skills. Commercialisation differs enormously based on technology and HEI characteristics, and it involves several distinct phases requiring very different types of

support. Many countries, regions and universities struggle to set up a good support system, and, for example, very few universities gain financially from their TTOs. It seems that many of the initiatives are based on inspiration from a small yet increasing number of success cases.

The literature generally recommends that the support structure is tailored to the specific norms, rules, organisations, specialisations etc. that exist in a country/region/HEI rather than to be blindly based on North American or other experiences – as these are not easily transferred. This notwithstanding, it is also a myth that commercialisation is extremely successful in the U.S. Only a small set of elite universities are able to carry out financially successful technology transfer – most often through patenting and licensing rather than creating spin-off companies, which is more heavily emphasised in Europe.

As argued in 9.1, it seems that the FORNY system has emphasised numbers over quality in the form of a fairly high number of spin-offs rather than a focused effort on a smaller number of high potential ventures. But as the number of spin-offs is not extremely high either, it may be relevant to claim that the FORNY system has not got the balance right: it has neither achieved a small number of high growth companies nor a large portfolio of firms where at least some of them have a good chance to succeed significantly in the future.

9.3.2 The structure of the Norwegian research system

To further discuss the potential for commercialization of publicly funded research in Norway, a quick glance at the structure and development of the research system is necessary.

Funding: Norway's R&D expenditure out of GDP on R&D is below the OECD average, despite the country's success in productivity and economic growth. However, the public expenditures on R&D are fairly high and substantially above the OECD average. It is the private R&D effort that is lagging behind in Norway compared to other countries. Various explanations have been offered, e.g. systematic underreporting of R&D, the country's industrial structure and more. It can also be mentioned that the public R&D expenditure is highly concentrated geographically, with 85 percent of it spent in Oslo/Akershus, Hordaland, Sør-Trøndelag and Troms.

Overall structure: Unlike countries like Sweden, Norway has a large research institute sector emphasising applied contract work for public and private users. Some institutes have had a clear historical role in commercialisation of research results and technology from HEIs. SINTEF was started by the technical university in Trondheim to play this role; SI (Centre for Industrial Research) was set up by the technical-industrial research council to play a similar role between industry and the University of Oslo. Many other institutes have done the same albeit with a less explicit mandate. Some of the country's most famous and successful spin-offs (like Norsk Data) have come out of the research institutes. It may generally be expected that ideas from such organisations are closer to market and therefore easier to commercialise.

FORNY was thus not created to cater for a system with a large gap between fundamental research and exploitation, but rather as an additional actor in a system where quite a few orga-

nisations already worked to achieve commercial success based on public R&D. This may help explain the rather narrow emphasis in the FORNY programme on commercialisation in a restricted sense rather than entrepreneurship or technology transfer. It can be added that some university professors have claimed that their spin-off companies have been met with some resistance from research institute representatives who have viewed the companies as competitors (Gulbrandsen 2003). This shows that the activities of at least some academic spin-off companies are typically already carried out by research institutes.

Incentives: There are no institutional incentives for commercialisation in the public research system in Norway. HEIs get a small share of their basic funding redistributed based on publication productivity, but commercialisation-oriented indicators are not included. Neither are they included in the new incentive system for the research institutes, even though some institutes wanted this. At the individual level, some research institutes and colleges may appreciate commercial results when assessing people for promotion or new positions. In general, however, this is uncommon in the Norwegian system.

The Ministry may signal its interest in commercialisation also through various meetings with the HEIs, documents and letters. Most important are probably the annual budgeting documents. Here, the HEIs are required to account for commercial activities and results, but it is doubtful whether this reporting actually signifies a strong incentive for the HEIs. It could raise their awareness about patenting, spin-offs and the like, of course. Similarly, the research institutes are required to report their patents, licenses, licensing income and spin-offs to the Research Council of Norway (RCN) which distributes basic funding in this part of the research system. This does not serve any clear purpose beyond the accountability, although it may also make the institutes more aware of the activities of commercialisation. It may also be mentioned that the legislative changes in 2003 of course created formal obligations for the HEIs to commercialise their results – and led them e.g. to start TTOs. But questions may be asked about the authorities' follow-up of these changes. They were, for example, to be evaluated after three years, but this has still not been initiated. This could signify a weak policy interest in commercialisation.

University-industry relations: As mentioned in 9.2, it can be argued that the relationship between HEIs and industry is strong in Norway. Industry funding of R&D in universities and colleges is about at the OECD average, despite the low R&D intensity in private firms in Norway and despite the existence of a large industry-oriented applied institute sector. Historical evidence points at strong ties between the important resource-based firms oriented at process innovation over a period of many decades. The community innovation survey, despite giving a generally low score to universities and research institutes as sources of information and collaboration partners, nevertheless shows that Norwegian firms score relatively high in these aspects.

For a discussion about the potential for commercialisation of public research, the close university-industry relations may have three important implications. First, they could imply that

many of the university professors in commercialisation-friendly fields like engineering and natural science choose problems that are highly relevant to Norway's large firms in e.g. the petroleum industry. When their scientific and technological problems are tied to the challenges of these firms, it is probably less likely that ideas will emerge that require special attention by TTOs and other support actors. Second, these ties signify that direct commercialisation through established firms could be an option – and a preferred option – for many Norwegian academics. Their ties to important big companies may offer many ideas a lead user and the necessary funding to reach commercialisation. Again, the support of FORNY, TTOs etc. may not be needed. Third, when academic research is entangled in industrial partnerships, contract research and joint centres, intellectual property rights may in many cases belong to the companies (Spilling et al. 2006).

When it comes to intellectual property rights, it may be added that this can also be a problem in other types of research and partnerships. Few of the universities have developed clear IPR policies for various reasons. Also the Research Council of Norway has been slow in developing IPR guidelines for its support for collaborative research. Clearer rules and adaptation to the legislative changes will likely continue to improve, however.

Finally, it should be mentioned that the commercialisation and entrepreneurship literature is full of examples of other factors that may influence the potential for commercialisation of research in a certain university, region, country, discipline etc. Some of the important factors are the economic cycle (e.g. good job opportunities for graduates), "entrepreneurial culture", tax regimes for entrepreneurship, sufficient professional private capital and more. It falls outside of the scope of this evaluation to consider such factors, but they may nevertheless be relevant in a strategic discussion about the future direction of FORNY.

The discussion about the potential for commercialisation is summarised in Table 9.1. It can be seen that there are several aspects that increase the potential and many other aspects that decrease it. The actual potential probably varies a lot between disciplines, research organisations, industries and more.

Table 9.1. The potential for commercialisation of public research in Norway.

Increased potential	Decreased potential
Significant public expenditure on R&D, higher than in many other OECD countries	Little industrial R&D could signify weakened opportunities for finding domestic lead users
Much applied research in the system with opportunities for close-to-market ideas	Many wider commercialisation tasks are already filled in the Norwegian system without FORNY
Probably great potential for the ideas at the intersection between HEIs, institutes and industry (but IPR possibly unclear)	Academic spin-offs sometimes seen as competitors to research institutes?
Strength in some commercialisation-friendly disciplines (geosciences, energy)	No institutional and few individual incentives for commercialisation – and fairly modest policy interest in it
Public R&D resources concentrated in the university/big city regions	Close university-industry links may mean fewer of the more radical ideas that require a separate support structure
Strong university-firm linkages in many industries constitute well-established channels of knowledge/technology transfer	University-industry linkages complicate IPR issues
Some indications that Norwegian public research is of a high and increasing quality	Strong economic growth, no "necessity" of entrepreneurship

In sum, the general message is that there are several aspects of the Norwegian research system and larger society that decrease the potential for commercialisation of the type that FORNY has focused on. Some of these are outside of the influence of the programme and the research council. Others should probably constitute strategic tasks for a renewed FORNY. Two tasks would be to work for clear IPR guidelines in the research council and to lobby more intensively for an improved understanding of commercialisation – its challenges and importance – to policy-makers.

9.4 Organising the TTOs and selecting the good ideas

As discussed in Chapter 4, FORNY has chosen a rather special model for the organisation of its activities as a mixture between a "TTO agency" and a regular R&D/innovation programme. The result is a highly decentralised system based on TTOs set up by universities, research institutes, university hospitals, counties and other actors partly involved in the programme. It is fully up to the institutions how they organise their TTOs with regards to staff, specialisation, strategies for commercialisation etc. And most of the FORNY budget is channelled to the TTOs as general grants for working with commercialisations, or to the specific projects that are followed up by the TTOs.

The whole programme is coordinated by a small secretariat and a programme board, and as summarised in Chapter 4, the FORNY system may be characterised as loosely coupled with a low level of specialisation, and it may even be characterised as fragmented. In total, the system of TTOs involved in the FORNY programme has a staff of around 110 people corresponding to around one hundred full time equivalents, and this is supplemented with a network of external experts. An important question therefore concerns a good or optimal way of orga-

nising such a large group of expertise; unquestionably there should be some kind of coordination and specialisation among the TTOs. It can, of course, be argued that a decentralised and bottom-up system can work very well in the support of commercialisation – but as argued in 9.1 and 9.2, this does not seem to be the case.

The present system is not organised according to any single clear principle. The most apparent principle is that of regionalisation as the original organisation of FORNY was based on four regions with six TTOs all together, i.e. Eastern Norway with three TTOs and the other three regions Western Norway, Mid- Norway and Northern Norway with one TTO each. Later, the fifth region of Southern Norway was included. During the later years, the structure of TTOs has developed into a more mixed pattern with some TTOs specialised on specific universities, research institutes or sectors. However, the regionally organised TTOs serving a mixture of institutions are still dominating. While the principle of regional organisation may have some advantages in terms of proximity between the TTOs and the research institutions, an obvious disadvantage is that it will be impossible for most of the individual TTOs to have a sufficiently specialised staff to work adequately with commercialisation in all disciplines. It is also important that FORNY is able to reward good TTO performance and development of expertise. This is discussed more in 9.6.3.

A further issue is how the TTOs are anchored in the institutions they are serving. The research institutions involved in the FORNY programme represent a heterogeneous group and the degree to which commercialisation is an integrated part of their activities varies significantly. The research institutes are probably the institutions in which commercialisation is closest to their regular mission, and we see that the TTOs specialised to serve specific research institutes, tend to be well embedded in the activities of their mother institutions. In the case of the university hospitals, the situation is more premature; generally it is recognised that there is a great potential for commercialisation and industrial development based on research in this sector. As outlined in Chapter 4, strategies for innovation and commercialisation are being developed. However, making commercialisation an integrated part of the missions of these institutions is probably somewhere in the future. Furthermore, the current organisation of FORNY is a bit confusing as parts of the university hospital system is served by one specialised TTO in the South Eastern part of Norway (Medinnova), while the university hospitals in the other regions mostly are served by the TTOs in their respective regions.

The university TTOs probably represent the most complicated structure in the FORNY system. Generally, changes in the university legislation have made commercialisation an important area of responsibility for the universities and colleges. However, most of these institutions have a long way to go before commercialisation is fully adopted as an integrated part of their strategies. This is also reflected by the different position of the TTOs serving the universities. Some TTOs, like Birkeland at the University of Oslo and NTNU Technology Transfer in Trondheim are fully owned by the university and are well off in terms of budgets allocated from their mother institutions. Most of the other university related TTOs are in a more mixed situ-

ation; they serve different types of institutions and generally receive smaller budgets from their mother organisations. It is crucial to the potential of the TTOs that they are well embedded in their mother institutions, and that commercialisation is an integrated part of the missions of these institutions; thus, this is a very important issue which should be a matter of concern for the future organisation of FORNY.

We do not have much data on selection criteria and assessment procedures in the TTOs. Most of them try to mix an "elitist" approach focusing on the high potential ideas, and a "letting the thousand flowers bloom" approach where a large portfolio is the best bet for future value creation. The rhetoric of FORNY is mainly an "elitist" one, while some of the TTOs have a stronger mission to be a "service unit" for one or several research institutions, i.e. offering help to all who need it and who presumably pass an initial threshold. There may in other words be a goal conflict between some of the TTOs and the FORNY programme. The somewhat poor results (cf. 9.1) could indicate either that the volume and/or quality of the ideas is not as expected, that the TTOs are unable to select the ideas with the highest potential, or that they are unable to redistribute funding from the low potential to the high potential ideas after an initial screening phase. We cannot state with certainty which of these three causes are most important. It may be argued that the volume and quality of ideas may not be as high as expected, especially considering that many of the TTOs earlier were largely preoccupied with ideas that could form the basis of a new firm. The survey among the spin-off companies (see Chapter 6) revealed that the entrepreneurs were generally happy with early phase support and not very happy with later phase support, which supports the claim that the TTOs are not able to redistribute funding. It can also be mentioned that the survey showed that the entrepreneur had previous entrepreneurship experience in more than half of the cases. The central premise behind many TTOs – that most researchers are inexperienced with such issues and detached from the marketplace – may therefore not be correct.

9.5 The rationale for a continued FORNY programme

The current goals and strategies of the FORNY programme refer to a general intention of promoting value creation through the commercialisation of research. There are, however, no explicit referrals to gaps or market failures that need to be addressed. Rather, there seems to be a general perception that "something" needs to be done in order to increase the value creation from research, and initiatives are developed based on practical experiences and international "best practise". From a more conceptual point of view, the FORNY programme seems to address two types of gaps in the innovation system. The first may be labelled the technology transfer gap, while the second may be seen as the entrepreneurship gap. There are considerable overlaps in the challenges presented by each gap, but it can be fruitful to discuss each in turn.

9.5.1 Technology transfer

Technology transfer is the application of information to use (Rogers, 2002) and may be defined as the process of developing practical applications from scientific research. The difficulty

of transferring basic research into commercial products has been conceptualised in several ways. A frequent argument is that there exists a market failure in this particular phase of the research process. Tassey (2005) has discussed the "risk spike" occurring when a project moves from basic scientific research into technology research. In this phase, both the technical risk and the market risk become relevant and private actors rarely have incentives to take this risk alone. To lower this risk and make the projects more attractive to private actors, the FORNY programme and similar programmes in other countries have introduced different forms of 'proof-of-concept' or verification schemes. Another explanation for the gap between academic research and commercial application is the cultural factors related to incentive systems and work practices in academic science. This has been addressed by the FORNY programme e.g. through the infrastructure scheme (Borlaug et al., 2008).

The market failure associated with technology transfer is similar to, or an extension of, the rationale for public funding of basic research. The private sector will invest less in research than socially optimal because it is not able to internalise the positive benefits from these investments. That is, investments in research will benefit many actors, but those who are making the investments are not able to get a high enough share of these benefits to justify the investment.

Technology transfer is the process through which the outputs of academic research are conveyed to those who make use of the research results. It can, occur in a variety of ways. Indirectly, technology can be transferred through education and research-based teaching, through publication of articles, books, and reports, through seminars and conferences, but also through informal contacts and researchers acting as consultants (Cohen et al., 2002). More directly, technology transfer may occur through contract research and industry collaboration and through licensing and the creation of new spin-off firms to exploit new technologies (Rogers et al., 1999). Even though licensing and spin-off firm formation stands for a relatively modest share of technology transfer from academic research, these channels can be very efficient and in some cases the only way to transfer new inventions into application. Therefore, a significant potential for increased technology transfer might be realised if there exists a well developed competence and infrastructure to use these mechanisms for technology transfer.

9.5.2 Entrepreneurship

Entrepreneurship, in the form of starting new firms (based on research results in the FORNY case), has so far been the most important output from the FORNY programme. As shown by the analysis of FORNY's firm portfolio in Chapter 5 and 6, these firms face substantial challenges in their development. From a theoretical point of view, these challenges may be related to the liability of newness and the liability of smallness that constrain the development of these nascent firms. New and small ventures have limited amounts of resources and may also have limited ability to access the resources needed to grow. The lack of resources may be related to financial and physical resources, but often more important the human and social resources

needed to develop the venture. Governments across the world have set up numerous initiatives to support the creation of new ventures, from financial support and incubator facilities to coaching, training and networking initiatives. Assisting the pre-start-up and start-up of new ventures have been an important part of the FORNY-funded activities taking place in the TTOs.

Table 9.2 Two models for commercialisation of research from public research institutions.

Model	Technology transfer	Entrepreneurship
Theoretical rationale for government support	Market failure related to underinvestment because of positive externalities	Liability of newness and liability of smallness
Key actors	Research institutions, researchers	Entrepreneurs (academics, but also others), investors
Output	Innovation and competitiveness mainly in existing firms	New firms

Following this argument concerning why governments should support technology transfer and entrepreneurship, it might be questioned whether the FORNY programme is struggling with pursuing a dual goal. Thus, FORNY is only partly filling the role of a technology transfer programme, and partly an entrepreneurship programme and, as a result, may have low performance in both.

On the one hand, FORNY is set up to increase technology transfer based on publicly funded research. Still, the focus is on the creation of spin-offs and licensing which represents a narrow set of mechanisms to achieve this goal. Moreover, the success metrics are related to revenue generated in a limited number of FORNY supported ventures and licenses, while the real impact of broader technology transfer activities is likely to be found across a range of firms and other actors in society. A further critique of the FORNY approach to technology transfer is that this activity has limited strategic relevance to the research institutions. Spin-offs and licenses are rarely very profitable and the direct impact is too low to be given priority among institutions and researchers. A strong commitment among the researchers and the research institutions is probably needed, but by focusing on commercialisation rather than technology transfer, the FORNY and TTO activities become less relevant to these key stakeholders.

On the other hand, FORNY aims to develop new ventures with a high growth potential, i.e. emphasised through the criteria for awarding bonus funding to the TTOs. As shown in Chapters 5 and 6, this has been extremely challenging within the current operation of the FORNY programme. Most of the spin-off firms from research institutions do not grow very much or at all. One explanation may be that they serve a different role by disseminating technology to their clients, rather than growing themselves. International examples show that high growth ventures are more likely to be spin-offs from industrial firms and even student ventures, rather than companies emanating directly from academic research. Still, universities and public research institutions can play a very important role in promoting high growth ventures in a region, as exemplified by cases such as Cambridge, Twente and Linköping in Chapter 3. Many high technology ideas are outside FORNYs area of operation, meaning that the programme

may miss out on some promising ventures that could beneficially have been promoted by the same support structure. By keeping a focus on research-based ventures, the research institutions are not assisted in becoming important players in regional development and job creation. Thus, the FORNY programme may not be able to mobilise many of the key stakeholders that are important for entrepreneurship.

The link between technology transfer and entrepreneurship is important. The creation of new firms based on research results can be a channel of technology transfer, but the benefits of these firms are not only related to size and profitability. Moreover, technology transfer creates opportunities for new ventures with high growth potential, but the research institution need not to be the incubator of these firms. The relationship between technology transfer and the entrepreneurship role is illustrated in Figure 9.1. The FORNY programme operates at the intersection between the vertical 'technology transfer' rectangle and the horizontal 'entrepreneurship' rectangle. As illustrated, FORNY plays a rather narrow role by not including other forms of technology transfer than licenses and spin-offs, by not including non-academic start-ups, and by not including technology transfer to ventures in the growth phase. Arguably, universities and other public research institutions can play important roles in all these activities and all activities are consistent with the main goal of FORNY (i.e. increased value creation in Norway through the commercialization of research results).

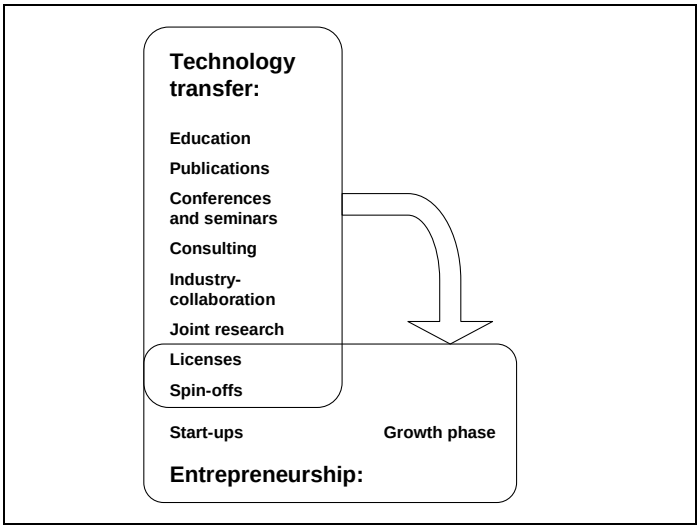

Figure 9.1 The relationship between technology transfer and entrepreneurship.

We do not have a clear single recommendation to the future design of FORNY based on this discussion. What matters is probably that RCN has a conscious treatise of these dimensions and principles when designing the strategy and organisation of the new FORNY. It would be important to try to improve the coordination between the core activity of commercialisation of research results and technology transfer more broadly, and to create synergies with other forms of entrepreneurship. This can be done by expanding the present focus to some extent,

perhaps by including advanced ideas from other actors or by urging (some of) the TTOs to play a broader role in technology transfer. A more radical solution may be to split the programme in two parts, where one is broadly oriented at increasing technology transfer from the Norwegian research institutions. The other part of the may be aiming at using the public research sector to leverage new venture creation, particularly with high growth potential. Coordination with e.g. SIVA's industry incubator programme may then become essential.

9.6 Main challenges for the future design of FORNY

In this final section, we discuss some important challenges for the upcoming revamp of the FORNY programme, where we include many of the aspects discussed earlier in the report and in the chapter. The challenges are related to: goals, coordination, bureaucracy, integration and balance.

9.6.1 Clarify the goals of FORNY

We believe that a future FORNY should reflect a lot upon its fundamental goals. What does the programme want to achieve? What is the problem it is trying to solve, the gap it is trying to fill, and the need it is trying to address? Historically the emphasis has been on the creation of spin-offs, which the name of the programme also reflects. This has obviously been a limitation for the success of the programme both in terms of getting ideas and in terms of creating results.

The goals are expressed more broadly now, but may on the other hand be seen as too numerous or too unclear. On the one hand FORNY has a fairly ambitious overall goal – wanting to increase "value creation" in Norway through commercialisation of research. Most of the underlying goals are a lot more general and diffuse, e.g. culture building and making commercialisation an integrated and prioritised part of the country's research activity. Partly, the goals point at very broad national concerns like research based industry development across the country and "improved coordination in the innovation system". Partly, the goals are self evident and thus unnecessary to formulate, e.g. competence as a basis for knowledge and learning or a positive development of the programme and its reputation. The fairly long list of goals may be seen in a critical light as a smorgasbord of good intentions that do not offer very much in terms of priorities and strategic direction.

We believe in particular that the programme needs to consider its fundamental delimitation to "commercialisation of research results". As argued in Chapter 3 and above in 9.5, commercialisation borders on "technology transfer" or "knowledge transfer" more broadly (including many types of university-industry relations) and it borders on entrepreneurship. In many cities and countries the latter often emphasises ideas and projects from students, and we have seen that many successful support programmes do not distinguish sharply between student-based and research-based entrepreneurship. By including both within one support programme, yet with clear selection criteria related to the potential of the idea and the growth potential and entrepreneurial skills, it might be easier to achieve a critical mass of commercialisation pro-

jects. A somewhat wider approach towards "technology transfer" could also help build a better support structure. Its aim would be e.g. to help ensure ideas from university-industry collaboration projects and to ensure successful commercialisation also for ideas that need neither patenting and licensing nor the creation of a new company. Only a minority of ideas are commercialised in these ways. FORNY may want to limit its funding to such projects, but there is no reason why the support structure of TTOs and the like should do so. With the close FORNY-TTO ties, this is a concern.

We recommend that the programme goals should be clear, concise and more focused on the specific tasks of the programme. Furthermore, the goals should be more dedicated to the core institutions it addresses (universities, colleges, research institutes, hospitals) and more specific in how to approach them. The goals should also place FORNY in a wider institutional system supporting entrepreneurship and technology transfer, including RCN, IN and SIVA and their various instruments. There should also be a good and clear link between the goals of FORNY and its funding mechanisms/instruments. Finally, the goals should ideally give some directions about the development of selection criteria and evaluation procedures.

9.6.2 Improve coordination in the commercialisation system

As argued in several chapters of this report, FORNY deals with a very complex system. It consists of a large number of universities, colleges and research institutes going through a strong period of growth, of a heterogeneous system of TTOs or "commercialisation actors" supporting many kinds of ideas going through various phases of development. The coordination challenges are formidable, and we will emphasise coordination related to commercialisation phases (here in 9.6.2) and technologies/industries (in 9.6.3). Coordination/integration related to research organisations is also important, this is discussed in 9.6.4. In general, we refer to coordination as attempts to avoid goal conflicts, unproductive overlap and too weak linkages.

Most spin-off projects and other commercialisation attempts go through rather distinct phases of development. Although the process is not necessarily linear and all phases are not relevant for all types of ideas, it is generally acknowledged that each phase needs specific types of funding and other forms of support. Coordination related to phases implies to ensure that there is not too much overlap between instruments (if all of them target only a limited set of phases) and that all the relevant phases for public support are covered. As argued in Chapter 7, we are somewhat sceptical about whether this is really the case.

Many of the funding and support instruments are clustered around the early phases of entrepreneurship, and there still seems to be a gap between public support and a later stage when private funding takes over. FORNY does not always seem to have a clear plan about what should happen before and after its support. For example, although verification (or proof-of-concept) funding is most likely a highly needed activity and found in many different countries, it is not really clear which instrument follows it in Norway. How can the verification funding help ensure a successful move to the next stage of support and growth? Some of the larger

user-oriented research programmes in RCN support FORNY with verification funding, but this does not seem to be very systematic. Many of the FORNY spin-offs go through IFU/OFU contracts, but there seems to be no active coordination between the two programmes at all. A wider system analysis is probably necessary, which is beyond the scope of this evaluation. These issues were, however, addressed to some extent in the assessment of the Norwegian government support schemes for the commercialisation of research (Rasmussen et al. 2007). Several specific suggestions for improvement of the Norwegian commercialisation system were outlined in that report.

Based on this evaluation, our suggestion would be to take coordination to a higher level in RCN and IN – the two owners of the FORNY programme, possibly also involving SIVA. A high-level group can be created that discusses relevant instruments for all phases of commercialisation/entrepreneurship and not least the linkages between these instruments. Some important issues are: what should be the next logical step after verification funding for a FORNY project, and who should run this funding mechanism based on which criteria? Can verification funds help the (good) commercialisation projects prepare for later funding mechanisms? Are there too many support instruments for the earliest phases; and perhaps gaps in the later phases as a consequence? Can some of the support, e.g. the verification funds, be somewhat expanded and made into a two-phase process with a low threshold Phase 1 with specific milestones and a higher threshold Phase 2 where only the most promising ideas are selected for a substantially higher level of support? Does the system lack a mentoring programme that could benefit projects in many phases of commercialisation – or is it assumed that sufficient mentoring is offered through the TTOs? Does the system lack a more centralised instrument for picking the most promising (but possibly underfunded) ideas – e.g. a set-aside of a few millions targeting the five best new mid-phase projects every year?

9.6.3 Improve coordination in the TTO system

We have also seen that commercialisation is very different depending upon the technology or scientific discipline in question. Whereas close-to-market ideas from e.g. ICT may require fast support and skip several phases, biotechnology is slow and expensive, moving through a large number of ever more resource-intensive stages. What is common is that all types often require very specific skills and expertise in the support structure – both to evaluate and find the best ideas, and to help them in a good way. This expertise is not necessarily needed "in-house", but many earlier studies of TTOs emphasise the need for industry-specific experience. In a small country like Norway it is unlikely that many TTOs can be built up with the necessary expertise to handle ideas from many different disciplines/technologies. Some form of coordination is therefore needed. FORNY has taken some important initiatives here, like the part of the incentive funds that rewards idea sharing and the regular meetings among the TTO leaders.

The basic approach of FORNY is to work through the TTOs, and most of the FORNY budget is allocated to them or directly to the projects these organisations are working with. Currently,

the system encompasses fourteen TTOs with a staff of around 110 people, and the main issue for the future organisation of FORNY is how this system should be designed in order to provide i) an efficient interface to the research institutions which create ideas for commercialisation, and ii) an efficient and specialised system for selecting and following up ideas and projects through the various stages of commercialisation.

As discussed above, the system has so far mainly been developed based on local initiatives. There has been no comprehensive strategy for how the system should be organised as a whole, and the system may presently be characterised as a less coordinated and loosely coupled system. Two principles of specialisations may be discussed as a starting point: by type of institution and by type of discipline.

Specialisation by type of institution: There are three main categories of institutions that are the target group of FORNY, i.e. universities/colleges, the research institutes and university hospitals, and the three categories raise quite different issues that may call for a differentiation of strategies in FORNY:

- The university hospitals are still in a fairly premature situation regarding culture for commercialisation and building system for commercialisation. Although some institutions have long traditions for commercialisation, like the Norwegian Radium Hospital, major parts of the system do not have these traditions. Medinnova now serves the hospital sector in the south-eastern part of Norway, while the university hospitals elsewhere are attached to the TTO serving the region's university.
- The research institutes are in a quite different situation. Industry relations are mostly well developed, and to some extent commercialisation is integrated in their primary activities. There may of course be some discussion and tensions related to the question of whether own commercialisation is possible and desirable for all research institutes (see Kaloudis & Koch 2004). If IPR issues and relations to existing users make commercialisation difficult, institutes would likely give low priority to it. Still, some of the best performing TTOs belong to the institute sector and are specialised for working with specific institutes. These TTOs have developed the most comprehensive strategies for commercialisation. However, again we have the mixed pattern, as many institutes are served by TTOs that also serve other types of institutions.
- The universities/colleges differ a lot in their traditions for working with commercialisation and practical application, and there are furthermore major differences with respect to disciplines and departments. Professional training e.g. related to engineering and agriculture has generally given rise to academic units with interests in and motives for commercialisation, but other fields are (increasingly) relevant. However, the incentives for working with commercialisation are vague and the majority of universities have not adopted a clear policy on commercialisation. Moreover, universities tend to create administrative support structure oriented at the whole institution, which means that university TTOs often have many other goals and consideration than value creation.

Specialisation by discipline: as mentioned, commercialisation processes differ a lot between different disciplines, technologies and industries. Specialisation can be achieved either as an incentivised bottom-up process or as a more top-down planned and controlled process. A combination is of course also possible; our general message would be to ensure that no strong incentives exist *against* specialisation.

A fundamental question is whether each research institution needs its own TTO, or if that would imply too much replication of effort. If the situation arises that more and more colleges, research institutes etc. start their own TTO-like organisations, FORNY needs to re-consider its strategies to avoid that the TTOs do not enter an unfruitful zero-sum competition game.

We suggest that the TTO support is reconsidered and remodelled after other institutional support schemes like the various centres of excellence programmes in RCN. The idea would be to introduce a stronger element of diversification yet maintain an emphasis on excellence (i.e. poorly performing TTOs can be removed from the system). An element of specialisation can be introduced in the selection criteria. There should probably also be a stronger emphasis on development of expertise in the TTOs.

9.6.4 Embed commercialisation, improve the integration with the research system

In an influential book from the late 1980s, Rikard Stankiewicz wrote about three approaches to academic entrepreneurship. A very common approach in Europe is *externalism*. In this view, commercialisation is seen as something that may be beneficial but that can also harm traditional academic activities of fundamental research and teaching. It therefore needs to be organisationally separate from HEIs, often found in a support structure of TTOs, science parks, incubators, liaison offices etc. in the borderline between the university/college and society's markets. This approach has many weaknesses and neglects the many synergies between entrepreneurship and research and teaching. The radical alternative, *internalism*, has been mainly favoured by e.g. specialised engineering colleges. The view states that all activities in academic departments should have an entrepreneurial and market- or user-oriented content. This has sometimes resulted in impressive innovations, but it has rarely helped create sustainable research units of consistently high quality.

For Stankiewicz, the ideal is a middle ground called *integration.* Academic entrepreneurship needs to be integrated with traditional research and teaching activities, but in a way that is mutually beneficial to both. We believe that FORNY needs to discuss three types of integration: with "normal" teaching and research, with university/research institute/hospital strategies, and with the needs of companies and the needs in markets.

Integration with teaching and research: This implies linking the activities and goals of FORNY with the individual and group levels in the research system, and this task has mainly been delegated to the TTOs. There is a dilemma between centralisation and decentralisation here

which has no easy solution. TTOs too far away (organisationally, culturally, geographically) from the basic research units will make it difficult to achieve a productive integration. However, a highly decentralised approach may make it more difficult to build visible TTOs with a critical mass of projects and expertise. To some extent the solution to the dilemma is to ensure that commercialisation is given priority in the strategies and overall activities of the universities, colleges, institutes and hospitals. FORNY's narrow approach as outlined above – with a weak linkage to broader entrepreneurship support and technology transfer activities – could, however, contribute to weakening the integration of FORNY-supported commercialisation with regular teaching and research.

Integration with HEI/institute strategies: It is an important precondition for the operations of the TTOs that commercialisation is an integrated part of the strategies of the research institutions, and that they prioritise the activities of the TTOs by allocating a sufficient budget to their activities. We believe that the strategic importance can be questioned, and that there is a lot of evidence that commercialisation or its broader and related activities of technology transfer and entrepreneurship are still minor goals compared to research and teaching. Changing research institutions in this respect is not easy to accomplish and depends upon framework conditions as discussed in 9.1. It is to a large extent beyond the circle of influence of FORNY to change the strategy and incentives of other actors. Even the aims to "change the culture" among the researchers will most likely be very difficult to accomplish if the institutions themselves give this a low priority.

The extent to which TTOs are embedded in the institutions they intend to serve also varies a lot. As the evaluation of NTNU technology transfer showed (Spilling et al. 2006), it can also be questioned whether the TTOs have strong top management support. There may be a danger that the TTOs' symbolic value as a follow-up of legislative changes and other demands becomes more important than their performance in practice. As was asked in the evaluation of the infrastructure funds, it is probably difficult for FORNY to have a strong commercial orientation for the TTOs if the TTO owners have a different view of these organisations' role. However, given the broader interest of the Research Council and some ministries, the current reorganisation of FORNY may also provide an opportunity to raise the broader issues of implementing a national strategy for commercialisation and influencing the strategies of the different types of institutions. FORNY could also contribute to starting a debate about the incentive systems for allocating basic funding to HEIs and research institutes, which presently carry no incentives for commercialisation.

Integration with the needs of companies and the needs in markets: This point falls largely on the side of the evaluation. There is still a need to emphasise that – given the present main goals of FORNY – the success of the programme hinges on the commercialisation projects' abilities to attract private investors and customers. With a large public support structure, there may be a danger that the TTOs (or some of them) only become vehicles for attracting more public money from other sources – and that the FORNY programme itself constitutes a

rather unfruitful view of innovation as mere technology push from academia. FORNY's incentive funds do take customers and private investments into account; this could perhaps be emphasised more strongly in the main goals and mechanisms of the programme.

In addition to what has already been mentioned, we suggest that FORNY works more actively for a better integration of its goals and activities with those of the research system it serves. FORNY should not be satisfied with becoming a general support mechanism for HEIs and some other research institutions, providing basic funding for TTOs and similar organisations. One solution would be to have a "matching funding" criterion: for each NOK of TTO support from the institutions' *own funds*, FORNY can put up a matching NOK. Another solution would be to expand and change the incentive funding scheme to give stronger incentives to the involved research institutions rather than to the TTOs – the latter can be expected to have fairly similar goals to FORNY itself.

9.6.5 Reduce the bureaucracy

As discussed, FORNY has chosen a highly decentralised structure with a fairly weak and small central organisation. The programme itself rarely deals with entrepreneurs and researchers directly; this happens through the TTO structure. In addition, FORNY itself is entangled in a complex set of delegation with multiple "principals" (who delegate tasks) and "agents" (who get chosen to perform specific tasks). The programme is developed in collaboration between RCN and IN, receiving money from several ministries, sometimes with specific strings attached. Each of these delegations increases the risk of goal conflicts, information asymmetry, severe reporting demands, slow decision-making processes and other aspects commonly associated with bureaucracy. FORNY's choices like many different TTOs based on different logics and four different funding schemes are likely part of a process of reducing goal conflicts and accommodating the needs of ministries and other principals. Some of this is therefore tied to the "sector principle" in Norwegian science policy – which has been frequently criticised, not least in the evaluation of RCN from 8 years ago. RCN's possible lack of strategic freedom may be a barrier towards developing a good programme for commercialisation of research results.

As we see it, the main challenge in this complex system is to identify, support and champion the best ideas and opportunities while creating as little red tape and delays as possible. This is not necessarily easy given the large number of actors involved with partly conflicting or partly overlapping goals. It may be added that FORNY seems very different from most other research council programmes. It does not give much funding directly to the ones who have the ideas that form the basis of the commercialisation activities; and the evaluation of the quality/potential of the ideas is left to the FORNY-supported TTOs rather than a more independent group of experts as would be the norm in most types of R&D-related support.

Our suggestion would then be to take some steps in making FORNY more like other R&D programmes where proposals are evaluated by independent "peers" (probably different ones are needed to assess market potential and scientific/technological potential). We would also recommend that – given the number of levels and actors in the commercialisa-

tion system – reporting and application procedures are kept fairly minimal. In the first phase of support, the system could perhaps be based more on trust rather than applications and reporting.

9.6.6 Deal with gender imbalances

As discussed in Chapter 8, gender issues are important for the future organization of FORNY. The programme operates in a field characterised by significant gender imbalances, and the programme currently contributes to strengthen the general tendencies of gender divided structures in academia as well as in the business world. Generally, there is a male bias in the most commercialisation relevant disciplines, and as documented, this bias is strengthened in the commercialisation process. While the share of women among the academic staff in the most relevant disciplines generally is in the area of 20-50 percent, the share of women among the teams of the commercialisation projects is significantly smaller; a rough estimate is about ten percent. Moreover, the FORNY start-ups with women as managers or chairmen of the board, account for just six and seven percent respectively of all the start-ups.

It is therefore most important to develop strategies that may contribute to a better balance between men and women in academia in general and in academic entrepreneurship and commercialisation processes in particular. However, as claimed in Chapter 8, rather than implementing specific measures as part of the FORNY programme, we recommend that gender issues mainly should be followed on a broader basis through more general programmes outside FORNY. The rationale is that FORNY is a very particular programme with specific instruments like commercialisation funds, proof of concept funds and leave of absence grants. The main criteria for selecting ideas and supporting projects are related to the projects' market potential, technological and scientific quality, the quality of the team etc. From this perspective it is of less relevance if the project is initiated by a woman or if the project team has a woman among its members.

It is important that these issues are followed up in the Governments' current action plan for more entrepreneurship among women, and in RCN's action plans for women entrepreneurship and women in research. A significant weakness in the Government's action plan on women entrepreneurship is that it provides no systematic focus on entrepreneurship among people in higher education in general and women in academia and their role in technology transfer and commercialisation in particular. The plan neither addresses issues related to entrepreneurship education provided by institutions for higher education, nor the potential of handling issues related to women entrepreneurship through these programmes. On the other hand, the action plan includes the strengthening of support for women entrepreneurs through some of the instruments in Innovation Norway and Siva; however, these measures could be further strengthened by more specifically targeting women currently in higher education, and women employed in universities and research institutes.

As far as RCN's action plan for more entrepreneurship among women[17] is concerned, the plan provides an overview of available data on the role of women in various RCN funded programmes, and it signifies ambitions for increasing women's participation in the programmes. However, regarding the ambition of more entrepreneurship among women the plan is surprisingly vague, and there should be a great potential for coming up with more committed strategies. Again, we will point to the need for addressing women in academia and for developing plans to motivate and support women to be more active in commercialisation and technology transfer. One potential action might be to launch a mentoring programme in collaboration with the primary target institutions of FORNY.

To sum up, we suggest that gender imbalances are targeted more broadly than within the frames of the FORNY programme. Nevertheless, a mentoring programme, as suggested in 9.6.2, could have a component targeting women in particular.

9.7 The way forward

FORNY is an innovative programme with a strong will to experiment and change its approaches over time and based on experience. It is entangled in many different tensions where the best it can do is to ensure that there is a good "balance" between various types of support. FORNY cannot effectively choose only to support a handful of assumed "excellent" ideas or to support any idea appearing in its way. A balance is obviously needed, but this does not mean that any middle road is equally good. Some important tensions and balances are:

- Supporting cultural change/"entrepreneurial spirit" versus practical help for commercialisation.
- Becoming a service organisation for everyone with an idea versus focusing strongly on the high growth potential ideas and entrepreneurs.
- Demanding results and deliverables versus exhibiting the patience necessary to allow commercialisation to grow.
- Asking critical questions to the entrepreneurs versus championing and cheerleading them.

These difficult balancing acts, the many changes over time – not least the legislative changes in 2003 which completely changed the rules of the game and the support structure – and the complex system that FORNY has helped create, all contribute to making evaluation and strategic advice very complicated. For example, some of the underperformance of FORNY is probably due to the noise created by the legislative changes and the slow follow-up of them by the HEIs and other actors (like RCN's IPR policy). We have generally recommended the following:

[17] "Mer entreprenørskap blant kvinner. Opptrappinsplan 2008-2013". Forskningsrådet, desember 2008.

- **Clarify goals:** FORNY contains many general and broad goals yet it is based on a rather narrow definition of commercialisation. We have recommended that the programme positions itself more openly with respect to the broader activities of technology transfer and (advanced and/or student-based) entrepreneurship.

- **Improve coordination and integration:** FORNY is only weakly integrated into a broader commercialisation support structure and only weakly related to the strategies and activities of the research institutions themselves. Several actions have been suggested to improve coordination and to create incentives for a better integration of the system.

- **Rethink the activities:** FORNY is one of several initiatives targeting the early phases of commercialisation and entrepreneurship. In addition, it gives more or less basic funding to a host of TTOs. We have argued that basic support to TTOs should to a greater extent be based on a matching funds principle, that the link between the different types of funding (also from actors other than FORNY like SIVA, IN and other RCN programmes) should be improved, and that potential gaps should be addressed. We have e.g. mentioned the post-verification phase and the possible need for a broader mentoring programme.

There may be good reasons to reconsider the "TTO agency"/"R&D and innovation programme" hybrid model of FORNY itself. Two radical new paths can be envisaged:

- **FORNY as a *TTO programme*:** In this model, FORNY cultivates its role as an organiser of the TTO system, emphasising the infrastructure and commercialisation funding for a first review and development of ideas and concepts. New mechanisms may be needed e.g. to ensure a good sharing of work and ideas between the TTOs and more directly to support development of expertise. Later phase support for verification/proof-of-concept and prototype development/commercialisation should probably be left to other actors like the Innovation Division of RCN or IN (or both if they can coordinate their efforts sufficiently). This may continue as a highly decentralised model or as a more top-down controlled model with a "TTO Norway" on top.

- **FORNY as an *R&D/innovation programme*:** In this model, FORNY cultivates its role as a supporter of the commercial development of good ideas and concepts that emerge from research institutions. Infrastructure and commercialisation funding should be reduced and at least based on equal financial support from other actors (preferably the research institutions themselves). Proposals – submitted by the entrepreneurs themselves or by the TTOs – are evaluated by independent experts based on a more or less explicit set of criteria. A milestones model may be developed where projects that meet pre-defined milestones will be eligible for a next phase of funding. The funding follows the good projects and their entrepreneurs, not the support structure.

The third alternative is to keep FORNY as a general commercialisation programme like today, which does provide many actors with a "one-stop-shop" for issues related to commercialisa-

tion. This alternative would still require a clearer demarcation between support for the system and support for the ideas, and a weakening of the ties between the TTO s and the FORNY central organisation. In this manner, TTOs may become more strongly anchored in their regions and institutions and play a broader role – even if FORNY continues to emphasise commercialisation of research results as its main activity.

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Appendix

As part of the evaluation, data has been collected through the following web based surveys:

1. Survey to the TTOs participating in the FORNY programme
2. Survey to the FORNY start-ups
3. Survey to licencees
4. Survey to licencers.

All questionnaires are in Norwegian, and may be available upon request to NIFU STEP.