

# Leveraging Science for Innovation

Swedish policy for university–industry  
collaboration 1990–2005

Merle Jacob and Luigi Orsenigo

A report from the SNS Project  
New Dynamics in the Swedish Innovation System

SNS – Swedish Centre for Business and Policy Studies

SNS Förlag  
Box 5629  
SE-114 86 Stockholm  
Tel: +46 8 507 025 00  
Fax: +46 8 507 025 25  
E-mail: [order@sns.se](mailto:order@sns.se)  
[www.sns.se](http://www.sns.se)

SNS – Centre for Business and Policy Studies – is an independent network of leading decision makers from the private and public sectors who share a commitment to social and economic development in Sweden. Its aim is to improve the basis for rational decisions on major social and economic issues, by promoting social science research and stimulating public debate.

*Leveraging Science for Innovation*  
*Swedish policy for university–industry collaboration 1990–2005*  
Merle Jacob and Luigi Orsenigo

First edition

© 2007 Authors and SNS Förlag  
Design: Allan Seppa  
Printing: 08 Tryck, Stockholm, 2007

ISBN: 978-91-85695-18-8

## Table of contents

Publisher's preface 5

Acknowledgements 6

Executive Summary 7

### 1. Changing higher education and research: a review of the state of the art in science and policy 20

Introduction 20

Innovation policy: the current orthodoxy in science policy 21

From Linear model to University-Industry collaboration 25

Alternative views 30

Structural differences between the Anglo-Saxon and the Continental European academic systems 38

How do structure and organisation matter? 39

Legitimizing narratives: the Triple Helix, Mode 2 and Systems of Innovation (SI) theories 47

– System of innovation (SI) 49

– Mode 2 knowledge production 55

– The Triple Helix thesis 61

– Conclusion 63

### 2. Promoting the evolution of the entrepreneurial university

– Swedish Policy, 1990-2005 65

Historical background 66

– 1940s–1960s: From Laissez-faire to Sector research policy 66

– 1970s–1990s: Mass education, Sector research policy, Decentralization 73

– First generation mechanisms for knowledge transfer 76

– The development of regional university colleges and universities 80

– Other developments 81

From Science to Innovation policy 84

Reform of the system for financing research 90

The strategic research foundations: Catalysts in the shift from science to innovation policy 93

The reorganised council system 100

Enabling the entrepreneurial university 108

- Linkage institutions 109

- Foundation universities 110

- The teacher exemption clause (lärarundantaget) 113

A Nordic Perspective 116

3. The way ahead: Observations; Indications of the future; Policy implications 124

    Concluding observations 124

    Some indications of the future 133

    Policy conclusions 135

References 140

## Publisher's Preface

In this report, professors *Merle Jacob*, Oslo University, Norway, and Research Policy Institute at Lund University, Sweden, and *Luigi Orsenigo*, University of Brescia and Cespri, Bocconi University, Milan, Italy, provide an analytical overview of the trends in the governance of Swedish public R&D, 1990-2005. The report focuses on the Swedish policy for university-industry collaboration.

The study is one of the outflows from a research project titled “New Dynamics in the Swedish Innovation System” (*Ny dynamik i det svenska innovationssystemet*). This project was initiated as a spin off activity by a group of international scholars who were invited to Sweden by the Swedish Centre for Business and Policy Studies (SNS). This group of scholars functioned as the international advisory panel for an evaluation, carried out by SNS and the Umeå Centre for Evaluation Research, of the then recently formed Knowledge Foundation's (*KK-Stiftelsen*) programme on knowledge exchange between universities and firms. The evaluation and the activities connected with it awakened the group's interest in the, at that point in time (around 2000), still unfolding innovation policy in Sweden. The group (which consisted of Professor *Henry Etzkowitz*, Science Policy Institute, State University of New York, Professor *Luke Georghiou*, PREST, University of Manchester, Dr *Ingrid Schild*, Umeå University and the two authors of the present report) continued to meet at SNS, participated in seminars, and formed the core research team of the SNS study of the Swedish innovation system. They have been a source of inspiration to several other publications from the project including one on the Triple helix and one on the Nordic innovation systems.

The report is based on extensive interviews with insightful people. Preliminary versions of the report were discussed at several seminars. The major part of the funding of the project came by a grant from VINNOVA, the Swedish governmental agency for innovation systems. SNS would like to express its gratitude to all who contributed.

Stockholm, March 2007

*Göran Arvidsson*  
Research Director at SNS

## Acknowledgements

The authors would like to thank the following for taking the time to read the text and giving critical feedback: Mats Benner, Aant Elzinga, Henry Etzkowitz, Sverker Sörlin. Special thanks to Sören Barlebo Rasmussen for help with the Danish part of the study. As always, mistakes and flaws that exist in this text are solely our own. The preparation of this document took a number of years and dialogue with actors from all parts of the system. We were met by openness, enthusiasm and courage. We would like to thank all of those whom we met but are unable to mention by name here.

Merle Jacob, Luigi Orsenigo

## Executive Summary

The adoption of the *knowledge society* as the new *leitmotif* for policymaking has encouraged OECD countries to focus policy efforts on the contribution of science and technology to innovation. The fundamental premise of the knowledge society – that knowledge is a source of economic growth – serves both as rationale and justification for changing the governance of public R&D. The primary objective of the new governance regime is to promote greater integration between public R&D and the economy. National research or science policy has been identified as a primary policy mechanism for achieving this realignment in part because the public research sector has been in most countries targeted as the main social carrier of the proposed changes. For this reason, research policy is progressively becoming subsumed under or integrated with innovation policy.

The first chapter of the report is devoted to a review of the policy arguments for research and innovation policy and the academic arguments for and against the policy rationale. The chapter is concluded with a review and analysis of three of the most, to date, influential perspectives on policy (Systems of Innovation, Mode 2 and Triple Helix). The next chapter contains a description and analysis of the Swedish case: The evolution towards the entrepreneurial university. The third and final chapter presents conclusions and observations about possible futures.

### From Linear model to University-Industry collaboration

Research or science policy, like many other policy endeavours, is a child of the post WWII era and this has influenced the way in which the area was constituted and subsequently developed. Students of science policy would know that the most dominant model and metaphor in the practice and theory of the field has been the ‘social contract of science’, which is in itself based on

the linear model of innovation. This contract metaphor was a convention adopted by science policy scholars to describe the terms, under which public money was allocated to science and how science would account for its receipt of this money. In its most idealistic form, the social contract assumes that scientific inquiry would produce gains in wealth and welfare for society without active steering from government or other stakeholders.

The advent of research and innovation policy has been accompanied by a shift away from the linear to a more interactive model of the relationship between science, technology and innovation. This new policy insight comes in the light of more than a decade of academic critique of the linear model and copious reports from the OECD.

During the period in which the linear model held sway, investments in science were treated as investments in future rather than present economic and social wellbeing. A number of factors have contributed to increasingly undermine, or at the very least create the need for alternative approaches to science policy. Among the more prevalent of these has been the increased dependence of technological innovation on science. The era of science based technology transformed to a certain extent the competence profile of industry to create a demand for more highly skilled workers and a closer connection between industry and sites of knowledge production such as the university.

The emergence of flexible, information, and bio technologies has raised the level of the knowledge requirements for entry level workers and created a need for continuous upgrading of the skills of the extant workforce. This taken together with the trend towards localisation of industrial R&D to universities and other types of knowledge producing organizations, have created a need for an emphasis on training and life long learning as opposed to education according to the *bildung*<sup>1</sup> model.

---

1. The *bildung* model emphasises education as a part of the preparation for citizenship in a democratic society rather than education as the acquisition of a specified class of skills necessary to qualify to perform a specific occupation (training).

Further, studies from organizations such as the OECD began to alert policymakers to the existence of what is now known as Europe's 'innovation deficit'. This deficit refers to the low level of innovation output relative to R&D investment by European countries. These heightened policy expectations are based on comparisons with the US and Japan. Although the notion of an innovation deficit gives the impression that there is a direct proportional relationship between R&D investment and innovation, research shows that this simple relation does not obtain. Translating research results into innovation requires a number of intermediary conditions including infrastructure such as technology transfer offices, organisational and individual incentives as well as supporting skills and cultural norms. Moreover, there has always been a significant percentage of innovation that is not research driven. A further point of interest in this regard is that, to date, there has been no systematic investigation of Sweden's innovation output relative to R&D investment or of the actual level of entrepreneurship that exists in the population.

As the linear model lost legitimacy in policy, a number of new evolutionary inspired perspectives began to emerge as influential both in research and ultimately policy. Among these the systems of innovation perspective is undoubtedly the most successful. Other influential models are the Triple Helix and Mode 2. It is often argued that policy is more influenced by policy and trends in other countries than by research. Recently however, there has been a deliberative attempt within research and innovation policy to couch policy arguments in the language and reasoning of the three above mentioned research perspectives. These perspectives all emphasise that innovation is a collaborative effort that involves several different actors within the economy. They further show that academic knowledge is but one component in innovation and emphasise the importance of elements such as entrepreneurship and technology transfer to the successful transformation of knowledge to growth.

One of the advantages of the linear model apart from its misleading simplicity is that it justified leaving research steering to researchers and the transformation of knowledge to wealth to industry. This implied that science policy could blackbox

the activity it was seeking to govern and rely on the principled agreement implied by the social contract to ensure that all parties met their respective commitments. Further, it relieved policymakers from having to understand or be informed of the ways in which knowledge was transferred from universities to industry and the society as a whole.

By shifting to a more interactive approach to innovation policy, policymakers inadvertently raised the barrier for how much knowledge about the relationship between R&D investment and innovation is required in order to create good policy. The inflation of knowledge demands for innovation policy is illustrated by the increased importance of expert bureaucracies such as the OECD, VINNOVA and the EU's DG Research.

This mix of international and national expertise on research and innovation policy is also co-dependent on the university research community. This co-dependence is gradually leading to, for the first time in OECD countries, an epistemic community comprised of practitioners and researchers in innovation policy. The increasingly important role played by this transnational advice community, the susceptibility of policy to fashion and imitation and the increasing influence of globalisation on the organisation of innovation may also explain another phenomenon i.e. the increasing convergence of policy instruments across OECD nations. By convergence, we mean the use of similar instruments such as centres or networks of excellence, promoting future research leaders, etc. These instruments may be found both at the nation state as well as the transnational (Nordic, EU) level. A close examination of the instruments will show however, that there are often variations in how they are implemented or designed depending on the peculiarities of the national context.

## Research and Innovation policy in Sweden

Sweden's public R&D sector has 61 higher education and research institutions (HER) and a small research institute sector. The majority of R&D performed in the public sector is done within the universities. This is a result of a decision to ensure that education and research are co-located. The historical development of Swedish research policy may be described as one

in which state steering of research has increased with time although the nature and form of this steering has changed. For example, universities now have considerable autonomy to decide on how to run their organisations, appoint professors, etc. This freedom is however balanced by state control over revenue flows and the rules of engagement for how universities can organise their activities. Increased steering of research has been the result of changing rationale for governance and funding of research and driven by international and domestic trends.

The innovation deficit argument that has driven concerns about European innovation output has also been an important driver in Swedish research and innovation policy. Sweden's annual investment in R&D is considered to be among the highest in Europe (4,3% of GNP, 2001). Although less than 1% of this accounts for public spending on R&D, the thrust of research and innovation policy has been that, with the right policy measures, the innovation output of the public R&D sector can be significantly improved. At the risk of oversimplifying a complex set of policy initiatives spanning a period of at least one decade, contemporary Swedish research and innovation policy may be said to have three broad objectives: to promote the development of an entrepreneurial culture in higher education and research (HER); to promote a greater degree of interaction between HER and the rest of society, but primarily industry; and to increase the pace of the commercialization of knowledge produced in HER.

These objectives have been pursued primarily, although not exclusively, through a reorganization of the research financing system to promote more reliance on competitive funding and the creation of infrastructure to commercialize research results. The introduction of these measures has been gradual and in many instances there has been a spirit of experimentation akin to a type of policy entrepreneurship. By this we mean that there was a vision rather than a plan. Many initiatives have been sponsored or championed by key individuals working within the research foundations or elsewhere. This spirit has meant that some initiatives were rather bold and were set into motion before the dependencies in the different parts of the system had been understood.

The above measures appear fairly straight forward however, in order to get the system, such that it was, to a point where these initiatives would make sense, a number of other reforms and measures had to be introduced. These ranged from reform of doctoral education and the system for appointing professors to a complete overhaul of the system for financing research. The last is possibly the reform measure which took the longest and involved the most change. Prior to reform, the system for financing public sector R&D was extensive but quite fragmented. One of the more important drawbacks of this fragmentation was that very few, if any, of the public research councils could support projects or programmes of the magnitude and costs that are now quite commonplace in research financing.

The strategic research foundations were introduced in the early 1990s (1994) as part of the first wave of research financing reform. The intention was that the foundations would assist in the renewal of Sweden's innovation system. The foundations differed from other public research funders in Sweden in 3 important respects. They do not depend on annual budget allocations, they fund large scale programmes usually of 4–10 year duration and they promote collaboration between research and other parts of society. Although initially controversial, the foundations initiated a number of innovations in research funding that have subsequently been adopted by other actors. These include the research schools and promoting the development of critical mass. While the foundations provide much needed large scale grants for starting up new research ventures, as yet there are no arrangements for ensuring the sustainability of the initiatives that they introduce. This remains an important drawback of the system that has yet to be addressed.

With the reform of the research financing system and the increased interest in innovation came the need for an agency that would coordinate this new policy area. In 2001, the government created a new agency called the Swedish Agency for Innovation Systems (VINNOVA). This agency has among other things responsibility for providing expert advice on innovation policy. As part of the support structure for its advisor role, VINNOVA performs, commissions and finances research in a number of areas including innovation policy. The creation of VINNOVA provided for the first time in Swedish history,

an advisory body for research and innovation policy that was not ad hoc. Nevertheless, the fact that universities are the main knowledge providers coupled together with the sheer number of other governing agencies in the public research sector implies that VINNOVA's mission is a complex one and its impact on the sector as a whole will be difficult to evaluate.

The reorganisation of the research financing sector continued six years after the founding of the strategic foundations to include the regular research councils. The result of this second level of reorganisation was a much simpler council structure with one council for basic research (*Vetenskapsrådet*) and two others (*FAS* and *FORMAS*) for more applied research.<sup>2</sup> The council for basic research has also been given responsibility for the governance of all basic research in the country. This is another way in which the governance structure for the Swedish research system has become increasingly complex as the basic science council is not yet another layer in an already overly complex governance structure. The basic science research council also has yet to exploit its full potential with respect to governance.

The attempt to promote more reliance on competitive funding has been successful in so far as universities are now more dependent on external money than when the policy was initiated. This has been in part due to the fact that fixed and direct appropriations to universities (*fakultetetsanslag*) have been reduced. This means that the majority of the fixed income of universities' comes from teaching rather than research and it is not permissible to transfer money from one activity to another.

The changing demographics, a market oversupplied with student places, labour regulations and the increased institutional burden all converge on creating pressure on universities. New recruitment for example is almost completely dependent on external grants. The increased dependence on soft fi-

---

2. It is important to bear in mind here that the distinction between basic and applied research is a fragile one. Thus, a significant portion of the research supported by FAS and FORMAS could be described as basic. The main difference between these councils and the basic science research council appears to be the dominance of disciplinary based research at the basic science research council.

nancing taken together with the changed pattern of funding towards large scale programmes has additional and perhaps unexpected impacts. Among the more significant of these have been the need for research support competence among university administration and the need for leadership competence at nearly every level of the university. The problem of leadership has thus far been given scant attention<sup>3</sup> and that of research support none. The interrelation between these competences and successful commercialisation of knowledge is also an area that has been more or less ignored.

A variety of different steering instruments have been used to promote the development of an entrepreneurial culture in HER. One of these is the creation of infrastructure for commercialisation of academic knowledge such as university holding companies and the innovation bridges. A second instrument introduced to promote entrepreneurship has been the reform of the university charter to include the Third task. According to this reform, universities are now obliged to inform the surrounding society about their research. While this does not imply the commercialisation of knowledge but rather knowledge transfer, commercialisation has become the preferred means of knowledge transfer. It is important to realise that while much attention is given to this aspect of knowledge transfer, very few concrete results and even fewer success stories have emerged. Knowledge transfer through *folkbildning* and working with local communities has yet to be fully exploited in Swedish HER.

Thus far, the approach to promoting entrepreneurship in HER institutions has been top down since the state has yet to explore the full implications of adopting a systemic approach to research and innovation policy in terms of participatory and stakeholder led policymaking. One consequence of this com-

---

3. A number of government reports about leadership in universities have been produced. Further, new dictates about leadership have also been introduced, e.g. that all employees are entitled to a personal development talk once a year. Apart from a few courses in leadership, there is little discussion about incentives for those leading or those being led. To the extent, that there is a discourse (practice and policy), it seems to be dominated by a culture of adding 'merit' rather than of promoting the development of a skill that would actually be valued and of practical use.

mand style research and innovation policy has been that thus far, there has been no systematic attempt to explore incentives as a potential instrument for promoting entrepreneurship. Thus, individuals and organisations are expected to engage in these tasks, in addition to all the other tasks they usually perform, in an era of decreasing resource allocation, because they have been told that it would be good for society as a whole. Surprisingly, this has been on the whole rather successful. Part of this success may be attributed to the ability of the research community to absorb extra costs through voluntary input of time and labour. Another reason for the success of policy so far is adaptation by the HER sector. Higher education institutions themselves have cashed in on the act by creating courses in entrepreneurship and promoting research about entrepreneurship. This is probably among the fastest growing new social science areas within Swedish HER.

## Policy Conclusions

HER institutions in the OECD and in Sweden in particular face a future of unprecedented challenges. Higher education is now treated as the integrating force for four powerful and important policy areas: science and technology, higher education, labour market and territorial (regional) development. This burden is all the more cumbersome given that Swedish research and innovation policy does not appear to have a self-conscious and outspoken commitment to coordinate these sectors. The underlying policy ambivalence about whether knowledge transfer or direct contribution to economic growth should be the lead performance indicator for HER is a paradigmatic instance of this dilemma. This, as mentioned earlier, is not a unique Swedish problem but is common in OECD countries.

In conclusion, the period of 1990–2005 has been one of intense reform in a policy sector that is noted for its complexity. Much of the result of this reform is difficult to evaluate for a number of reasons, in other instances, evaluation would be premature. The overall impression is that reform has been necessary to bring Swedish HER policy more in line with other OECD countries. In the light of extant reforms however, it is now apparent that a number of issues need to be singled out for

attention in the near future. In order to make sense of this, we have chosen to couple suggestions to particular actors rather than provide a list of suggestions of things to be done. Our chosen targets for this advice are university management, research councils and policymakers at the ministerial and agency level. It is important to understand that these conclusions are not all deduced from the discussions here but are also developed with an eye to what would be logical next steps given the status quo described in chapter 2.

## **Policymakers**

### *1. Clarify the goal of research and innovation policy*

All policies benefit from having clear objectives. At present Swedish research and innovation policy is confused on the issue of whether knowledge transfer or growth is the immediate objective. Clarity on this issue would be necessary in order to develop appropriate indicators of evaluation and new instruments to promote policy objectives.

### *2. Diversify the public R&D sector*

The Finnish example shows that if producing knowledge to promote innovation in the short and medium term is the main goal, then a good functioning institute sector is a better provider than the university. Several studies both national and international show that universities are not the preferred knowledge providers for many firms particularly SMEs. Innovation policy may need to focus not just on ensuring knowledge supply but also on understanding the nature of existing demand for knowledge.

Universities serve multiple stakeholder interests and of necessity promote a knowledge culture which is directed at knowledge production for more long term needs. This implies that universities would be better at securing current and future absorptive capacity of the population through their education function and producing knowledge for innovations in the future through their research function. It is important to understand, however, that developing an institute sector in Sweden is not a quick fix to the problem of knowledge transfer. It may

take at least a decade before one sees professional and well functioning institutes that can fulfil the needs of the system.

### *3. Promote the development of skills needed to lead and support the commercialisation of knowledge*

There is a general shortage of the capital (competence and financial capital) needed for Swedish universities to promote commercialisation of knowledge. Institutional solutions such as the innovation bridges and the university holding companies perform well but are not in themselves enough to achieve the goal of commercialisation.

A pilot approach which would allow available financial capital to be concentrated at one or two sites where the competence in commercialisation already exists would be one solution to improving the situation. The pilot cases could be used to develop experience and as sites from which individuals could develop the necessary skills for leading and implementing commercialisation efforts.

### *4. Encourage universities to develop a professional administrative competence*

The administrative structure of Swedish universities needs to be re-evaluated. In particular, attention should be paid to identifying the competence and skills necessary to support and not just administer the core functions (teaching, research and knowledge transfer). This process cannot be achieved through policy directives alone but will require additional capital and continuous dialogue between university leadership and the state.

## **Universities**

### *1. Re-examine the role of faculty and departmental leadership*

Leadership and management have become critical issues within universities as a result of their changed circumstances and new missions. Swedish universities are gradually moving towards a more professionalised cadre of management at the vice chancellor level. This however has to be accompanied by a similar approach at the other levels such as deans and department

leaders. Universities need to be encouraged to lead the initiative to change the way in which academic institutions are led and managed.

### *2. Develop new management models*

Universities need suitable models for managing institutions of research and education and should search for such models in higher education research and practice primarily. Swedish universities should avoid duplicating the indiscriminate borrowing from the corporate sector that has become the norm in higher education and research in other countries.

### *3. Organisational Profiling*

Universities need to focus more on profiling themselves by singling out those competences at which they excel and building on them. The idea that universities should be entrepreneurial is not new although it is certainly new to Sweden. It is, however, important to bear in mind that there are several ways in which universities can be entrepreneurial. Commercialising knowledge is one approach and even in this model, there are variations. There are several other paths to the entrepreneurial university, including anchoring the university more firmly in its local community. Whatever the path chosen, it should be grounded in a realistic assessment of the current competence of the organisation, local demand and its future potential.

### *4. Explore the possibility of institutional integration*

The current market for higher education and research in Sweden is oversaturated. Policy has been preoccupied with finding reasons for supply based on ideological motives rather than on basing the supply of student places on an assessment of demand trends. It may therefore be necessary for Swedish universities to imitate some of their counterparts in the UK by promoting institutional integration. Strategic mergers or partnerships with other universities in the same geographic region need to be investigated as a potential solution. Swedish universities are limited in their ability to take advantage of this option in the fashion of their UK counterparts but alliances and shared offerings may be possible assuming resource allocation problems can be surmounted.

### *5. Use individual incentives to promote new organisational goals*

Incentives are very rarely used as mechanisms for introducing organisational and attitudinal change in Swedish universities. Even the universities that are legally able to innovate in this sector, such as Chalmers, are surprisingly uncreative in this regard. The dominant approach has been legislation and new steering rules. Experimenting with prizes and other types of positive incentives to individuals and institutions, that represent qualities which are seen as exemplary or future oriented, can be one approach for future policy. Staff and other stakeholder communities should also be encouraged to submit suggestions for what kinds of incentives would be appropriate and what kind of attitudes and performance that are not currently covered in the incentive system that they would like to lift out as exemplary.

## **Research Councils**

### *1. Support the improvement of project management*

The linking of research with innovation policy taken together with EU initiatives such as the European Research Area (ERA) mean that the governance of research is now a multilayered policy task. Research councils may have to at least for an initial period promote the development of management skills at universities. This could be done by demanding accountability from universities for the administration of projects.

### *2. Use internationalisation to increase benchmarking and innovation in commissioning strategies*

Research council commissioning policies and infrastructure for the development of such policies need to be benchmarked against that of other countries with a view to identifying possible sources of learning and innovation. The research councils in Sweden are increasingly becoming internationalised because of the multilayered nature of research and innovation policy. This implies increasing cooperation across national boundaries and even funding of transnational projects that may include partners outside the Nordic or EU regions. This is a new source of knowledge that could be exploited and used to the national benefit in a systematic fashion.

# Changing higher education and research: a review of the state of the art in science and policy

## Introduction

This is one in a series of reports from an international collaboration initiated as a spin off from an evaluation of a program to promote knowledge transfer between universities and firms in Sweden. The evaluation was organized by the *Centre for Business and Policy Studies* (SNS), carried out by the *Umeå Centre for Evaluation Research* (UCER) and supported by an international advisory group. This group then initiated a study of the dynamics of the Swedish innovation system. One of the sub-projects is the subject of this report.

The material presented below comes from a number of sources and was collected over a period of two years. During this period, the project group<sup>4</sup> met with and interviewed a number of actors in the policy (chiefly research foundations) and business environments in Sweden. Our interviews were conducted with an eye to collecting information but also with the intention of giving those interviewed the benefit of the group's experience and knowledge. A second and perhaps more important source of material for this report has been existing government reports and evaluations (*SOU utredningar*) and debate articles and papers that were written either in response

---

4. The research group was comprised of the following: Göran Arvidsson, Per Elfner, Henry Etzkowitz, Luke Georghiou, Luigi Orsenigo, Merle Jacob and Ingrid Schild.

to these reports or to government white papers. Thirdly, the context of the project was unique in so far as not only did we have access to many of the influential actors in the Swedish policy and business contexts but the group as a whole represented a rich mine of knowledge and experience about science and innovation policy in Europe and the US. At least two of us are well initiated in one or more of the Nordic countries policies as a result of years of participation in various evaluation committees, etc. The experience of the group members was utilized to nuance the understanding of Swedish policy and situate it against the backdrop of OECD or EU member states actions.

A fourth source on which the report draws is academic literature from the science policy tradition. One of the defining characteristics of present day innovation or science policy is the relationship between the policy accounts, measures and some of the academic research. Here we speak specifically about the “systems of innovation”, “Mode 2” and “Triple Helix” perspectives. Given this relationship some special attention will be devoted to these three lines of thinking and how they figure in Swedish policy.

In general, the report seeks to be policy relevant while remaining policy neutral. This is no mean feat, and one of the results of taking this stance is that the report can appear to be both critical and supportive of the same policy approach. The task of remaining neutral while being relevant becomes even more challenging when one comes to that part of the task that requires one to make conclusions and even policy recommendations. Our approach in this section has been to point to ways in which the current focus could be broadened as well as provide suggestions as to what could be next steps if the current policy focus were to be sustained.

## Innovation policy: the current orthodoxy in science policy

The adoption of the *knowledge society* as the new meta framework for policymaking has provided a new policy focus, i.e. the promotion of innovation on a national level. Policy documents often vacillate between presenting the knowledge society

(or the knowledge economy) as an existing state of affairs for which we were not fully prepared and as an hypothesis about the future of the economies of industrialized countries. For this reason, observers may be forgiven if there is at times some confusion as to the ontological status of the phenomenon. According to a recent report commissioned by the EU, the knowledge economy is presented both as a “product of socio-economic trends and policy choices” and as an “empirical hypothesis, a policy goal or vision” (EU, 2002a).

Despite the apparent confusion as to whether the knowledge economy is here or if it has to be invoked, there is a stable consensus on the kinds of issues that ought to form the focus of policy for the knowledge economy. These are problems such as how to promote the creation, transfer and diffusion of knowledge. Put differently, the issues on the agendas of OECD policymakers have begun to mirror those found in books aimed at their corporate counterparts. This convergence between corporate and national agendas is not surprising given that the last decade has seen an increasing conversion of the public sector to corporate management ethos. It was therefore only a matter of time before the policies for the governance of public R&D would be subjected to the same logic.

The fundamental premise of knowledge society – that knowledge is a source of economic growth – serves both as rationale and justification for changing the terms for management of national knowledge infrastructures and for seeking a tighter integration between the knowledge infrastructure and the economic structure. National research or science policy has been identified as a primary policy mechanism for achieving this realignment in part because the public research sector has been in most countries targeted as the main social carrier of the proposed changes. For this reason, research policy is progressively becoming subsumed under or integrated with innovation policy. In order to demonstrate this, we shall have to make a brief digression.

Research or science policy, like many other policy endeavours, is a child of the post WWII era and this has influenced the way in which the area was constituted and subsequently developed. Students of science policy would know that the most dominant model and metaphor in the practice and theory of

the field has been the ‘social contract of science’, which is in itself based on the infamous linear model of innovation (more on this later). This contract metaphor was a convention adopted by science policy scholars to describe the terms, under which public money was allocated to science and how science would account for its receipt of this money. In its most idealistic form, the social contract<sup>5</sup> assumes that scientific inquiry would produce gains in wealth and welfare for society without active steering. Science’s control of its research agenda is seen within the social contract as an indispensable requirement for guaranteeing the epistemic and political authority of science.

Although the purity of the distinction between the role of the state and that of science outlined in the social contract has been maintained only at the level of rhetoric, it remains, even today, one of the persistent metaphors which policymakers and scientists deploy to set boundaries to each others actions.<sup>6</sup>

The second aspect of the social contract metaphor is that it is often accompanied by or implies a linear model of innovation. This is particularly apparent when policymakers use the connection between science and innovation as a further justification for funding science.

In fact, examining the policy argumentation about the nature of the linkage between science and innovation is one of the ways in which to make sense of successive generations of national science policy and ultimately the transition from science to innovation policy. If we may pre-empt our argument a little and borrow from our example, Sweden, one would find that using the social contract metaphor, the Swedish state has progressively redefined the boundaries between science and policy with each generation of science policy. The first phase, a

---

5. Vannevar Bush’s *Science: the Endless Frontier* is generally considered to be the paradigmatic example of a science policy that follows the social contract, cf. V. Bush, *Science: The Endless Frontier* US Government Printing Office, Washington DC. 1945

6. For more on the social contract between science and society see among others Guston, David and K. Keniston, (1994) *The Fragile Contract: University Science and the Government*, MIT Press, Cambridge, MA. Demeritt, D. (2000) *The new social contract for science: Accountability, relevance, and value in U.S. and U.K. science and research policy*, *Antipode*, 32, pp. 308-329.

Vannevar Bush inspired policy, was characterized by a *laissez faire* approach in which scientists determined the agenda for research in all but a few areas e.g. defence. The second important policy shift was the sectoral policy (*sektorsforskning* from this point) era in which an argument was made that universities would function as the research institutes of society. This doctrine meant that: (a) the size of the research institute sector in Sweden would be severely restricted and (b) university research would be submitted to a certain amount of external steering. Public agencies, the major intended beneficiaries of this new policy, were to be allowed to place specific demands on university science in terms of the agenda for knowledge creation. While *sektorsforskning* meant some encroachment on the territory that scientists felt was theirs, it was eventually accepted after considerable debate (cf. Persson, 2001; Stevrin, 1978).

The present approach of embedding research policy in innovation policy in order to satisfy knowledge economy considerations may in some respects be said to constitute a further revision of the social contract in favour of direct steering of science for economic and social reasons. The most immediate expression of this direct steering is the prominence of mechanisms for promoting collaboration between universities and firms in particular but also between universities and other public research organizations (PROs) and the wider society.

The coupling of research and innovation policy in Sweden may in one sense be regarded as a rhetorical shift. The evidence for this would be the formation of the basic science research council (Vetenskapsrådet, [www.vr.se](http://www.vr.se)) which has an annual budget of circa 268 million. In our view there are several indicators which would support a reading of the founding of the basic science research council as a confirmation of the move towards innovation policy.

One such argument is that the need to separate funding of basic from other kinds of research at the very time when evidence points to increasing difficulty in distinguishing basic and applied research signals an intention to limit the definition of applied research to ever more narrow terms. The increasing popularity of descriptors such as 'needs motivated' (*behovsmotiverade*) in Swedish research policy go some way to supporting this claim. Secondly, the distribution of money to basic, stra-

tegic and need motivated research is skewed towards the last two categories. This issue is one of the sites in the debate about Swedish research policy where there is some disagreement even among the academic experts. The controversy is built around different interpretations of the budgets and mandates of the new research foundations in relation to the entire budget for public R&D. We will return to this issue in Chapter 2, however, very shortly, the point is that some actors simply count the entire budget of the new research foundations and compare it to that of the research councils. The reality is a bit more nuanced<sup>7</sup> but even so it does not change the main thrust of the argument that more public money is allocated to applied research of varying degrees of intensity than is allocated to basic research. If one then couples that with the reductions in fixed allocations for research to university faculties, it is difficult to understand how the view that basic research remains the favoured category in Sweden can be sustained.

## From Linear model to University-Industry collaboration

Recently, it has been suggested that innovation policy at least within the first 15 EU member states may be seen as having gone through at least two incarnations: the first being the linear model and the second is the collaborative model. In the linear model, there are few or no overt efforts to induce collaboration between universities and industry or any other partners. According to this view, universities contribute to innovation primarily through the conduct of research and teaching. Research generates new opportunities for innovation that are subsequently exploited by firms. Teaching provides skilled

---

7. For example, one would have to compare not just the budgets of the respective foundations but the portion of the respective funders' budget that is directed to open calls (i.e. those that do not target a specific research theme) with that directed to programme or other types of targetted calls. Calls which require the research community to demonstrate user interest in the project as a condition for eligibility or require other kinds of relevance demonstrations would also have to be separated from those without such conditionality. To the best of our knowledge, no statistical analysis of this type has yet been done.

graduates who are eventually employed by companies. Jointly, these functions increase the possibilities and the productivity of industrial R&D.

In this context, direct interaction with industry is not perceived to be a fundamental mission of universities. This does not necessarily imply that academia should be a pure ivory tower, totally separated from industry and from commercially-oriented activities. On the contrary, at least in generic terms, the notion has been frequently widely acknowledged that scientific research is and has to be useful for technology, the economy and the society. But here, the central notion remains that the main task of universities towards industry is to train skilled people and provide new technological opportunities that could be exploited by firms.

Observations such as the shortening of the lag time between invention and innovation as well as the growing dependence of invention and innovation on scientific research (Mansfield, 1998; Rosenberg and Nelson, 1994) have led generations of policymakers to make incremental changes to science policy. While it is difficult to provide an exhaustive review or description of the various arguments that have been outlined over the years as critique of the linear model, in what follows we shall provide a sketch of the main arguments. This will be done in two parts, the first of which will focus on the policy argumentation or policy drivers. The section following this will feature a sketch of some of the main hypotheses of the academic work which has been used by policymakers in a variety of ways to legitimate and motivate the turn from the linear model.

Since the end of the Cold War, the linear model/social contract metaphor has been influential. This has meant that national science policy was an investment in future rather than present economic and social wellbeing. A number of factors have contributed to increasingly undermine, or at the very least create the need for alternative approaches to science policy. Among the more prevalent of these has been the increased dependence of technological innovation on science. The era of science based technology transformed to a certain extent the competence profile of industry to create a demand for more highly skilled workers and a closer connection between industry and sites of knowledge production such as the university.

Observers such as Zuboff and others (Zuboff, 1988; Piore and Sabel, 1984; Rosenberg, 1976) have argued that flexible, information, and bio technologies have raised the knowledge requirements for entry level workers and created a need for continuous upgrading of the skills of the extant workforce. This taken together with the fact that since the 1980s, industry in OECD countries began to relocalise R&D to universities and other types of knowledge producing organizations, have led to an emphasis on training and life long learning as opposed to education according to the *bildung*<sup>8</sup> model.

Further, studies from organizations such as the OECD began to alert policymakers to the existence of what is now known as Europe's 'innovation deficit'. This deficit refers to the fact that the innovation output of European countries relative to their respective investment in R&D is low in comparison to the output realized by the US and Japan for their respective investments. Concerns about the implications of the innovation deficit for future economic growth provided the motivation for the emergence of a new policy doctrine, the essence of which might be imperfectly summarised as follows:

- a) Universities should contribute more directly to industrial innovation and to (local) economic growth;
- b) science's natural tendency is to promote its own interests and therefore policy will have to intervene to facilitate the development of a more positive climate in universities towards more applied concerns;
- c) the speed of technological development suggests that national competitive advantage can only be developed and maintained through linking the sources of the production of knowledge directly to those that create wealth;
- d) as a consequence of a, b, and c, most countries have put into place a matrix of collaborative policy instruments aimed at promoting and securing closer links between

---

8. The *bildung* model emphasises education as a part of the preparation for citizenship in a democratic society rather than education as the acquisition of a specified class of skills necessary to qualify to perform a specific occupation (training).

- industry and public sector research organizations of all kinds (cf. OECD, 2003);
- e) additionally, universities must be encouraged to not restrict themselves to providing knowledge to existing firms but to engage in the commercialization of knowledge themselves; and
  - f) it is the responsibility of government to support the development of the support institutions that would assist universities in moving towards a more systematic set of policies and institutions for the commercialization of knowledge.

In the paragraphs immediately below, we shall elaborate further on the above arguments in order to provide the reader with a better understanding of the individual propositions and their relation to each other.

Jointly with the recognition of the potential role that universities might have on economic growth came also the acceptance and wide diffusion of a particular conceptualization of how the goal of closer university-industry ties could be achieved. Once again, also in this instance several different – and not always coherent – motivations were used to support this view. In short, the model that – despite enormous variations across countries and regions within Europe – became largely dominant was for the most part intended to promote technology transfer and was essentially an attempt at replicating the “American model” to the European context.

The innovation deficit (also known as the European paradox) doctrine mentioned previously is just one particular instantiation of this broad approach. In a nutshell, this model assumes that the key problem in establishing closer university-industry ties is closing the “gap” between the academic and the industrial worlds. There are at least four sets of arguments that are often used to justify this approach.

*Universities engage in too much basic research and too little applied research of relevance to small and medium sized enterprises (SMEs)*

One claim is that universities engage in too much basic research

which is often remote from industrial applications, particularly as seen from the point of view of the needs of small and medium sized enterprises (SMEs) in traditional industries. The implication here is that universities should engage in more applied research and that they should be more active in working closer to SMEs, understanding their needs and translating the obscure jargon and the difficult concepts of science in practical applications.

*Knowledge production at universities is governed by a different system of values from that prevailing in industrial research*

A second and not unrelated argument is that there are cultural differences between university and industrial R&D. These differences are the result of the different orientations and value systems governing academic and industrial research. According to this view, scientists do not have sufficient incentives to engage in activities that are relevant for industry. Scientists are motivated by the rules of “open science” and “by the publish-or-perish” principle (Dasgupta and David, 1994). Reasoning from this view, one arrives at the conclusion that appropriate incentives should be introduced for scientists to engage in research relevant to industry. One of the most popular policy approaches to creating such an incentive has been to increase the need for public research to seek industry funding by reducing the amount of available public funding. This incentive has two other accompanying measures which are intended to promote increase in the translation of scientific knowledge into commercial applications. One of these is the removal of the legal and bureaucratic impediments to the engagement in industry-sponsored research. The other is to encourage staff at public research organisations to patent their research results, both as a financial incentive for undertaking research for purposes of industrial utility and to facilitate the transfer of knowledge from academia to the commercial world. Another, slightly different version of this argument has been particularly relevant in Italy. In this view, emphasis is attributed less to the norms of Open Science as an impediment to the development of university-industry ties than on the bureaucratic and administrative inefficiencies that characterize the Italian academic system.

*We need to develop institutions that can translate and transform academic research into terms and language that would make it useful to industry.*

A third interpretation is based on an argument that basically reverses the traditional view expressed in the linear model. Here, the main problem is identified in the observation that academic research is far from being a public good. Rather, it has a largely tacit nature and it has partly the property of “natural excludability”. Moreover, it is claimed that the traditional “linear model” is fundamentally flawed, since it fails to recognize the intrinsically interactive nature of learning processes. Thus, the transfer of knowledge requires close interaction with firms, a task for which it is argued, universities do not have the necessary organizational structures. This interpretation lends itself to the conclusion that it would be necessary to create bridging institutions (e.g. technology transfer units) that would take on the task of diffusing academic knowledge.

*Scientific knowledge is now being produced in a range of institutions and not just at universities*

A fourth version claims that scientific research has become increasingly multidisciplinary and involves different types of institutions, techniques and methods (Gibbons et al., 1994). Thus, universities are no longer the privileged institutions in scientific research, but one agent in a dense and ever changing web of relations with other agents. Once again, the implication is that closer and flexible interaction with firms should be promoted and that appropriate institutions to facilitate these exchanges should be created.

### Alternative views

Although the above represents the prevailing orthodoxy in policy, the academic literature contains several divergent arguments. The most glaring instance of this is the centrality which the policy debate gives to innovation deficit hypothesis. There is very little actual data on this issue and the few emerging studies show that at least for Sweden, the view that R&D investment outstrips innovation output is questionable particularly when applied to academic R&D. A further difficulty with

the innovation deficit thesis is that it creates the impression that there is a direct proportional relationship between R&D investment and innovation. This is of course a flawed argument and the emphasis on linkage institutions such as technology transfer offices, etc. confirms that there is some policy awareness of this (more on this in ch. 2). A similar problem exists for many of the other arguments used to support contemporary policy positions. In this section we will provide an overview of some of the better established alternative points of view on the main arguments for current policy directions.

*Engaging in industry oriented research and commercial activities may be detrimental in the long term to upholding the values that sustain the system of knowledge production at universities*

Several authors have for instance challenged the view that universities ought to engage in industry-oriented and commercial activities. Mazzoleni and Nelson (1998) have on the question of university patenting made the observation that patents are not a necessary condition to generate incentives for firms to invest in development work needed to take an invention to the commercialization phase. David, Mowery and Steinmueller (1992) and David, Foray and Steinmueller (1999) have cautioned policymakers about the potential dangers of the insertion of commercial incentives for the orientation to open communication traditional to science.

Nelson (2001) has also argued that European policymakers should approach the current statistics on patenting from US universities with caution for two reasons. One is that the increase in patenting may have more to do with the emergence of biotech and information technology rather than the Bayh Dole Act.<sup>9</sup> The other is that the increasing degree of commercial interests on the part of university researchers taken together

---

9. The Bayh Dole Act refers to 1980 enactment of P.L. 96-517, The Patent and Trademark Law Amendments Act, and amendments included in P.L. 98-620 enacted into law in 1984. This legislation gave universities and small firms the right of ownership of inventions made under federal funding and to become directly involved in the commercialization process. This right of ownership also includes exclusive licensing.

with universities' interests in income from research output may eventually weaken the traditional commitment to publish in the open domain and contribute to public science. Geuna (2001) has pointed to the perverse effects that an increasing dependence of academic research on forms of "formula" and contractual funding in general of quasi-market allocation principles - might have on the behaviour and efficiency of the academic system. Other research has shown that an increased focus on technology transfer and cooperation with industry often leads to a reduction in the speed with which faculty publish their research findings and in the willingness to talk openly about their research to other faculty and students (Blumenthal, et al. 1997; Stephan, 2001).

*The gap between basic research and its technological application is closing in terms of time but it takes a considerable amount of resources and experience to turn products of basic research into commercially viable applications*

A second line of critique is that levelled against the conventional wisdom that has informed generations of science policy in OECD countries and that is the hypothesis that science and technology are growing closer and that lag times are rapidly decreasing between an invention and its commercialization. *There remains a considerable difference between what comes out of a university laboratory and what is regarded as potentially marketable.* (Interestingly enough, this is one of the arguments often advanced by firms against property rights being held by universities). Further, Mansfield (1998) has in an update to his seminal paper provided a number of important caveats that suggest that caution is necessary in terms of interpreting the time lag between invention and commercialisation.

The continued uncertainty about this aspect of innovation policy may to a certain extent be explained by the qualitative difference in how innovativeness is defined in research and how it is defined in industry. Innovation in university based research is measured in terms of criteria such as: (a) an advance in knowledge; (b) providing new means for further research; and (c) improving or deepening understanding of processes (know why, how and what). Commercial innovation is defined

in Schumpeterian terms, i.e. it is market success rather than originality or newness that is the predominant value. This emphasis taken together with the demands from shareholders to show a profit often translates into a preference for improvements with relatively short financial payoff lead times.

The above two definitions of innovation are not necessarily mutually exclusive. However, they are often difficult to reconcile, particularly when we include the fact that publication is still the main performance indicator for researchers, and that commercialisation or commodification of research results is invariably a time consuming process. As mentioned above, some scholars have expressed the view that there may be a hard limit to the degree of commercialisation and commodification that universities can pursue without compromising the complementary relation between open and commercial research (Dasgupta and David, 1993; Lee, 1996). In this respect, Liebeskind et al. (1996) argued that the social norms of science, including the emphasis on priority (i.e. being the first to publish), might actually provide more protection to innovations than legal methods such as patenting and trade secrets.

From the perspective of the economy, Boldrin and Levine (2004) have argued that intellectual property may inhibit rather than promote innovation in all but a few well known areas such as pharmaceuticals. Although this has so far only been substantiated to a limited extent for bio and information technologies and mainly in the USA, there are some problems in applying this on the European level because of differences in the European and US patent regimes.

*History, trust and clearly defined demands are important prerequisites for university-industry interaction*

Rosenberg and Nelson (1994) have observed that US universities have a long tradition of interaction with local industries in response to practical concerns, particularly in practically oriented disciplines e.g. engineering, medicine, agricultural sciences. Until WWII, this and teaching were the only two functions that universities performed that had any utility for firms. Thus, the existence of long standing relations and above all of a strong demand by industry – especially at the local level – might be a critical factor on which new ties can be developed.

Similarly, Mowery and Rosenberg (1998) have argued that the contributions of US university research to economic growth were not only the product of a few elite universities, but involved many universities, many of them providing local service to local industry and agriculture.

An additional factor that has been determined to be significant in promoting academy-industry linkages for US universities has been the proactive role that many of these institutions play in seeking places for students (Adams et al. 2005). Very few European universities engage themselves actively in student placement after graduation.

Studies show that a similar pattern obtains for European universities that have been successful at commercialization. Here too, the available evidence points to the importance of history, trust and clearly articulated demands from a local market rather than the presence of facilitating infrastructure such as technology transfer offices and other linkage institutions (cf. Johansson et al. 2005). Other evidence also supports the view that governments may have over estimated the importance of technology transfer offices. For example, it takes a relatively long start up time (average about 10 years) for this institutional innovation to pay off.

Further, universities that are more pre-disposed to creating companies may be more likely to establish commercial entities to promote such activities rather than rely on industrial liaison officers and technology transfer offices (cf. Franklin, et al. 2001; Siegel et al., 1999; Felsenstein, 1994). Variations in organisational preferences as well as the long gestation period for the investment in a technology transfer office to pay off converge well with results from the exploratory study performed by Bercovitz et al. (2001). According to these authors, the organisational structure of the technology transfer office is an important determining factor in explaining the patent and licensing behaviour of a given university. This structure is in its turn dependent on the university's broader history.<sup>10</sup>

---

10. The performance of technology transfer offices is still a relatively under researched area. Even in the US where the phenomenon is most common, there is still a paucity of data about best practice and little systematic evidence about institutional incentives, etc. A number of recent studies have been trying to bridge this gap. Among others see *Research Policy* 34(3)

*The US boom in university-industry relations is densely concentrated in bio and information technologies*

A third line of critique has been that the recent explosion of university-industry relations in the USA is closely linked to and concentrated in the new booming technologies such as IT and biomedical research (Mowery et al., 2001). US firms, it is argued, mostly use university research that is performed in high quality research universities, published in quality academic journals, funded publicly and cited frequently by academics themselves (Pavitt, 2001; Mansfield, 1995; Narin et al., 1997; Hicks et al., 2000). Moreover, this growth in university-industry collaboration pre-dated the introduction of incentives (e.g. the Bayh-Dole Act) to university patenting. These observations might suggest that the intensity of university – industry relations depends less on the existence of strong incentives for academics and academic institutions to “commercialize science” and more on academic willingness to meet the technological “needs” of firms (Colyvas, et al., 2002).

*Firms’ ability to cooperate successfully with universities depends on the firms own experience and ability to absorb and integrate new ideas into its operations*

Put another way, the “conventional” doctrine that emphasizes incentives and the creation of markets and transfer structures for facilitating the exchange of knowledge between industry and academia – implicitly assumes that both the “supply” and the “demand” of knowledge are already present and that the problem resides mainly in market or organizational failures that prevent a smooth and efficient exchange. However, in some instances – e.g. in local areas mainly populated by small firms active in “traditional industries” and substantially lacking technological capabilities – it is mainly the weakness of local demand that prevents the establishment of stronger rela-

---

2005 and Link, A.N., Siegel, D.S. (2005) ‘Generating science-based growth: an econometric analysis of the impact of organizational incentives on university-industry technology transfer’ *European Journal of Finance*, 11(3) pp. 169–181.

tions with local universities. Indeed, managers of local technology transfer offices often complain that local firms simply are not interested in the research and services that universities are offering and that the marketing of such services should become the first priority in the activities of these centres. Further, one of the more stable findings from research on SMEs is that they use knowledge sources other than universities (Jacob, Iversen, et. al. 2003; Kaufmann and Tödting, 2002; Keeble, 1992).

*Academic research impacts on industry in a variety of different ways and through channels not currently envisaged by policy*

Research on the effects of academic research on local economic growth supports the above in so far as it shows that the processes through which the knowledge created within universities impacts on industrial development and technological innovation are far more intricate than it is usually assumed in most (theoretical and empirical) models. First, the relevance of academic research and above all the mechanisms through which such knowledge is transmitted vary greatly across scientific disciplines, technologies and industries (Rosenberg and Nelson, 1994). In general, academic research contributes to the solution of technical problems of firms through a variety of channels (Klevorick et al., 1995, Sequeira and Martin, 1996, Pavitt, 1996):

- Instruments and techniques for engineering programming, including the creation of models and simulation in addition to theoretical prediction;
- The provision of instrumentation, like e.g. the cathodic tube and more recently the “gene sequencing” techniques;
- Background knowledge: often industrial researchers are less interested in the content of publications than in the experience and tacit knowledge of the authors of those articles;
- Participation in professional networks at the national and international level: scientists and engineers provide “knowledge of knowledge” to the solution of technical

problems, i.e. they know that they can rely on the skills of other colleagues for specific problems.

Second, the effective acquisition of academic knowledge requires, on the firms' side, at least three types of competencies: (i) **knowledge seeking capacity**, which is the capability to explore an expanding set of opportunities (through closed links with the scientific community); (ii) **absorptive capacity**, i.e. the capability to absorb new knowledge created outside the firm (Cohen and Levinthal, 1989; Iansiti, 1997); and (iii) **integrative capacity**, which is the ability to integrate different new and old scientific disciplines (Henderson, 1994; Iansiti, 1997).

*Geography is still an important determinant in university-firm interaction*

Third, knowledge flows from university to industry are often local and geographically bounded (Jaffee, 1989), mainly because knowledge is often embodied in individual scientists and research teams. The access to such knowledge requires the development of social ties and personal contacts, but also and mainly deep involvement in the research process and bench-level scientific collaboration.

*Enabling personnel mobility between and within sectors is the most efficient and effective means of transferring and diffusing knowledge in society*

Finally, knowledge flows largely occur through the mobility of people and teams across organizations and through the labour market (Zucker and Darby, 1996; Lamoreaux and Solokoff, 1997; see Breschi and Lissoni, 2001 for a provocative discussion of these issues). In addition, Dietz and Bozeman (2005) have shown that mobility may also provide gains not only in terms of patents but also increased research productivity. This study was based on an analysis of the career paths of 1200 research scientists and engineers. Dietz and Bozeman concluded that inter-sectoral changes in jobs throughout their careers provide university scientists with access to new social networks and scientific and technical human capital, which results in higher productivity. Thus, the mobility of individuals rather

than intricate institutional mechanisms and commodification processes such as patents and licenses remains the most effective and powerful source of knowledge transfer. Lundvall (2002) showed that at least for Denmark, labour market structure was an important determinant of innovation. If we extrapolate from this, it may be useful to explore the connections between labour market policy and mobility between sectors.

## Structural differences between the Anglo-Saxon and the Continental European academic systems

The policy debate about repositioning Europe's universities in relation to innovation policy has often referred to US universities as the model of choice. The American universities that are cited most often in this role are without exception private and elite institutions. The majority of Continental Europe's universities are, however, public. A number of issues follow from this essential distinction and not all of them have been satisfactorily raised and confronted in the policy debate.

Before we go further, it is necessary to clarify the terms of reference. We will use the term Anglo-Saxon here to distinguish between on the one hand the British and American systems and on the other hand the Continental European system. A further distinction needs to be made since within the Anglo-Saxon system there are considerable differences between the British and American systems. The British system is a quasi-public system, in which universities, although regulated and to some extent funded by the national government are independent of the state. The American system is predominantly private, but there are several state universities and these do have public funding at the local government level. Further differences exist within the Anglo-Saxon model such as how fees are regulated. The American system is almost completely market driven while British university fees are still regulated to a large extent by government through a variety of mechanisms such as student loans and grants, etc. A third caveat needs to be added here and that is even when we restrict ourselves to using Continental European to denote European universities other than those in the United Kingdom, there is still a problem of radical

heterogeneity (e.g. the French higher education system differs from that in Sweden, etc.), which makes it difficult to speak in terms of systems. However, a similar claim can be made of the US system in that it is difficult to speak of a US higher education system because here too, heterogeneity rules.

Our use of these terms is therefore intended to function merely as a short hand descriptor and applies only at the most general level and should not be seen as attempting to represent the full complexity of any of these systems. A good example of this is the case at hand, the Swedish university system. If one looks at the structure of positions (*tjänster*), one may be easily tempted to describe the Swedish system as traditional continental model. However, further scrutiny would reveal Anglo-Saxon moments in the Continental European reality in so far as Sweden is slowly evolving towards making for example a post doctoral period mandatory as well as homogenising the career path of academics. Previously, one could become lecturer right after graduation for example, now even in the humanities it is more common that newly defended PhDs take a postdoctoral position before going on to assume a lectureship.

Even in the new, there are differences from the American and English systems. The Swedish postdoctoral position contains a more generous allocation of research time, and little teaching is expected of the person holding that position. Similarly, the notion of tenure review (which is integral to the American system) or even periodic assessments as in the case of the British research assessment exercise (RAE) is not a part of the Swedish system. Swedish academics have quite sophisticated preferences. They identify very strongly with the cultural values of the Anglo-Saxon university system in terms of respect for publication, etc. They do however prefer to follow the continental European model for dealing with issues such as tenure for individual academics and allocating money to faculties.

## How do structure and organisation matter?

Comparative history and sociology of academic systems offer further interesting insights for understanding the difficulties that (mainly Continental European) universities face in linking with industry. This literature posits the conjecture that one

(certainly not exclusive) important determinant of the diverging attitude towards collaboration with industry of the Continental European academic (and more generally, research) systems and the American (Anglo-Saxon) systems is to be found in their different structures and organisation.

First of all, it is often remarked that a major difference between the two systems is to be found in the public nature of European academic systems as compared to the largely private one dominating in the USA. In Continental Europe, university professors are public servants and their careers are fundamentally determined by bureaucratic rules, essentially based on seniority like in most other public jobs. In this interpretation, these rules have contributed to create and preserve bureaucratic and feudal-like systems determining academic careers that attribute too little merit to research and teaching performance - and even less to the ability to interact with industry.

A second fundamental distinction – in this literature – concerns the degree of integration of teaching and research (Ben-David, 1972; Clark, 1995; Braun, 1994). Indeed, one of the main differences between the American (and to some extent the British) academic system and those in Continental Europe is to be found in the higher degree of integration of teaching and research that has characterised the former since the end of the nineteenth century, and the higher degree of professional orientation of advanced scientific training. An important caveat should be added here since the Swedish system is probably a middle variant between the Continental European and Anglo-Saxon systems in this respect. The high respect accorded to peer reviewed publication and the small size of the research institute sector in Sweden means that teaching and research are institutionally collocated. In addition, all university staff is expected to conduct research although this is being gradually undermined by the shift to competitive research funding. Time for research is now an indication of performance in the competitive grant system or of ability to attract resources from industry. Thus, although research and teaching currently remain institutionally collocated, there is the possibility that they may in the near future become estranged, as some academics will gradually be assigned the role of teachers while others will focus on research only.

These differences are expressed not only in the structure of curricula, but also in the organisation of the universities. Specifically, in the USA and in Great Britain departments have long been the main organisational entities as opposed to the European institutes, dominated by a single professor and far less interdisciplinary in nature. As a consequence, for example, American universities have been and typically are particularly rapid and flexible in developing and integrating, new scientific and engineering disciplines that were formed to support new technologies when they arose (Mowery and Rosenberg, 1998).

Moreover, the integration of teaching and research has been achieved to a much larger extent in the USA than in Continental Europe, through the separation between undergraduate and post-graduate levels. The creation of research-oriented, post-graduate studies entailed, in fact, a number of important consequences. In particular, post-graduate students are typically exposed and trained in the practice of scientific research within research teams composed by students and professors within departmental organisations. This arrangement does not only tend to free resources for scientific research, but also provides valuable experience in participating and managing relatively complex organisations. In other words, it constitutes an essential source for the development of organisational capabilities. Moreover, graduate students joining the industrial world after the completion of their studies constitute an essential source of skilled demand for academic research.

Again, the Swedish system constitutes an important exception to the rule in Continental Europe. This has become increasingly so since changes were instituted in the admission criteria for doctoral students in Swedish universities (more on this in Chapter 2). Briefly, however, Swedish doctoral education is being increasingly conducted either within the context of research schools or project teams. This has yielded three main advantages: shortened average number of years from entry to graduation, increased emphasis on supervisor responsibility and input in graduate education, and increased resources for doctoral education (this applies only to research schools).

Some of the more immediate disadvantages include: the combination of the role of supervisor and project leader re-

duces the student's autonomy; project or programme funding often implies that students either have too narrow a specialisation on graduation or have a broad 'interdisciplinary' competence but are not able to conduct or lead independent research themselves.

A third and less well understood problem is that doctoral students in the new structure are often delegated many of the project administration tasks. This is a result of the dependence of doctoral education on soft money and the fact that Swedish universities have little project management competence. This stint in project administration is not in itself negative but the student is not given any systematic training in this area but is more or less up to his/her own devices. Universities and students would benefit enormously from professionalizing this function either in the form of training doctoral students in project administration or hiring competent project administration staff.

It is reasonable to assume that the coupling between scientific and organisational capabilities constitutes an essential pre-condition for subsequent developments in industry-university relations. Indeed, as mentioned previously, the successful development of an entrepreneurial function within universities has not simply or necessarily substituted the other, more traditional, functions that academia offers to industry. Rather, the entrepreneurial function appears to be strongly complementary to and integrated with the other functions, primarily teaching. The US experience would seem to suggest that linkages with firms cannot develop without the constant mediation of teaching, that produces demand for such relationships, and it is an important source of the creation and renewal of absorptive capabilities within firms.

In Continental Europe, the integration of teaching with research has progressed far less than in the USA (and to some extent than in the UK). Clearly, enormous differences in education systems, especially on the higher education level, exist across Continental European countries and they certainly should not be overlooked. For example, in France, universities have never been the main centre of both scientific research - which has been essentially conducted within the national laboratories and co-ordinated by the CNRS (Centre national de la

recherche scientifique). The education of the French elite class is still monopolised by the system of the *grandes écoles*. In Germany, the institute – dominated by an individual professor – has been the main organisational unit co-ordinating teaching and research. Moreover, the German *Fachhochschulen* is an extremely efficient intermediate structure, which integrates teaching and practice for applied disciplines like engineering. *Fachhochschulen* do not however conduct fundamental research.

In Sweden, there are also important differences with certain disciplines and types of universities. Technical universities and medical faculties may be regarded as the sites with the highest intensity of cooperation with firms. In these institutions one finds cooperation taking place via teaching and research. In other disciplines and types of universities cooperation may be confined to firms or public sector actors and research is often the medium of choice.

Despite these enormous differences, however, the structure of the academic systems of many European countries shares some important common features, as compared to the Anglo-Saxon systems. PhDs are a relatively recent innovation in many Continental European countries. They were first introduced in Italy in 1983 and the Italian PhD education is still less professionally oriented than its US counterpart. Departmental structures are also relatively new, and in many cases institutes continue to be a very important organisational entity.

In general, research has tended to be far more removed from teaching than in the USA. And in fact, in many Continental European countries save for Sweden, research has been to a large extent separated from universities and concentrated in specialised institutions. It is possible to speculate that this separation might have had negative effects on both the quality of research and on the ability of academic institutions to interact with industry, mainly through the severing of the main channel through which knowledge flows take place, i.e. teaching.

Moreover, the separation of teaching and research and the permanence of institutional academic structures that attribute an enormous power to the individual chair-holders might also have contributed to the persistence of promotion mechanisms that favour much less scientific and teaching performance than

the protection of influential “barons”. In this view, the development in Continental Europe of various types of specialised institutions for technology transfer, which act as intermediaries between research and industry, might be considered as an attempt to compensate for this gap between teaching and research and of escaping from the feudal and bureaucratic academic rules. The presence of large scale intermediary institutions, however, might have paradoxically increased the distance between university and industry, introducing an additional layer in the relationship instead of favouring the required scientific, organisational and integrative capabilities directly within firms and within academic institutions.

The evidence is mixed as to the relative superiority of one as opposed to the other type of structure for the organization of research. However, the evidence from the US, which continues to be the best performer with respect to the integration of higher education and research into the innovation system, shows two characteristics as standing out above others. One is co-location of basic and applied research with teaching, and the other is heterogeneity. One way of dealing with this from a policy perspective would be to encourage the development of heterogeneous university systems in which universities are encouraged to discover what they are best at and given the resources to develop a profile to match this competence.

There is one foreseeable drawback to this in the context of Continental Europe in general, and in Sweden in particular, and this is that many universities have been developed as part of regional development initiatives. This has meant that such institutions were intended to serve a broad range of needs emanating from the local population. It is conceivable that as such institutions begin to niche themselves; their ability and/or interest to serve these needs may wane or change.

Still continuing with the US example, a third feature of that system, which usually emerges when US academics are asked to describe what they believe distinguishes their system from those in Continental Europe, is competition. US universities are very competitive institutions and this permeates nearly every aspect of institutional life. US universities compete with each other for students, staff, resources, etc. Competition is

however a feature that is remarkably absent from the European university system with the UK being the exception.

As will be seen in more detail when we elaborate on the Swedish case, it is not unusual for European countries to integrate their universities in policies that are intended to achieve objectives other than research or education. For instance, the late 1960s and 1970s was a period in which many new universities and polytechnics were established in different European countries. Many of these institutions were set up as parts of regional development initiatives rather than for extending or introducing diversity into higher education. Despite the rationale for their development, many such universities have subsequently developed into well respected and established universities, thus the original intention for its establishment says little about the prospects for a given university's development.

However, regional development policy in Europe generally is an area that remains mired in concerns of equality, redistribution of wealth, welfare, decentralization of decision-making, etc. In other words, all of the artefacts and buzzwords of previous development trends seem to converge at the level of regional development policy. The introduction of innovation as a new policy objective in this setting is therefore not likely to displace other longstanding objectives nor is it clear that this is an expressed intention. The prerequisites for promoting innovation via higher education and research policy however, may not always cohere with the more traditional objectives of regional policy.

A not often discussed issue that follows from the fact that Continental Europe's universities are largely public is that this implies that the social contract between science and society is not simply an issue of *whether* science delivers health and welfare to society but what is delivered, to whom and why. Surprisingly, little has been said in the policy documents about the distributional implications of privatizing public science. As long as the issue of steering higher education and research to meet societies' needs remains at the level of promoting university-industry linkages, the question of who gets what, when and why is, although relevant, still not acute. However, if we include, as extant policy does, the commercialization of knowledge by universities in this, the problem does become acute.

Current policy discussion steers clear of this public-private dilemma and operates with a hidden trickle down logic which assumes that once science is commercialized, everyone will eventually benefit. However, there are no guarantees that this will actually be the case and there is precious little that policy-makers can do to create such guarantees, since if such ventures are to be successful they have to be able to pursue capital and opportunities wherever they may exist regardless of their origin. The university, like any other economic actor would have to encourage the firms that it creates to maximize their profit.

This brings us to the other aspect of the social contract between science and society, and this is welfare creation of a more direct character. By this we mean welfare not introduced through increases in wealth but directly, for instance, research on problems that afflict disadvantaged groups, etc. Once universities begin to focus on wealth creation, some mechanisms will have to be developed to provide incentives for focusing on research problems that do not promise commercial pay off.

Although the focus of innovation policy is often on university research, education is a significant part of the general policy thrust. Further, as education and research are institutionally co-located in many Continental European universities, changes in one part of the system inevitably creates impacts and changes in the other. One such unintended consequence of planned action is the increasing modularity of university education. Aided and abetted by the European framework programmes as well as different types of programme funding initiatives, the teaching landscape is becoming increasingly fragmented. Courses are, for instance shared by a number of different providers, many of which may not even be located in the same country. In the European context, this process has been viewed largely through the prism of regional integration and is therefore seen as a win-win situation from the nation-state perspective.

It is still too early to determine the impact on the respective universities and on the respective national higher education and research systems as a whole. What is clear at this stage, however, is that there is an emerging pattern of mobility of individuals among European countries which may have future labour market and knowledge transfer impacts of a beneficial nature to innovation.

## Legitimizing Narratives: the Triple Helix, Mode 2 and Systems of Innovation (SI) theories

The above description of alternative views to the policy orthodoxy may create the impression that policy and research are completely at odds. However, as mentioned earlier, the convergence between policy and research is at an all time high in science policy. In this section we shall outline three research narratives<sup>11</sup> that have been very influential in the policy arena in general, i.e. the Triple Helix, Mode 2 and systems of innovation (SI) narratives. Sweden's policy has in particular been influenced by these narratives and the relationship between the community that makes innovation policy and the researchers working in these traditions has in many instances a history that predates the current period.

Although it may be argued that policies are usually made and justified in their own realm, and to the extent that these arguments coincide with academic discourse, it is merely post hoc reconstruction or legitimation, one of the tasks of this report will be to use the Swedish context to explore the relation between contemporary science policy discourse in the academy and discourse in the policy arena. We believe that Sweden is a good case for exploring this facet of science-policy relations for a number of reasons. One of these is that Sweden has a long history of policymaking driven by expert consultation; the science policy sector is no exception in this regard. A second is that Sweden has played an instrumental role in the introduction of at least one strand of the recent academic discourse on science policy i.e. the Mode 2 discussion, the foundational text for this discourse having been financed by a Swedish research council (which did not survive the reorganization of the research system). Thirdly, the other two strands of academic discourse on science policy, i.e. the Triple Helix and innovation systems discourses, have been used explicitly as legitimating devices in Swedish policy discourse on innovation. For this rea-

---

11. We use the term narrative rather than theory or model to refer to these perspectives since strictly speaking none of them meet the epistemological criteria necessary to be classified as scientific theories or models. Despite this, these perspectives or narratives have been influential in inspiring both scientific research as well as policy.

son, it would be interesting to pit the actual policy initiatives and their implementation against the discourses to which they refer for their legitimation to see to what extent, if any they match, and finally what have been their impacts, if any on the system they purport to change.

From the point of view of science policy analysts, the SI narrative represents a special situation since it has achieved a remarkable level of diffusion in the policy arena (Mytelka and Smith, 2002; Miettinen, 2002). For instance, the OECD has for years been the social carrier for the SI perspective. Mytelka and Smith recently (2002) argued that in the area of innovation policy there has been a co-evolution of policy and theory. Mytelka and Smith's paper traces the development of an alternative conceptualization of innovation in the academic literature beginning with Nelson and Winter's (1977) work which pointed to the need for a different perspective on innovation. This work, taken together with the crisis of the 1970s and subsequent diffusion of the notion of innovation as a learning process to policy organizations through academics working with such bodies, led to a gradual shift in policy perspective on innovation.

Looking back, one might argue that the policy uptake of the new perspectives on innovation has been phenomenal. The OECD, UNCTAD, EU and others have taken on the role of frontline social carriers of the SI perspective through research programmes and reports. It should come as no surprise therefore that the notion of SI has now trickled down to the national agencies for science policy. The creation in Sweden of an agency for innovation systems may be seen as the culmination of the diffusion of the SI perspective in the policy arena.

Although the bulk of analytical attention has hitherto been given to the diffusion of the SI concept in policy, we would like to extend this argument to include two other perspectives i.e. the Triple Helix and Mode 2 perspectives, which although more recent than the SI perspective, have been equally popular in the policy arena. In this short section, we shall also show how extant policy narratives constitute a storyline that is built around a set of connections which builds coherence among these narratives. In the following paragraphs we shall provide a summary overview of each of the three narratives as well

as some examples taken from Swedish innovation policy discourse of how they have been utilized. We shall begin with the systems of innovation perspective.

### **Systems of Innovation (SI)**

The SI approach belongs to that group of theories that take their inspiration from what is known as evolutionary economics. Some argue that the discussion about innovation systems and related issues may be traced back to the work of Friedrich List (1841) who introduced the notion of national systems of production and learning – a concept which took into account a broad set of national institutions including those engaged in education and training as well as infrastructures such as networks for the transport of people and commodities (Freeman, 1995). It was focused on the development of productive forces rather than on allocation of given scarce resources. Thus, List pointed to the need to build *national* infrastructure and institutions, which he argued challenged the ‘cosmopolitan’ approach of Adam Smith. Today, the SI concept outlined by Lundvall (1992) builds on List’s idea but maintains that it is not intended to be taken to mean that one can conceptualise and plan the totality of institutions and relations that constitute the backbone of innovation on a national scale.

The SI perspective is difficult to summarise in an overview as brief as the present without running the risk of appearing overly critical, because reviews of this kind are often dependent on defining key concepts and important variations or addenda. The SI perspective is notoriously weak on definitions of key concepts. For example, the key idea, system, is grossly under theorised despite the rich literature available on the concept of system. The most notable attempt to date to define system remains that of Carlsson et al (2002: p. 234) in which it is asserted that ‘systems are made up of components, relationships and attributes.’ This fits well with Edquist (1997: p. 14) which defines an SI as ‘all important economic, social, political, organizational, and other factors that influence the development, diffusion and use of innovations’ and Lundvall (1992: p. 2), which claims that a SI “is constituted by a number of elements and by the relationships between these elements ...

which interact in the production, diffusion and use of new and economically useful knowledge”.

Components are argued to be the ‘operating parts of a system’ and we are told that they can be actors or organisations such as individuals, business firms, banks, etc. or parts or groups of each. Put differently, any organisation or institution can be considered as a system component. Physical and technological artefacts as well as laws, regulations, etc. are also eligible as system components. Organisations appear to be defined in the management sense of the term and institutions in the sociologists’ definition of the term. Many SI workers however, use the terms organisations and institutions interchangeably.

Relationships, the second key constitutive element of a SI, are linkages or the glue that binds components. SI components are highly interdependent so one may deduce that relationships in an SI are of necessity thick. Further, it is posited that systems are highly adaptive and robust in that if a component is removed or changes, other components would alter to compensate for the loss. Technology transfer and acquisition are argued by Carlsson et al (2002) to be two of the more important relationships in a SI. Relationships are also the source of interaction and ultimately feedback in the system.

The third element of SIs is described as attributes. Attributes characterise the system and are the outcome of the interaction between relationships and components. The function of an SI is argued to be the generation, diffusion and utilisation of technology. Despite the above, many authors have argued that innovation systems are very difficult to delimit and that they are not necessarily coterminous with administrative or national borders (Rip, 2002; Håkansson and Snehota, 1995).

Perhaps because of the difficulty in delimiting the boundaries of SI, several researchers have undertaken to apply and extend the concept to more manageable levels of analysis than the nation state, the original site of application. Most significant of these include the sectoral systems approach outlined by Malerba (2002), the technological systems approach (Carlsson, 1997; Carlsson and Stankiewicz, 1991) and the regional systems of innovation perspective (Cooke, 2002; Asheim and Isaksen, 2001). With respect to application, one might contend that there are two overlapping discourses about innovation sys-

tems: an academic discourse that is divided between the network of individuals associated with the original development of the concept, i.e. Lundvall, Freeman and Edquist to mention a select few, and a number of followers whose applications have made the concept ubiquitous. A second discourse about innovation systems may be found in the realm of 'grey literature' where institutional actors such as the OECD, the European Commission and UNCTAD promote the concept as an integral part of their analytical perspective. It is to this policy discourse that we will devote our attention in this subsection.

The innovation system idea posits a number of statements about the loci and nature of innovation processes. The more salient of these are:

- 1) Firms do not innovate in isolation, so that innovation has to be seen as a collective process involving other firms as well as a number of other non-corporate entities such as universities, research centres, government agencies, etc.
- 2) Firms' capacity to innovate is further shaped by institutions (Lundvall, 1992; Carlsson, 1995; Edquist, 1997).
- 3) Learning and interdisciplinarity are key determinants of innovation (Edquist, 1997; Lundvall and Johnson, 1994).

These rather general propositions, although simple, imply a critique of the linear model of innovation which had held the study and practice of innovation captive for decades. Not surprisingly, efforts to apply the insights of systems thinking to innovation have led to a number of concretisations which take different levels of analysis as their point of departure. One may argue that the two dominant approaches are spatial (e.g. national or regional systems of innovation) and technology (e.g. biotechnological) oriented. In this respect, it is important to point out that the sectoral system of innovation and the technological systems of innovation approaches outlined by Malerba and Carlsson, Jacobsson and others are very similar in terms of the unit of analysis they seek to isolate. Although, to be fair, it may be argued that workers within the tradition of technological and regional systems of analysis are those who

have paid most attention to methodological problems arising from the approach such as ‘how to delimit the boundaries’ of a technological or regional system of innovation.

*Putting Systems of Innovation in practice: Regional, sectoral, and technological systems of innovation*

Over the decades of articulation of the notion of innovation system, the concept has been applied to a number of different levels of analysis, each of which has a direct resonance with the landscape with which policymakers work. As mentioned earlier the OECD and the Swedish Agency VINNOVA are among two of the more dedicated followers of the SI concept. To this end, we have tried to ascertain how these organizations define and use the concept. VINNOVA has an extensive definition of SI on its website which states that:

An innovation system is a network of organisations, people and rules within which the creation, diffusion and innovative exploitation of technology and other knowledge takes place. The system of innovation is also an effective method for assisting with investments in research, development and other measures for promoting innovation and stimulating renewal in order to promote sustainable economic growth and societal development. (Translated from Swedish, available at [www.vinnova.se](http://www.vinnova.se), accessed May 2004.)

A national system of innovation has been defined by VINNOVA in the following manner:

The concept of national innovation system takes its point of departure in the fact that there are differences between nations with respect to actors and frame conditions, resources and capacity for innovation. Measures intended to improve the functioning of innovation systems must be designed with this in mind. One example of an obstacle to innovativeness in the Swedish national system of innovation is the low level of mobility between industry and universities. A limitation of the national perspective is that it does not take into consideration the fact that different sectors of the economy function in different ways.

The OECD has outlined the definition of SI that it finds most useful in many different contexts of its reporting procedures.

However, most observers of science policy would concede that the gist of these definitions is encapsulated in Metcalfe's early effort to pin down the problem in the *Handbook of Economics of Innovation and Technical Change*. According to this text a system of innovation may be defined as:

A set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which government forms and implements policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies. (Metcalfe, 1995)

Although the national level is very important to these discussions, it is at the sectoral, technological and regional levels that the more concrete attempts to enact SI may be said to exist. Within the OECD discourse, one may find some reference to the sectoral and/or technological systems of innovation. VINNOVA's deployment of this terminology is more interesting in this context for obvious reasons as well as for the fact that as an entity working on the national level, its ability to pursue policy directives based on this or any other position is greater than that of the OECD. VINNOVA maintains that

*Sectoral systems of innovation*— such as innovation systems for IT or biotechnology, or on a lower level, for example environmental biotechnology make it possible to develop an understanding of how the preconditions, driving forces and obstacles differ across innovation systems. If public intervention is to have the desired effect it is critical that it is adapted to the respective sectoral innovation system. One obstacle for innovativeness in the IT sector for example is the shortage of competent personnel.

*Regional systems of innovation*— Apart from the national and sectoral perspectives, it is often of advantage to study innovation systems in regions. Innovation processes often take place in contexts where it is geographical proximity and associated factors that are critical determinants. Factors that are unique to a particular place or region can be the source of specialised knowledge, local social networks and trust between the parties in question. An industrial structure with too little activity

in high growth and innovative sectors is a typical example of an obstacle to innovativeness in a region. (www.vinnova.se, accessed May 2004)

The above two definitions both share some basic features of the academic versions of the concepts. For example Malerba defines a sectoral SI in the following fashion:

a set of new and established products for specific uses and the set of agents carrying out market and non-market interactions for the creation, production and sale of those products. Sectoral systems have a knowledge base, technologies, inputs and demand. The agents are individuals and organizations at various levels of aggregation, with specific learning processes, competencies, organizational structure, beliefs, objectives and behaviours. They interact through processes of communication, exchange, co-operation, competition and command, and their interactions are shaped by institutions. (Malerba, 2002)

Although limitations of space do not permit us to introduce the academic definition of regional systems of innovation, the pattern remains the same. There is a resonance between the academic and policy definitions up to a point. VINNOVA's definitions of the different variants of the SI all have an instrumentality that outweighs that found in the academic counterpart to this discourse. Further, the move from nation to sector to region is justified in the policy definition but not in the academic ones. In fact, one may argue that the main task of VINNOVA's definitions of regional and sectoral SI appears to be to explain why these shifts in analysis or in this case policy focus are necessary and how they can be operationalised. For example at the nation state level, VINNOVA makes the claim that SI should be seen as a support tool for R&D investment and operationalises this through the identification of gaps in the system. This identification of gaps performs a dual role in that it: (i) concretises the argument by showing a practical illustration and (ii) simultaneously adds credibility to particular policy conclusions that VINNOVA has drawn on the basis of other types of analyses by implying that the SI perspective can either be used to identify or solve this problem. In this way, SI is woven into the policy discourse and given a certain amount of analytical thrust and agency. This then creates an illusion

that the knowledge claims being made in the policy report are implicitly or explicitly outcomes of a SI analysis.

Through this weaving of the academic narrative into the policy argument, VINNOVA is able to invoke SI as legitimation for policies that it probably would have pursued anyway. Sweden's history of following the OECD line in science and now innovation policy taken together with the increasing convergence among OECD countries in this policy area would be strong arguments for supporting this position. It should be noted however that the SI narrative is also influential within the OECD discourse so perhaps we should be viewing this interaction between policy and academic discourse about policy as co-evolution rather than diffusion. In the next subsection we shall turn to the second narrative that appears in Swedish innovation policy.

### **Mode 2 Knowledge Production**

The Mode 2 thesis, although much newer than the SI perspective has also had its share of impact on the policy. Unlike SI, which is oriented towards the macro level whether it is applied on the national, regional or sectoral level, the Mode 2 argument is concerned almost exclusively with the conditions for the organization and production of knowledge.

The primary arguments of the Mode 2 thesis are outlined in the publication entitled the New Production of Knowledge (NPK) which was published in 1994. The book was the outcome of a panel of notable academics brought together by the Swedish Council for Planning and Coordination of Research (FRN)<sup>12</sup> which was a research council whose mandate was to fund interdisciplinary research of a strategic cut. It is difficult to judge from the tone of the NPK whether its authors expected to initiate a discourse that would be as popular. Much of the text is written in a manner which suggests that it is outlining a state of affairs already in existence. The argument of what is now familiarly known as the Mode 2 thesis has been outlined in NPK (Gibbons et al., 1994) and some of the ensuing debate and reports of applications may be found in Jacob (1997), Go-

---

12. FRN no longer exists after the restructuring of the research council system in 2001.

din, and Gingras (2000), Fisher et al. (2001), Hakala and Ylijoki, (2001) so we shall restrict ourselves to a summary overview of the main points.<sup>13</sup>

According to NPK, a new mode of knowledge production is emerging. This mode of knowledge production which they dubbed Mode 2 has five distinguishing features:

- Transdisciplinarity;
- Knowledge produced in the context of application;
- Quality control;
- Social accountability and Reflexivity
- Heterogeneity and Organisational Diversity.

The first feature, transdisciplinarity, is a departure from the previous Mode of Knowledge Production (Mode 1) in which the source of intellectual inspiration for knowledge production is the discipline. Although Gibbons and his colleagues concede that transdisciplinarity did not emerge with Mode 2, they argue that the transdisciplinarity in Mode 2 goes beyond the mere assemblage of scholars from different disciplines working together in the same project but from their respective disciplines that characterised transdisciplinary research in Mode 1. Mode 2 transdisciplinarity is by contrast a strong transdisciplinarity based on the development of a distinct framework intended to guide problem solving efforts.

This framework according to Gibbons is generated and sustained in the context of application and not developed first and then applied to that context later by a different group of practitioners (cf. Gibbons et al. 1994). The final result is a genuine synthetic effort and not traceable to any single discipline. Despite its grounding in practice, Mode 2 knowledge is not parasitic on Mode 1 but is based on an independent set of theoretical structures, research methods, and modes of practice, though they may not be located on the prevalent disciplinary map.

---

13. See also *Minerva*, 41, 2003 for a debate the Mode 2 thesis between the authors and other scholars.

The channels for the communication of Mode 2 knowledge also differ from Mode 1 in that results are communicated to those who have participated as they participate. Thus diffusion occurs in real time. Subsequent diffusion is dependent on the mobility of the project participants' rather than through reporting results in professional journals or at conferences. Communication links are maintained through formal and informal channels.

Transdisciplinarity according to NPK is dynamic; in Gibbons own words,

It is problem solving capability on the move. A particular solution can become the cognitive site from which further advances can be made, but where this knowledge will be used next and how it will develop are as difficult to predict as are the possible applications that might arise from discipline based research. (Gibbons, 2003)

Knowledge produced in the context of application is the second feature of Mode 2. This means that whereas in Mode 1 it is argued that research is conducted almost exclusively in universities, in Mode 2 collaborative partnerships between stakeholders/clients/practitioners are the loci and foci of knowledge production. Researchers work with problems defined often solely by practitioners or a group of practitioners and researchers, and knowledge is developed in the context to which it will be applied. Since knowledge is produced in the context of application, issues of validity and quality assurance are defined in terms of social utility and other criteria of validity which may suit the needs of users.

In the follow up publication to NPK, *Rethinking Science* (Nowotny, Scott and Gibbons, 2001), the notion of social robustness was introduced to describe this. Although many have taken issue with social robustness and other forms of user led criteria for validating knowledge, it would be fair to say that while Gibbons and colleagues have argued for new criteria, such criteria differ from but do not exclude the usual forms of epistemic validation that currently prevail in science.

Finally, Gibbons et al. point in NPK to the growing diversity of the spheres of knowledge production in society and that the university is no longer the centre of knowledge production

in most societies. The Mode 2 thesis is probably the one of these three perspectives featured here that has been subject to the most criticism and this may in part be explained by the fact that it unlike any of the others addresses directly issues that are easily recognizable as part of the everyday life of academics.

*Mode 2 in the context of application:* Disputes over what counts as evidence of policy take up are notoriously difficult to resolve, because collection of evidence is often difficult in such cases. Notwithstanding this we posit that policy documents, e.g. the guidelines issued by research councils as to their official policy, the norms that they report influence their funding practices as well as the practical accounts taken from the academic literature, may count as legitimate sites for finding evidence. A perusal of these sources suggests, not surprisingly given its origins, that the Mode 2 thesis has had highest impact.

Research councils, particularly in Europe but also elsewhere in e.g. Canada and Australia, have been preaching the wisdom of user involvement for at least a decade. The level at which user involvement is required or mandated varies, and this variation is surprisingly not dependent on the scientific tradition of the research groups involved, but seems to be more or less based on the policies of the research council. Thus, in some instances, up front involvement of users is required while in others it may be possible to satisfy demands by setting up a board of users as a reference group for the project. Still other levels of involvement include researcher-practitioners<sup>14</sup> being involved in the actual research process and user led evaluation of the results of the project or programme in question.

A number of the institutional innovations that have now become familiar features in the science policy landscape may also be seen to be real life enactments of Mode 2 knowledge production. These include centres of excellence, a form of organizing research that embodies the Mode 2 ideal of the organization of knowledge production. Centres of excellence are usually problem oriented and transdisciplinary. A third basic

---

14. The category researcher-practitioner refers to a practitioner (a corporate, public sector or employee from outside the university) who is engaged in research. Usually, this person is conducting research in collaboration with the academic partners in the project.

feature common to centres of excellence is that they are intended to achieve critical mass in a particular area of endeavour by building networks that span several sites. Ordinarily such an endeavour would be too costly to contemplate but the technological means provided by IT coupled with the international orientation of the scientific community, particularly its elite members, ensures that such groups may be constituted in relatively short periods of time.

The increasing dependence of scientists on external funding and the, particularly in Europe, inability of most universities to figure out the real costs of research means that costs to the financier are kept low as researchers pull resources from every available source to make the constitution of such poles of excellence possible.

As with the question of user involvement, diversity is the name of the game for how centres of excellence are organized. In some cases, they are research communities and are oriented to practical problems in a particular field with practitioner participation restricted to the periphery; in other cases practitioners are involved as members. Yet another model is to use centres of excellence as a means of directing investment in the development of a new field; areas like nanotechnology and materials science are often given this type of treatment.

Swedish science policymakers have had two generations of betting on centres of excellence. The first wave predated the Mode 2 discussion and at that time, the preferred terminology for such experiments was 'competence centres'. The Swedish Business Development Agency (*Verket för näringslivsutveckling*, NUTEK) was particularly instrumental in funding and setting up competence centres. The second wave of centres of excellence formations came after the reorganization of the Swedish research funding system (more on this in chapter 2) and has been a steering mechanism used by a number of research councils although the popularity of this instrument is not as great in Sweden as elsewhere. This might be explained by the fact that one of the central tensions that continue to plague Swedish research policy is that between a desire to promote excellence on a world class level and a deep commitment to promoting a similar level of scientific competence across the university system. Despite the relative small size of the country,

the size of the university system means that this tension often leads to confusing policy signals.

The Swedish research councils that have been the most consistent users of Mode 2 ideology are FORMAS and MISTRA. Interestingly enough both of these organisations fund environmental research although FORMAS' mandate also includes agricultural and spatial sciences (see figure in chapter 2 on overview of the Swedish research council system). Both FORMAS and MISTRA emphasise interdisciplinarity, a feature they share with the Mode 2 proponents.

As can be seen from the graphic depiction of the research council system in chapter 2, there is a historical linkage here since FORMAS contains within it staff from the now defunct FRN. It is therefore possible to argue that the interest in interdisciplinarity and ideas from the Mode 2 thesis have been introduced into FORMAS by key members of staff from the old organisation who moved to the new organisation. There is no such connection with MISTRA however, but from its inception MISTRA has been a strong promoter of interdisciplinarity and programme research. If one sticks to the level of official policy, it is MISTRA more so than FORMAS that embodies the Mode 2 ideology in its strategy for financing research.

Unlike SI and as we shall see later with the Triple Helix perspective where VINNOVA and other policy actors explicitly refer to the academic discourse, there is no explicit reference to the Mode 2 thesis in MISTRA's policy documents. MISTRA's discourse as represented by its policy statements and practice (e.g. how it structures and selects the programmes which it finances), resonates incredibly well with the theses of the Mode 2 narrative. For instance, MISTRA only funds problem oriented, interdisciplinary research in the form of programmes rather than projects. The commitment to interdisciplinarity is seen as fundamental to the Foundation's strategic outlook and is justified in the following way:

Heavy investments in cross-disciplinary research programs stimulate new ideas, new directions and new forms of cooperation to the benefit of Swedish environmental research as well as to the nation as a whole. ([www.mistraresearch.se](http://www.mistraresearch.se), accessed May 2004)

Further, researchers seeking MISTRA funding are encouraged to show as much as they can how the views of different stakeholders relevant to their research have been incorporated in their selection of research topic, structuring of the research, etc. In the words of MISTRA itself its policy is to finance:

broad, long term oriented research programmes which break with disciplinary boundaries. The research results should be practically applicable within firms, public sector and volunteer organizations and contribute to solving environmental problems. ([www.mistraresearch.se](http://www.mistraresearch.se), accessed May 2004)

An intricate system of review committees and reference groups accompany MISTRA research programmes as the utility of the research is as important as its academic quality. This implies that all MISTRA financed research has to be evaluated on both academic as well as practical grounds. This fits well with the Gibbons et al. requirements of knowledge produced in the context of application and that the eventual knowledge production must be evaluated for its social robustness.

### **The Triple Helix thesis**

The triple helix narrative was introduced by Etzkowitz and Leydesdorff in 1997. The main thesis is that knowledge based regimes of innovations, such as those emerging in most OECD economies, cannot be expected to stabilize but will remain in transition. Translated to the three main actors identified in the Triple Helix narrative (university, industry, government), this implies a situation of unstable boundaries and of actors such as universities and firms taking on different roles and performing tasks that they hitherto have not. The core proposition of the Triple Helix is that the university can play an enhanced role in innovation in increasingly knowledge based societies (Etzkowitz and Leydesdorff, 1997; 2000) and that university-industry-government relations may be considered to be a triple helix of evolving networks of communication. Triple helix interactions are posited to be more complex than the interactions between the double helices on which it rests.

Although the Triple Helix thesis is widely considered to be a homogeneous argument, particularly by those who apply the concept in academic discourse, examination of the writings of

Leydesdorff and Etzkowitz would reveal that there are two distinct strands within the Triple Helix tradition, or perhaps in time we may begin to read them as complementary parts of the same whole. At the present time, this complementarity is still at the level of potential.

In order to differentiate the two parts we shall refer to them as Triple Helix I and II. The focus of Triple Helix I is entrepreneurship in universities and the emerging infrastructure for promoting this end such as incubators, liaison offices and other similar structures. The thrust of the argument outlined is similar to that of the Gibbons et al. thesis in that it posits that the university as we know it is undergoing a process of change. Whereas the NPK emphasizes social utility and the organization of the production of knowledge at the micro level, Triple Helix I is concerned with turning knowledge into wealth. The evidencing of the thesis is a stylized model of history of the evolution of the university in which academic entrepreneurship is depicted as the latest stage (Etzkowitz, Webster, et al. 2000).

The Triple Helix I thesis is both descriptive and normative. Narratives about the changing situation in academe are mapped, catalogued and then retold all using the lens of the Triple Helix. The emphasis is on institutions rather than individuals and on the way in which roles, rules and knowledge are transformed as a result of this tripartite coalition, which may be observed the world over (Etzkowitz, 2005).

Triple Helix II is probably that part of the thesis which is striving most for the status of model. The argument is more self-conscious of its academic status and makes explicit reference to its intellectual heritage which it locates in the tradition of evolutionary economics. A consistent theme in Triple Helix II is the effort to construct a narrative that coheres with the Mode 2 and SI innovation perspectives (Leydesdorff and Guoping, 2001; Leydesdorff, et al. 2002). Despite its commitment to the core argument about transition and evolution of the roles of the university, industry and the state, Triple Helix II seems less concerned with entrepreneurship and more with questions of evaluation and the criteria for the validity of knowledge (Leydesdorff and Meyer, 2003). Apart from this, Triple Helix II addresses itself to fine tuning the metaphor of Triple Helix into a model, building on theories of complex systems.

The Triple Helix thesis as a whole has been quite successful in policy and research spheres; in fact considering the relatively short period of its existence its diffusion both in the research and policy worlds is impressive. While constant reference is made to examples from the US in Triple Helix I accounts, there is surprisingly little evidence of official policy interest in the model and US scholars of science policy appear to have reached no level of consensus on what kinds of tools may be relevant for explaining science policy moves in the US. One possible explanation for this might be the fact that historically the US has always shied away from admitting to having an official policy for funding science. In conjunction with this, the American preoccupation with not using taxpayers' money to fund industry in an overt fashion suggests that there may be practical and ideological reasons why the Triple Helix has less appeal to Americans.

The most notable example of the diffusion of the thesis to the world of policy may be found in VINNOVA's (the Swedish Agency for Innovation Systems) operationalisation of the thesis into a course which it offers to mainly government employees working with regional and other local government issues. A perusal of the course material will quickly reveal however that the Triple Helix is operationalised as a new model or perspective for how key actors in the innovation system ought to operate. The point of a Triple Helix course therefore is to help public managers adjust to and better understand how to create good functioning partnerships with the other two helices, universities and business. The course literature in keeping with the way in which the academic discourse is operationalised by VINNOVA combines the Triple Helix with a number of other perspectives. Thus, the notions of clusters and regional systems of innovation are built into the framework that is dubbed the Triple Helix.

### **Conclusion**

In summary, the above three perspectives have been unusually influential in contemporary policy discourse on innovation among OECD countries in general and in Sweden in particular. There is no one to one theory-policy relation as is seen from the selected examples provided and will be further illus-

trated when we elaborate on the details of the Swedish case. However, there are two features which are worthy of mention since together they may be said to characterize the essence of contemporary innovation policy.

The first is that the diffusion of particular academic narratives to the policy world has been accompanied and facilitated by interaction between selected groups of academics and policymakers through organizations like the OECD, VINNOVA and their publications. Together these actors may be said to form an emerging epistemic community to which policy refers for authoritative knowledge on how to proceed.

A second and perhaps not unrelated characteristic is that despite the continued marked differences among European countries, particularly with respect to the different components of their innovation systems, there is a high degree of convergence among countries' policies on innovation. The emergence of an epistemic community around the area of science/innovation policy perhaps explains this convergence of policy in that it is the same body of knowledge that is brought to bear on the problem regardless of its nature.

## Promoting the evolution of the entrepreneurial university Swedish Policy, 1990–2005

The purpose of this chapter is to outline the policy changes which have been introduced to reform the higher education and research sector in Sweden during the period 1990-2005. The main argument is that the period under discussion is distinguished from its predecessors by its focus on innovation, university-industry collaboration and the commercialisation of academic knowledge.

The chapter is structured in the following fashion. The first section will be devoted to a historical overview which will be summary and cover the post WWII period up to 1990. The bulk of the chapter will cover the period of interest to this document i.e. 1990-2005. This part of the chapter will be further subdivided into four sections, the first of which will introduce the distinction between science and innovation policy as well as provide a brief introduction to the terms of reference for the rest of the discussion. The next section will feature a discussion of the new research foundations as well as the reform of the council system. The following section addresses itself to the measures taken to promote the commercialisation of knowledge from universities. In this section the discussion revolves around the linkage institutions (technology bridge foundations<sup>15</sup>, holding companies, the foundation university experiment and the professors' exemption clause. The final section

---

15. As of 2005, the technology bridge foundations were renamed the innovation bridges. This shift in nomenclature has also been accompanied by some restructuring and redefinition of the mission of the organisations.

provides a brief overview of similar reforms in Norway, Finland and Denmark.

## Historical background

The evolution of the Swedish academic system in the post-WWII era can be usefully divided in three periods: the era of *laissez faire* science policy; sectoral research (*sektorsforskning*) and mass education, and finally the era of innovation policy and the entrepreneurial university. In this section we will summarise the first two eras briefly as part of a background discussion to our main interest, i.e. the third era which is our main concern. The era of innovation policy and the entrepreneurial university are treated in the following sections which form the core of the report.

### 1940s–1960s: From Laissez faire to Sector research policy

The first era began during WWII and stretched up to 1965–69.<sup>16</sup> This phase initiates the beginning of research policy proper, the development of a research funding infrastructure (government funded research councils, etc.) and the growth of university science. The basic structure of the Swedish academic system was essentially shaped in the Humboldtian, European (German) tradition, i.e. a public system in which professors and other university staff are civil servants, with careers that are largely based on seniority.

We have dubbed this period the era of ‘laissez faire’ research policy for want of better terminology. Laissez faire here is meant to be a comparative terminology with the period under investigation as the reference point. In simple language, this means that laissez faire research policy refers to the period of Swedish research policy where the discourse and rationale for funding science were formulated in terms of a longer term and more differentiated payoff to society at large. Thus laissez faire is not intended to indicate ‘the absence of steering’ but steering which does not have the promotion of industrial policy and economic growth as immediate ends.

---

16. The dating of the phases employed here is roughly based on Elzinga (1993)

Sweden had at this time, like many other countries, a research infrastructure in the public sector that was well built out in certain key areas such as defence and infrastructure (telecommunications). The main source of funding for research was direct contributions to faculties (*fakultetetsanslag*) and competitive research funding was dominated by strongly disciplinary based research councils.

While many European and Nordic countries moved away from this system to greater or lesser degrees by instituting the public research institute tradition, Sweden, however, deliberately chose a strategy of institutional development for the higher education and research sector which kept research and teaching within the university system. This has two practical consequences. The first is that Sweden does not have a large or even sizeable research institute sector that conducts research independently of teaching, and the second is that universities constitute the centre of the public research system.

*Universities & university colleges are the dominant knowledge providers in the Swedish public research sector*

In order to appreciate the dominance of the universities in the Swedish public research system, it is important to understand the structure of the university system. There are now sixty one institutions of higher education and research in Sweden<sup>17</sup>; these are divided into state run and private institutions<sup>18</sup>. At the core of the system is the six large research universities: Uppsala (founded 1477), Lund (circa 1666), Gothenburg, Stockholm<sup>19</sup>, Linköping (1962) and Umeå (1975). These institutions are complemented with at least five new universities, seven inde-

---

17. Figure taken from the National Board of Education's homepage [www.hsv.se](http://www.hsv.se)

18. The main difference between universities and university colleges is that the former have the right to conduct research education and grant doctoral degrees while the latter do not. There are however exceptions to this rule in the case of technical university colleges and university colleges that have been granted research education rights in a particular field, e.g. medicine, engineering, etc.

19. The universities of Gothenburg and Stockholm were both founded in the latter part of the 19th century as private institutions and became integrated into the national system of education after the second World War.

pendent colleges of art, and sixteen university colleges including the Stockholm Institute of Education and the Stockholm University College of Physical Education and Sports. Chalmers University of Technology, the Stockholm School of Economics and the University College of Jönköping are run by private sector governing bodies. There are also a number of smaller private institutions of higher education with the right to award certain degrees of undergraduate education. The size and diversity of the university sector both explains the strong emphasis on university-industry linkages that will characterise Swedish innovation policy in the 21<sup>st</sup> century and provides some insight into the rationale behind specific policy measures such as nurturing the development of an entrepreneurial culture within universities.

Several commentators have provided rich overviews of the pre 1990 period (Odén, 1991; Ruin, 1991; Elzinga, 1980; 1993; Nybom, 1989) so we will treat this period summarily. Swedish research policy is no different from that of other countries in that it is guided by a mix of national and international driving forces. Among the latter, the OECD figures as a consistent influence since around the 60s, and in this respect one can argue that the OECD's singling out of Sweden as a best case example in areas such as R&D spending is no doubt a result of a long historical trend of mutual shaping of policy and its advisory knowledge base (OECD, 1963, 1971). One of the most important domestic drivers of research policy in pre 1990 Sweden has been the building of a social democratic welfare state, the central organising principle of which was the leitmotif 'the people's home' (*folkhemmet*). Among the more important characteristics of this ideology are commitments to egalitarianism and protecting the weaker segments of the population from the vicissitudes of capitalism. Central to this ideology was a commitment to education and research and some commentators argue that there is a parallel between the expansion of higher education and research and the growth of social democracy in the country (Elzinga, 1993).

Since our main concern in this report is not science policy per se but its connections with innovation policy (previously known as industrial policy), it is pertinent to pose the question 'What connection if any existed between universities and

what in retrospect may be called innovation policy during this period?' There are several rationales for this and among these, three deserve mentioning here.

First, a baseline study which provides data on what kind of relationships existed between university research and industry prior to contemporary innovation policy would be of enormous utility. Such data would for instance provide us with the possibility to make a better estimate of, if and how the role of public research and universities has been transformed in Sweden.

A second is that it would increase our chances of explicating the underlying mechanisms that have shaped and continue to shape the form of interaction between Swedish universities and the other parts of society, more significantly industry.

Thirdly, one of the more popular hypotheses about Swedish industrial policy is that it has been demand driven through public procurement. Linkages between the science and technology and the industrial system according to this account grew out of a policy of public procurement of research and development for specific infrastructural needs. Demand driven innovation policy is still a viable strategy for inducing and supporting innovation through public means.

Understanding the policies that have been used in the past, however explicit or implicit they might have been, is an important first step in creating efficient policies for the future.

The only data that we have been able to find on past efforts at stimulating innovation via public procurement of R&D relates to the telecom sector (cf. Hörstedt, 2000; Lindmark, 2002; Weinberger, 1996). The story of the development of telecommunications in Sweden suggests that Televerket, the state telephone service provider, was an important actor in stimulating and conducting R&D. Contrary to what would be expected given this prominent public procurement role and Televerket's relationship with Ericsson, the firm's subsequent development as an international player is not linked to its relationship with the state monopoly in the manner that would be expected. Instead, Televerket functioned more as a competitor which drove Ericsson to seek external markets. This role would however change with the paradigm shift to mobile telephony.

There is however, little or no comparative data of this type for other sectors and much of what is available takes the form

of rich case studies of particular companies or sectors and their research relationships. Given the paucity of data, we are not able to make any conclusive remarks about the nature of university connections with industry in the period under discussion. If we extrapolate from the available evidence, we may conclude that the picture does not differ radically from that of other European countries.

*Public procurement or demand driven policy for university-industry relations was an important pillar of Sweden's early industrial policy*

From the end of World War II up to the 1970s, academic research in Sweden, as in all European countries, was predominantly funded by public sources, basically reflecting the "Arrow-Nelson" / linear model. Interaction with industry was not perceived to be a fundamental mission of universities, which was thought to reside essentially in teaching and in free, pure research. In practice, university-industry interactions were certainly not uncommon. Reliable data are not available in this respect, but university-industry interactions were in place especially in fields such as chemistry, medicine, telecommunications and engineering schools and involved a range of activities from rather simple and down-to-earth activities, such as testing of machinery, materials, etc., to big science and consultancy. The last was a rather widespread activity among university professors.

Within telecommunications, the available research confirms the importance of public procurement as a stimulus to innovation in general. As our discussion of the Televerket-Ericsson relation above shows the situation is often more complex than the anecdotal evidence often gives one to believe. With respect to university-industry/public sector relations in the telecom sector, the data also show that Televerket had a monopoly position in public R&D in telecom and that a considerable portion of this was done in-house (cf. Granstrand and Sigurdson, 1985).

Most of the university-industry activities were informal and not systematically organized. Within the medical and engineering sciences, Swedish universities have a long history of collaboration with companies such as Astra, Pharmacia, Volvo, Ericsson

son and SKF to name a few. These collaborations have been and continue to be diverse in character ranging from funding for infrastructural development (e.g. money for building new labs) to project and programme based funding. Swedish universities have also a history of collaboration with public sector entities with research needs such as the road authorities, defence, etc. These collaborations share one feature which makes them difficult to trace and evaluate and that is that researchers and not the university in question have been the main gatekeepers or contact persons for interaction. A classic example is the relation between Lund University and Astra which was primarily brokered by Swedish Nobel laureate, Arvid Carlsson and his colleagues (Stankiewicz, 1997).

That it is individuals not organisations that create and manage the networks that constitute university-industry interaction continues to be a central tension for policy that seeks to persuade universities to take responsibility for organising cooperation with industry. The currently prevailing tradition of property rights in the Swedish academy which grants individual researchers the right of ownership of the knowledge they produce, may be one reason that network development and management is strongly tied to researchers and research groups rather than the university itself.

In principle, the Swedish university functions as a public funded arena for the assembly of scholars and students to pursue research and education rather than a homogeneous organisation with traditional employer-employee relations and the consequent clear lines of responsibility that ensues from such relations. To the extent that the university may be regarded as organised, this has been mainly directed at the teaching and education functions rather than the research function.

Even here, the *laissez faire* spirit of the Vannevar Bush model for science policy prevailed in that the state gave signals with respect to what it required the university to deliver in the form of education. These signals were generally of an output character and left the content up to the university. Some examples of this are: setting targets for number of engineers, PhDs, etc.; setting the rate of remuneration per student that universities can claim for education and providing broad rules of governance for how the higher education sector should be run.

This approach while consistent with the spirit of the social contract model provided neither means nor incentive for either contractual partner to develop a constructive or proactive approach to the realization of their shared objective. For instance, output based steering encouraged the view that policymakers did not have to understand the internal workings of science to be able to set goals or to implement them successfully. This in turn meant that the system became more and more dependent on trust, as bureaucrats and policymakers were forced to rely on scientists to provide them both with feedback signals as to what mechanisms worked and with the necessary information for designing these signals.

While there is nothing inherently wrong with this system such that it is, it does presume at least the basic capacity to design a mechanism that would be able to seek and collect information from a wide cross section of the system. Perhaps because of the small size of the Swedish scientific community, this approach worked and still continues to function more or less smoothly. The obvious disadvantage of such a system is that it will be inherently conservative in so far as it relies on those who have been rewarded in the current system for information on what works and what does not. In Sweden more so than in many other Nordic and European countries, there is a concerted effort to fight against this through the widespread use of benchmarking and international referees. While this system functions well, it would be even better if Swedish policymakers were to create feedback mechanisms that would allow them to collect information on how the university system actually functions.

*The governance mechanisms for Swedish HER need to be developed with an eye to the organisational practices and capacity of universities*

While there are several agencies that have been developed to administer and govern higher education and research in Sweden and they collect different types of information, this system is both complex and functionally differentiated. According to the National Agency for Higher Education, there are no fewer than thirteen government agencies that work with different aspects of governing and regulating the higher education

and research sector. Effective coordination and fast exchange of information and knowledge among the different parts of this bureaucracy, and between this bureaucracy and the higher education and research sector, is critical if higher education and research is to support innovation policy.

*The future governance system will have to be agile and facilitate quick interchange of knowledge among its parts and between itself and the higher education and research sector*

### **1970s–1990s Mass education, Sectoral research policy, Decentralization**

Swedish science policy may be said to have taken off in the 1970s. However, unlike many other countries in which research policy has been recognised as a legitimate and separate area of policy, Sweden has chosen to (and this remains true of contemporary policies for research although to a lesser extent) steer research by establishing priorities and demands from sector needs (Persson, 2001). This steering of science policy from sectoral needs should be distinguished from what the Swedish research community and what this report refers to as sectoral research policy. Steering public sector research via sectoral demands is a concerted strategy of demand driven innovation. It implies that different sectors of the economy and society would be induced to collaborate with the public research organisations through a number of mechanisms. These include special grants for which the eligibility requirements include collaboration between universities and business/public sector.

Another mechanism for using sector needs to stimulate innovation is for government departments or agencies to specify new functionalities for products and services which would exert pressure on producers to innovate. This is to be distinguished from what we shall now discuss and what was known as sectoral research (*sektorsforskning*) policy in Sweden. Sectoral research policy was a concerted effort on the part of the Swedish state to change the public research and education system to provide the knowledge needs of the public sector.

A number of events in Sweden and Europe in general led to a shift to a sectoral research policy and what may in retrospect

be described as an incremental shift away from the *laissez faire* policy approach of the immediate post War era. The student revolts of the late 1960s taken together with the attempt to introduce a mass education system put the traditional system under strain. As in the rest of Europe, the diffusion of mass academic education coupled with stricter budgetary constraints put severe pressures on university funding. The sharp increase in the number of students undermined the efficiency of the academic structures, not only financially but also in terms of the quality of teaching and research. Physical structures and infrastructures could not bear the load of such a big population of students. Increasing teaching pressures also reduced time and resources for research. At the same time, the industries that had traditionally been more active in linking with academic research – the typical example being chemicals – underwent a deep crisis contributing to the weakening of existing university-industry relations.

Apart from the above pressures, science policy itself was undergoing a shift in focus as the Swedish government was in the process of revising its research policy to create an alternative to research funding driven by identification of needs at the sectoral level. This ushered in a new era in which universities were increasingly being expected to justify and account for the money they received from governments in terms of addressing more directly in their research agendas, the problems that society considered to be important. The first phase of this more overt steering of research in Sweden is known as the era of sectoral research.

The sectoral research era may arguably be said to constitute an important first step towards the collaboration policies which are the centre piece of contemporary innovation policy. Sectoral research, like contemporary policy, began with an implicit redefinition of the role of science in society through changing the terms of reference for research. This policy rested on the assumption that the university should function as society's 'research institute'. In practice what this meant was that universities were expected to provide the knowledge base for public policy through collaboration with various public agencies.

*Sectoral research was an early attempt to redefine the role of science in society*

This brief includes not just applied research but also basic research. With hindsight one can argue that sectoral research had three main objectives: (i) the creation of a knowledge and competence base for the knowledge intensive parts of the policy sector; (ii) the introduction of a number of mechanisms for securing collaboration between the university and the wider society and (iii) finally the creation of a space in science policy from which policymakers in Sweden could demand accountability from science. Briefly, we shall describe how each of these objectives was actualized in practice.

With respect to the creation of a knowledge base for the policy sector, sectoral research was and still is a research and development strategy that was more important to specific parts of the public sector than others. At the heyday of sector research there were at least sixty such organisations, many of which had sizeable research and development budgets. Agencies such as the Rescue Services (Statens Räddningsverk), the Swedish National Road Administration (Vägverket), the Agency for Development Cooperation (SIDA), the department of defence, etc. had and still do have significant R&D budgets.

This money was used to commission research from the university both of a basic as well as applied nature. The overall goal was and remains to develop and maintain a level of professional expertise as well as knowledge in the research areas relevant to their policy sphere. This area of sectoral research functioned in a manner analogous to the way in which public sector procurement was used to stimulate the industrial sector in Sweden. By this we mean that the agencies provided stimuli for research in the fields in question to develop.

*Some agencies have been successful and continue to use the university in the fashion envisioned in the sectoral research policy doctrine*

Further, the approach that was usually applied by the agencies meant that even research in the social sciences as well as in some areas of the humanities is funded. This implies that, in some areas, sector research has been able to support basic

research that may not have been funded by the regular research councils, as well as stimulate applications of the human and social sciences that would not have been possible with the research council approach either. Curiously enough, there has been little systematic appraisal of the type of research that has been funded by the different sectors. The studies of the building research council are an exception in this regard (Sandström, 1999; Thorpenberg, 2000, HSRF, 1999). Further, the appraisals that do exist do not compare the kinds of research funded directly by the sector agencies with that of applied research funded by the councils to ascertain what if any differences exist and how these differences relate to the competence profiles developed by researchers involved in such fields.

The introduction of sectoral research led to a considerable amount of debate. The research community in particular felt that this type of political steering of research went against the terms of the original social contract between science and society, whereby science would be left alone to determine its research agenda. Despite the resistance, the sectoral research policy orientation went ahead and after the initial debate, the situation settled down. A number of new institutional measures were introduced to implement this new policy, many of which were intended to promote collaboration between universities and the wider society. These mechanisms may in retrospect be dubbed first generation collaboration instruments. Below we provide an overview of the more important of these mechanisms.

### **First generation mechanisms for knowledge transfer**

*Contact secretary:* The contact secretariat was introduced by the former Board for Technical Development (STU), which set aside funding in the late 1960s for the employment of contact secretaries at technical universities initially. Later this was extended to all universities and university colleges. The purpose of the contact secretary was to first and foremost help smaller companies to gain access to universities and university colleges. The actual content of the contact secretary's job varied from university to university and the initial focus on smaller companies was widened to include larger firms. The duties of the contact secretary were also expanded to include assisting

university researchers to take out patents, start companies, etc. The overall responsibility for the contact secretariat function was passed on in the 1980s to the Office of Chancellor of the Universities and University Colleges (*Universitets- och högskoleämbetet*).

*Contact researcher:* Since the 1970s universities and university colleges have financed 'contact researchers.' This means that a researcher who is hired at a university or university college may during a specified period of time work either part or full time with a company or another organization. Money from the state may be used to fund at least half of the salary costs. The nature of the researcher's assignment while s/he is on secondment should be to participate in research around a specific problem. One of the main purposes of secondment is that it would lead to a wider network and in the long term new research commissions for the university or the university college. The participating researchers get an opportunity to experience the conditions for research and development work outside the university or university college.

In the initial stages, there was a special fund for this type of activity although it was very small. This has been changed and now it is up to the higher education institution to decide what resources it will set aside for this. It is doubtful whether contact researchers exist any longer. However, many of the specialised government agencies maintain linkages to the university through a system of formal and informal networks. This is often sustained through commissioning research from select researchers at universities. In rare cases, these networks often include education (mainly research education).

*Adjunct professors:* This is a form of university-industry interaction<sup>20</sup> which is built on direct exchange of personnel between industry and the higher education sector and the basis is employment outside universities or university colleges. An adjunct professor should be competent to be a professor and will typically be hired part time (about 20%) at the university. The position is usually fixed term (normally about 3 years in the first instance with the possibility of an extension of a

---

20. Introduced around mid 1970s

further 3 years). The number of adjunct professors has grown steadily, particularly in the technical areas. The adjunct professorship provides the higher education sector with access to highly qualified lecturers and supervisors who have their main employment in industry. The institution of higher education usually pays for the cost of the work time spent at the university. There are also contracts in which the company pays for this time as well.

*Industrial doctoral students:* These are corporate employees who have within their employment contract, provisions that enable them to pursue doctoral studies at the university.

*Science Parks:* The purpose of the science park was to offer a good working environment for R&D intensive firms. There are two main types of activity that can be found in science parks: (i) R&D departments of large firms for the purposes of networking and recruitment and (ii) spin-outs from the university or university college. Initially, science parks were limited to providing physical facilities (offices and practical service)<sup>21</sup>, later the functions of science parks were expanded to include support for patent application, venture capital, etc. In recent years the number of science or (vetenskaps eller teknikparker) has burgeoned to 30 and they have been organized in an umbrella outfit known as Swedepark (see also HSV, 2004).

*Industrial research institutes:* The industrial research institutes are probably the oldest of the mechanisms introduced to promote U-I collaboration and the first such institute was introduced in the 1940s. There are about 30 industrial research institutes (see [www.iris.se](http://www.iris.se) for information on all the institutes) and many of them have broad mandates such as environment, optics, corrosion. The main tasks of the industrial research institutes are:

- Industry related research
- Innovations and problem solving
- Technology transfer
- Collaboration and coordination of larger research programs with higher education institutions, industrial research institutes and industry as partners

---

21. Ideon (Lund) was the first science park and was opened in 1983.

- Contacts with foreign firms, institutes and other knowledge centres
- Development of new standards
- Assisting with the recruitment of research trained people to industry.

The above listed mechanisms of collaboration are for the most part still in existence. Apart from the contact researcher which has disappeared probably as universities were made responsible for funding their end of such collaboration, the majority of these mechanisms are being retooled or refurbished and put into service in the next generation of science policy. Although collaboration was the main issue in sectoral policy, the emphasis was decidedly on the public sector and to a much lesser extent on industry.

The general lack of support from the research community for sectoral research and a growing dissatisfaction with the performance of particular sectors in commissioning and conducting research undermined this policy initiative. One of the few evaluations that does exist of sectoral research is that conducted by the Humanities and Social Science Research Council (HSFR) in the early 90s (well after the period when sectoral research was abandoned for the most part). Although HSFR's report was limited to the cultural sciences (humanities and some social sciences), the conclusions were unfavourable to sectoral research. In general, the view was that there was little coordination among sectors and between sector agencies and research councils. Further, many sector agencies had little or no competence to procure research. This was particularly the case for the sectors within the general humanities area such as museums (cf. HSFR, 1999).

By the 1980s sectoral research policy had already begun to lose official support and was gradually whittled away through the removal or downsizing of research budgets at the sector level. The decade following that dominated by sectoral research policy was one in which the research council and scientific community's influence on research policy was established and strengthened through the development of lasting institutional networks, norms and rules (Persson 2001). Persson further

argues that this implies that, unlike in other countries where disciplinarity began to decline around this time, in Sweden the trend is the opposite. In our view this is a correct estimate if one focuses on: (i) the establishment and development of the research council system as an alternative to research funding driven by the sectoral identification of research needs and (ii) the role of the scientific community in setting research agendas. The commitment to promoting interdisciplinarity and utility in research did not end with the loss of legitimacy of sectoral research policy. Instead, these criteria were integrated into other structures and institutional rules such as the research councils and within universities such as Linköping where interdisciplinarity is built into the faculty structure.

Perhaps, the positive contributions of the sectoral research period lies with the research capacity, innovation and public policy output of sector agencies in areas such as Telecom, defense, road networks, etc. A further contribution of this particular science policy doctrine is the development of collaborative mechanisms for knowledge transfer, etc. listed above.

In summary, it may be argued that from the 1970s up to the mid 1990s Swedish research policy transformed from a *laissez faire* approach to a differentiated steering instrument in which the conceptualisation of science policy as a tool for achieving a variety of political and economic needs and interests was a key feature. In keeping with this a new agency was introduced, the Swedish Council for Planning and Coordination of Research (FRN). FRN's brief was rather wide ranging and included a number of tasks which were retained in the science funding system that succeeded FRN. Among these tasks included the promotion of interdisciplinary research, the promotion of the popularisation of science and the coordination of research about the disabled. FRN was further charged with the task of involving users/stakeholders in its research funding decisions (see <http://www.notisum.se/rnp/sls/lag/19770035.htm> for a detailed list of FRN's duties).

### **The development of regional university colleges and universities**

A second current which emerged around the same time as the sectoral research orientation was the emergence of a policy for

regional development in which the introduction of university colleges to service regional needs was a key instrument. This resulted in a de facto expansion of the academic system, mainly through a process of decentralization and development of new universities in peripheral areas of the country. The intention of this policy initiative was to reduce regional disparities in levels of education. The dominant regional development ideas of the 1970s and 1980s were however not primarily related to universities (though Sweden's first university science park, Ideon in Lund, was established in 1983 following Stanford's success). Instead, the idea of 'technology centres' played an important role in regional development thinking.

Current policy emphases have inadvertently created a re-reading of the first phase of the development of regional university and university college as part of the now dominant narrative of growth policy. The notion of regional development that informed this phase was however one that in keeping with the discourse about development prevalent at the time, emphasised development as the outcome of progress on a number of social indicators. In this case, education was targeted as a key social indicator. Thus Luleå University of Technology was introduced in the wake of the downturn of the steel industry to provide the region with the means for pursuing 'another development' trajectory. Umeå University was established in 1965, not primarily in order to stimulate the local economy, but to allow students to study nearer home; prior to this, students from the northern part of Sweden had generally moved to Uppsala to study.

The regional colleges established in the 1960s (e.g. Växjö, Örebro, Karlstad, Linköping) were originally teacher training colleges and the like, and/or subsidiaries of the old established universities, and tended (with the exception of Linköping) to be strong in social sciences rather than engineering and natural science. All four of the last mentioned colleges have been upgraded to university status.

### **Other Developments**

In retrospect, the case may be made that the period from the 1970s up to the mid 1990s witnessed as least as many changes as the present period. Thus, apart from the major changes

mentioned above there were a number of other noteworthy developments that we must mention briefly in order to provide context for the main focus of our study. One of these is that a number of reforms have given universities more autonomy over how they position themselves and use resources allocated to them. An immediate effect of this is that there is more autonomy at the faculty level. A further change is that all universities now have boards in which there is significant representation from industry, the public sector and the wider community.

The professor reform which removed the old chair system made the step from senior lecturer to professor one that was dependent on evaluation of the researcher's merits at the instigation of the individual in question. This is in stark contrast to the winner takes all approach of the chair system which meant that in principle fewer researchers could attain the rank of professor.

The introduction of this reform has created more opportunity for upwardly mobile researchers but it has had two important negative effects. One is that it increased the personnel costs for most universities and thus put them in an even worse position with regard to preparing for new recruitments when the expected demographic shift kicks in. A second is that since universities are already cash strapped many have instituted a policy that staff may be promoted to professor but they cannot expect to get additional resources or a higher salary. This has created a great deal of frustration in the system, since in principle it means that many senior lecturers got the title professor but had to keep their old jobs. The fact that several universities have had to relent on the salary issue has added to this frustration since teaching remains the only source of fixed income to support such budgetary inflation.

The reform of doctoral education is another significant piece in the puzzle since doctoral students are an important part of the Swedish research community and perform a great deal of commissioned research. Concern about the low rate of graduation and crisis in supervision prompted the then Minister of Education, Carl Tham, to propose a series of reforms. The most significant of which was that departments were prohibited from enrolling students into their doctoral programmes without sufficient funding to finance the entire period of the

student's study. Connected to this requirement was a change in the rules governing doctoral studies which mandated that full time students complete their course of study in 4 years and part time students in eight years.

Unfortunately, the combination of the requirement for full financing with the reduction of fixed funding has meant that in many departments doctoral studies have to be financed through the competitive research grant system. This places the doctoral student in the uneasy situation of being both project employee and student. Other side effects include reduced autonomy of students vis-à-vis choice of research topic in a system where the prevailing culture is still one where doctoral students are expected to and often expect to work on a topic of their own choosing. Departments also have less autonomy over assigning students to supervisors since in principle whoever is principal investigator of the project that finances the student becomes his/her supervisor.

The impact of the doctoral reform is not all negative in that it has led to more attention to the duties of supervisors vis-à-vis students and the role of doctoral students in the research system. The supervision model is also gradually evolving into one where the project is becoming the site for doctoral education rather than the old apprentice like system that dominated particularly in the humanities and the social sciences. This project based supervision is particularly controversial for the social scientists and humanities where researchers are still expected to be able to conduct and lead autonomous research projects immediately after graduation. It is likely, that the research assistant period will have to be gradually restructured to provide for post graduation supervision which will help graduates to develop the skills required to function independently. At present, the research assistantship is either unsupervised or project based.

In addition, and perhaps even more importantly, the upsurge of university-industry relations in the USA in the 1980s, the examples of the Silicon Valley and of the take-off of biotechnology – in general, the American science-based model of economic growth – provided a further and even more powerful argument for the promotion of a stronger involvement of universities in activities closer to the industrial world. The idea

that universities could, and should become key agents of economic growth at the national and local levels quickly became one of the leading policy recipes in the 1990s.

## From Science to Innovation policy

One of the few points, on which the research community that studies and analyses national policies for steering higher education and research converges, is that there has been an appreciable upsurge in interest on the part of OECD member states in innovation rather than science policy (Rip, 2002, Etzkowitz and Webster, 1991). Although this distinction is often made, there are few who define either science<sup>22</sup> or innovation policy and even fewer who care to define the difference between the two. One possible reason for this is that in many respects, the distinction between science and innovation policy is often a matter of degree and intention that is only possible to divine through an analysis of statistics, policy implementation and effects as opposed to objectives.

This notwithstanding, we would like to posit that science policy be defined as *policy intended to guide and steer the production, dissemination and expansion of scientific knowledge with the overall objective of contributing to human welfare and economic growth*. Innovation policy is *policy intended to promote the generation of research, technology and development that stimulates innovation and economic growth*.

The objectives stated and implied in the two definitions are not mutually exclusive but what differentiates one from the other is that innovation policy usually focuses on specific kinds of outcomes and means, such as innovation and technology respectively. Science policy tends to be more overarching in these two respects with welfare often being substituted for growth and no distinction being made between research and technology. Even with these nuances, we concede that innovation policy

---

22. The standard definition that practitioners and academics alike refer to in the few cases where science policy is defined is that coined by the OECD in 1963 and 1971 which is *the collective measures taken by a government in order, on the one hand, to encourage the development of scientific and technical research and, on the other hand, to exploit the results of this research for general political objectives*. (OECD 1963 and 1971)

may and often does carry objectives similar to science policy. In fact, one of the characteristics of contemporary innovation policy in many OECD countries is that it often attempts to marry the objectives of science and innovation policy. With this crude distinction between science and innovation policy as our frame we shall proceed to outline the Swedish situation in the four remaining sections.

The election of a conservative/liberal government to power in the early 1990s was the catalyst for the transition of what may be described as a science system to an innovation system with the universities being accorded the central position. Although policy for the higher education and research sector in Sweden has always been influenced by a balance between local stimuli and international trends in the area, Sweden's accession to the European Union in the period under discussion has meant an additional and more pervasive influence on research policy. This additional influence comes about as a result of need to coordinate national research policy with European level initiatives such as the Bologna Declaration, the framework programmes and lately the plans for an European Research Area (ERA).

It should be noted here that Sweden has yet to develop a systematic policy for coordinating research calls on the national level to either take better advantage of EU policies or to adjust for possible negative impact. However, few European countries have achieved this and given that EU funding of research accounts for about 5% of overall funding in the region for research; it may be argued that national policymakers can hardly give such coordination much priority under the circumstances.

The social democratic government that succeeded the conservative/liberal coalition four years later continued the transformation process initiated by the conservative/liberal coalition. The reasons for moving from science to innovation policy in Sweden have been many, but in keeping with the policy convergence that may be observed in OECD countries in general and in EU member states in particular, Sweden's rationale followed closely the arguments that were outlined in the first section of this document. If there is one argument that may be selected as particularly influential in Swedish policy

as opposed to that in other countries, it would have to be the narrative about Sweden's innovation deficit. According to this narrative Sweden is one of the biggest spenders on R&D in the OECD with an expenditure of 4,3%<sup>23</sup> of GNP but its innovation output in relation to this level of investment in R&D is relatively modest (Sörlin and Törnkvist, 2000; Henrekson and Rosenberg, 2001; Goldfarb and Henrekson, 2003).

This difference between input and output is in a nutshell the innovation deficit, a.k.a. the Swedish paradox. It is important to note before continuing that this deficit argument implies a direct correlation between R&D output and innovation. There is little evidence to suggest that such a correlation exists, instead as mentioned in the previous chapter, the rate of transformation of R&D into innovation appears to be dependent on a number of other factors such as demand from local industry, etc.

Sweden's annual investment in R&D has become legendary and is often the envy of science policymakers from other countries. As with all legends, closer inspection reveals a more differentiated picture. For instance, the share of public R&D in this figure is approx 0.83% which is lower than France and Finland (0.99%).<sup>24</sup>

It is important to note here that the special nature of Sweden's public R&D sector, with its heavy dependence on universities and the absence of a well developed public institute sector that is comparable to those which exist in other European and Nordic countries, implies that the comparisons made between Sweden and other countries with respect to expenditure may be in need of adjustment. Jacobsson and Rickne (2004) have analysed Sweden's public R&D expenditure and concluded that Sweden's total expenditure on public R&D (higher education and other governmental expenditure) is relatively modest and does not outstrip that of other OECD countries (see table 2.1 below). Further, Jacobsson and Rickne's analysis show that the ratio of business to academic R&D in Sweden is not as favourable to academics as in other OECD countries.

---

23. Figure taken from VINNOVA and represents expenditure for 2001 cf [www.vinnova.se](http://www.vinnova.se) accessed 08/05.

24. Figure obtained from Research Finland [www.research.fi](http://www.research.fi)

| Country                  | 1<br>Gross Domestic<br>Expenditure on<br>R&D – GERD<br>- (as a<br>percentage of<br>GDP) | 2<br>Business Enter-<br>prise Expenditure<br>on R&D – BERD<br>- (as a<br>percentage of<br>GDP) | 3<br>Higher Educa-<br>tion Expenditure<br>on R&D – HERD<br>- (as a<br>percentage of<br>GDP) |
|--------------------------|---|--|---|
| Israel                   | 4.81 (1)  | 3.52 (1)   | 0.82 (2)  |
| Sweden                   | 4.27 (2)  | 3.31 (2)   | 0.83 (1)  |
| Finland                  | 3.40 (3)  | 2.42 (3)   | 0.62 (3)  |
| Japan                    | 3.09 (4)  | 2.28 (4)   | 0.45  |
| Iceland                  | 3.06 (5)  | 1.80   | 0.58  |
| Korea                    | 2.96  | 2.25 (5)   | 0.31  |
| United States            | 2.82  | 2.10   | 0.40  |
| Switzerland (2000)       | 2.63  | 1.95   | 0.60 (4)  |
| Germany                  | 2.49  | 1.76   | 0.40  |
| France                   | 2.20  | 1.37   | 0.41  |
| Denmark (1999)           | 2.19  | 1.42   | 0.43  |
| Singapore                | 2.13  | 1.34   | 0.50  |
| Belgium (1999)           | 1.96  | 1.40   | 0.47  |
| Canada                   | 1.94  | 1.11   | 0.59 (5)  |
| Netherlands (2000)       | 1.94  | 1.11   | 0.57  |
| Austria                  | 1.90  | ..   | ..  |
| United Kingdom           | 1.90  | 1.28   | 0.41  |
| Norway                   | 1.62  | 0.97   | 0.42  |
| Australia (2000)         | 1.53  | 0.72   | 0.41  |
| Ireland (2000)           | 1.15  | 0.83   | 0.23  |
| Italy (2000)             | 1.07  | 0.53   | 0.33  |
| New Zealand<br>(1999)    | 1.03  | 0.31   | 0.35  |
| Spain                    | 0.96  | 0.50   | 0.30  |
| European Union<br>(2000) | 1.89  | 1.22   | 0.40  |
| Total OECD               | 2.33  | 1.62   | 0.40  |

Table 2.1: Expenditure on R&D as a percentage of GDP by different sectors around 2001, for all fields of science for a number of rich countries (Ranking within parentheses)

Source: OECD (2003): Main Science and Technology Indicators, 2003:1, OECD. Missing data for Luxembourg, Japan (adj.)

Finally, given the absence of a well developed public institute sector in Sweden, Swedish higher education and research institutions also bear the brunt of the burden for industry and public sector research that is not performed in-house. Jacobsson and Rickne’s analysis is preliminary and based on bibliometric indicators only but they are supported by other sources.

A recent article in *Teknisk Framsyn* (2004) makes a similar argument and this is borne out by statistical analysis done by analysts from the Swedish Research Council who show that the portion of basic research funded with public money is lower than the analyses of OECD data cited by policymakers gives one to believe. For example, figure 2.1 below gives an overview of the percentage of externally funded to fixed funded research at Swedish universities and university colleges. This data shows that the percentage of external funding to Swedish universities has increased from about 32% in the 1980s to about 54%. This trend has been fairly stable since 1998.

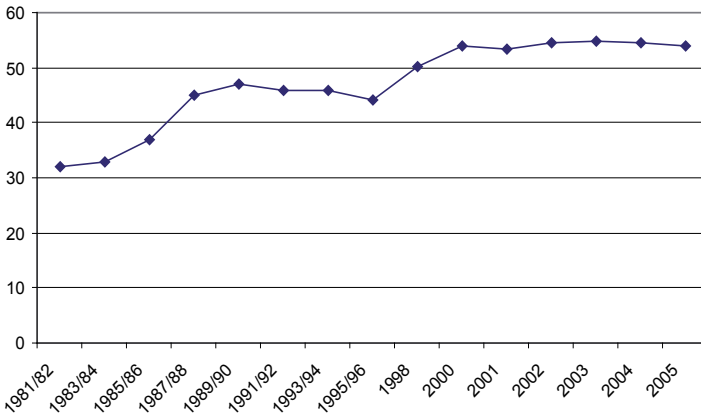


Figure 2.1: Share of externally financed research and development at university colleges and universities (figures are for every other year 1981/2–1998).

Source: National Agency of Higher Education. Special thanks to Marie Kahlroth at the National Board of Higher Education for providing this data.

Increased dependence on soft money does not necessarily imply a reduction in basic research since research council money is also counted as soft money. Analysts at the Swedish Research

Council have, however, done a review of SCB's statistics on research funding (see figure 2.2 below) which confirms that the share of strategic-basic (*riktad grundforskning*) and applied (*behovsmotiverad*) research in publicly funded R&D has increased steadily since the 1970s. These analyses do not in themselves refute the prevailing policy argument that there is an 'innovation deficit' but they do raise some questions that at the very least need to be answered before further decisions are made about the way in which Swedish research can be made to contribute more to innovation.

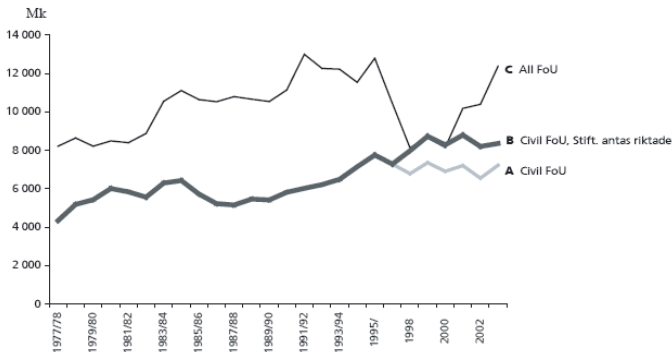


Figure 2.2: Targeted funds in State R&D budget 1977/78-2003. (Price level: 2002) (FoU= R&D; Stift. antas riktade=Foundation grants supposed to be targeted).

Source: Sandström, Heyman, and Hällsten (2004).

Further, given the relative small size of the institute sector, the business and the public sector have traditionally had to rely on the university for any research needs that they themselves could not provide or find alternative sources. This tendency has in some instances increased as some agencies, for instance the Swedish Environmental Protection Agency (*Naturvårdsverket*), substantially downsized its own research staff in the mid 1990s. *Naturvårdsverket's* research budget for 2005 is a little under 9 million.<sup>25</sup> This would suggest that a certain percentage of university research must be already done in response

25. Approximately 2 million of this comes from *Viltvårdsfonden* – a fund which has been established to take care of hunting and wildlife issues.

to the demands from the business and public sector agencies. Indeed, the already existing university-industry ties as well as the university- public sector links that developed and survived the sectoral research period would bear out this fact. This does not imply that the Swedish university is perfectly aligned with the needs of its surrounding community but it does nuance the ivory tower image that has hitherto driven the pronouncements from those in charge of creating research policy. Further, it may be more accurate to argue that to the extent that the current policy arguments are addressed to the degree of commercialisation of knowledge produced at universities they are correct but in so far as responding to the needs of the society outside of the framework of commercialisation, the current system may be performing better than we are led to believe.

## Reform of the system for financing research

The reform of the research council sector is at first sight a slightly tangential issue to innovation policy. However, because of the centrality of the university sector to Swedish innovation policy, reform of the research council sector has been a significant part of the reshaping of the Swedish research system. Traditionally, research funding from the Swedish public sector has been substantial but fragmented, scattered across a number of small to medium sized research councils whose mandates included funding basic, sectoral and strategic research.

The reform of the system for funding science is probably the most significant link in the chain of adjustments to post 1990 science policy in Sweden and may be described as having two phases: the first of which was the introduction of the strategic research foundations (*löntagarfondstiftelserna*<sup>26</sup>) in 1994 and the second was the reorganisation of the existing councils. The strategic research foundations (were intended to provide an additional injection of research funding but this funding was mainly earmarked for promoting innovation. The foundations are a separate chapter in the history of research and innovation

---

26. The *löntagarfondstiftelserna* (wage earner fund foundations) were so called because of the origin of the money on which the foundations are based. The money came from the dissolution of a fund collected on behalf of workers by the state. This name is no longer used.

policy in Sweden and so the treatment here will not even attempt to provide anything but a brief overview.<sup>27</sup> The foundations unlike the other public research funding organisations do not depend on annual budget allocations.

The foundations listed in the table below do not represent the full complement of the strategic foundations. There are a number of other strategic foundations with similar historical background but with different missions and character. Among them are the technology bridge foundations (now innovation bridges) which were specifically set up to bridge the gap between university and industry.

| Name of Foundation & Purpose   | Total Initial Capital Base (billions SEK) |
|--|---|
| Foundation for Strategic Environmental Research - MISTRA (www.mistra.org) Funds strategic environmental research   | 3,9                                       |
| Foundation for Baltic Countries and East European Studies - Östersjöstiftelsen (www.ostersjostiftelsen.se) Finances research on Baltic countries etc conducted at Södertorn University College   | 2,5                                       |
| Foundation for Health Care Sciences and Allergy Research – Vårdalstiftelsen (www.vardal.se) Finances research and research education within the area allergy, caring sciences and hypersensitivity   | 0,5                                       |
| International Institute for Industrial environmental economics at Lund university – IIIIEE<br>An institute för higher education and research   | 0,3                                       |
| Foundation for the International Cooperation in Research and Higher Education - STINT (www.stint.se) Funds researcher mobility and internationalization of Swedish higher education & research   | 1,6                                       |
| Knowledge Foundation – KK-stiftelsen (www.kks.se) Supports the use of information technology; funding research at the smaller universities and colleges and supporting exchange of knowledge and competence between industry and public R&D institutions | 3,6                                       |
| Foundation for Strategic Research - SSF (www.stratresearch.se) Funds research in medicine, the natural and technical sciences of a strategic character   | 6,0                                       |

Table 2.2: Overview of the strategic research foundations.

27. Detailed studies are available in Benner, M. (2005) "En ny aktör söker sin roll - stiftelserna genom 1990-talet" in Sörlin, S. ed. (2005) *I den absoluta frontlinjen*, Nya Doxa.

The strategic research foundations represented a new approach to research funding characterised by:

- a) A preference for programme funding and large grants spread over a substantial period of time (usually 4 years at a time with the possibility of renewal);
- b) Emphasis on collaboration across universities and between universities and industry or public sector organisations;
- c) Evaluation of eligibility for funding and evaluation of outcome of the programme in terms of scientific quality and relevance with the latter being given equal weighting as the former;
- d) Involvement of targeted stakeholders in the design and management of the research programme;
- e) Emphasis on creation of critical mass in a few areas considered to have strategic significance for the Swedish economy and society rather than the entire research landscape.

As mentioned earlier, the founding of the strategic research foundations represents a controversial moment in the history of Swedish science policy and although the dust has for the most part settled (See Sörlin, 2005 for an account of this dispute), there are several who remain unconvinced about the contribution of these entities to the research funding landscape. For this reason, while we cannot do an exhaustive account here, we will attempt to provide a summary appreciation of the foundations in two parts. One is a discussion of their role from the perspective of the move from science to innovation policy, and the other will be to compare them to the newly formed more conventional research councils. The latter discussion will be preceded by a brief presentation of the new research councils.

## The Strategic Research Foundations: Catalysts in the shift from science to innovation policy

There have been several evaluations of the strategic research foundations and of their programmes (see [www.kva.se](http://www.kva.se), Schild and Sörlin, 2002) and regardless of the objective of the evaluation, the results are usually mixed. There is also a tendency to treat the foundations as a homogeneous group although their only salient commonality is their origin. This tendency is probably a result of the fact that while they are in one sense accepted, many aspects of their missions are still regarded as rather controversial. In view of this, it is probably best to try to evaluate the foundations' contributions without the existing evaluations as the starting point but to adopt a frame that is in line with the purposes of this report, i.e. to pose the question, 'how do the foundations contribute to the promotion of innovation rather than science policy?' The close dependency between innovation and science policy is only one of the reasons that answering such a question is difficult but this dependency does in part explain why the scientific community continues to be frustrated with the dictates of contemporary innovation policy. It also encapsulates the dilemma of the strategic foundations and the outcome of their evaluations.

The foundations were specifically charged with the task of renewing Sweden's innovation system. Although funding university research is one of the mechanisms that was anticipated that the foundations would use to achieve this goal, it was by no means the only one. A perusal of the guidelines laid down in the founding documents of the foundations would reveal that in many instances funding research was not at all mentioned as an objective of the organisation to be formed (See table 2.2 for a quick overview of objectives of the respective strategic research foundations). That being said, research financing is not expressly ruled out as a means of achieving the stated objectives.

If one takes the foundations together and accepts their objectives at face value one would see a picture that reflects very much the history of their formation. By this we mean that they represent both an attempt at forging a science policy that would fund capacity building for Sweden's future economic

development and the results of the political compromises that are the peculiar product of Swedish style democracy. Nowhere is the latter more evident than in the singling out of allergy and caring sciences research as areas of research so important to Sweden's future that they would require a special foundation. The foundation for Baltic Sea research and development of Södertörn university college is another even more specialised area that is probably better explained by the necessities of political negotiation rather than science or innovation policy objectives. Despite these peculiarities, or perhaps because of them, the entry of the foundations may be said to have ushered in a new era of funding science in Sweden.

Apart from the fact that their funding strategy differed from that of the then existing research councils, the foundations did introduce a number of innovations in the research landscape. One of these was the creation of research schools for doctoral students. This was initiated by the Strategic Foundation and later extended by the KK Foundation with a more extensive programme aimed at promoting university-industry collaboration in a broad range of sectors (cf Schild and Hanberger, 2000). The research school idea has since been taken up by the state and is now becoming an increasingly popular form for doctoral education in Sweden. The quick uptake of this innovation has no doubt been facilitated by the fact that research education in Sweden has long since been considered to be an area in need of reform because it has been plagued by long gestation times for producing graduates and poor or non-existent supervision.

Research schools represent a form that can, together with the Tham reform<sup>28</sup> that preceded their introduction go some way to remedy this problem and prepare Sweden for the eventual Bologna process. The KK financed executive doctoral research school is considered to be a particularly interesting innovation in the Nordic context and it has inspired the formation of at least one similar type school in Denmark.<sup>29</sup> The research schools as originally envisioned embody the intention

---

28. Tham reform includes, among other things, three issues: reform of doctoral education, professors' reform and measures to promote gender equality in universities.

29. The Danish DOCSOL programme

of the foundations in so far as they carry two characteristic key values: collaboration with industry and strategic knowledge creation.

It may be argued that although user/stakeholder involvement in research was not a novel idea in the research funding landscape in Sweden, having been employed by NUTEK, FRN and a number of significant others, it was with the foundations that the idea strengthened. In this respect, KK foundation and MISTRA may be regarded as the most aggressive promoters of user involvement and in the case of the latter, many of their earlier programmes required that stakeholders be involved in the research process.<sup>30</sup> While this requirement fits with the state of the art in research funding praxis in Europe at the current time, as well as with the arguments of collaboration outlined in Mode 2 and Triple Helix narratives mentioned in chapter 1, it must be said that this strategy, has hitherto had rather limited success. In order to elaborate and exemplify this argument, we will take the case of MISTRA as an example.<sup>31</sup>

If one follows MISTRA programmes from proposal to evaluation one finds that the operationalisation of this policy of user involvement is considerably more nuanced than official MISTRA policy would lead one to believe. For example, while MISTRA is very eager to have users involved in its research programmes, and this is one of the criteria for getting funded, it is usually up to the researchers to decide who these users are and how they can be integrated into the research process.<sup>32</sup>

---

30. MISTRA may be credited for introducing the notion of researcher-practitioner through its insistence in active stakeholder involvement in the first generation of its programmes.

31. It should be noted that the KK foundation also requires stakeholder involvement as a condition for eligibility for funding for some of its programmes. Mindful of the fact the KK foundation is not strictly speaking a research financing organisation we have chosen to restrict the example to MISTRA.

32. MISTRA has also been known to select user groups and use these groups as part of the process of commissioning a particular research programme. In such cases, the user group is chosen prior to MISTRA receiving proposals from the research community in response to the call. See Mobjörk, M (2004) *En kluven tid? En studie av idéer och föreställningar om vetenskap och kunskap i Stiftelsen för miljöstrategisk forskning*, MISTRA, PhD thesis, Linköping University, Linköping, Sweden for a detailed discussion of MISTRA programmes.

MISTRA programmes may be said to follow the Mode 2 dictate in that the Foundation is particularly proud of its commitment to interdisciplinarity. Close examination would reveal that many MISTRA programmes are only interdisciplinary in so far as they are an assemblage of scholars from different disciplines. This weakness is particularly acute in those programmes in which MISTRA has attempted to get natural and social scientists to work together. MISTRA has attempted to overcome this weakness through the development of instruments for managing its research programmes which would force researchers to at least produce an interdisciplinary account of their research findings. These documents otherwise known as synthesis reports are not utilised in all programmes and are viewed by researchers as example of the excessive management that MISTRA demands for its programmes.

In keeping with its conformity to Mode 2 criteria, the official MISTRA narrative is that there is no contradiction between utility and good quality scientific research. Nevertheless, in practice MISTRA evaluation procedures separate the assessment of utility from that of scientific quality both in front end proposal assessment and in the evaluation of programme success (cf Schild and Sörlin, 2002). This separation is more in keeping with a linear or Mode 1 model than the rest of MISTRA's official storyline. This shifting back and forth between Mode 1 and Mode 2 is also present in MISTRA's official narrative as shown in the following citation taken from their website

A MISTRA programme is successful when high quality scientific research finds practical application in a company, a public authority or elsewhere. ([www.mistra-research.se](http://www.mistra-research.se))

In contrast from the rest of the storyline, this success criterion implies that rather than users and researchers creating and applying knowledge together, MISTRA's expectations are of a more traditional character. The Strategic Research Foundation (*Stiftelsen för strategisk forskning*) represents yet another example of how the foundations both conform and diverge from the pattern outlined in academic narratives such as Mode 2. The Strategic Research Foundation has chosen to separate its research programmes into two categories: those with industry

involvement and those without. All their programmes have the requirement that the research should be relevant to industry.

The foundations' use of programme funding, or more specifically long term, large grant financed projects in all areas of research has inevitably led to a growing interest and need for more emphasis on project and research management competence in Swedish higher education and research. In this sense, one may argue that the foundations have actualised some of the descriptions/prescriptions outlined in narratives such as Mode 2 and Triple Helix mentioned in the first chapter. This is particularly reinforced by a development that may be seen as a result of evolutionary adaptation of the Swedish research community to the reduction in the availability of fixed funding, the existence of the foundations and reform of the other parts of the research sector.

One manifestation of this evolutionary adaptation is that foundation funding is sought and used as a type of capital for starting new ventures such as research centres or building up a particular research capacity. This is particularly so in the natural and engineering sciences where this practice may be said to have been facilitated by the industrial mode of organisation that these disciplines developed after World War II as well as Swedish participation in EU framework programmes. There is also growing evidence that such practices are now spreading to the social sciences and with time to the humanities. The chief benefit of this adaptation is that it fosters entrepreneurship within the academy and allows researchers to pool and organise resources with a degree of flexibility that is greater than that allowed for by fixed funding.

It is still an issue for debate both within the EU funding sphere, where there is a longer history of this type of programme funding, and in Sweden as to the virtue of programme funding in some parts of the social and human sciences. The respective disciplinary cultures of the humanities and social sciences lead to inherent bias towards a proliferation of small scale research projects tackling more or less the same issues with small variations. This strategy for knowledge creation is seen by many in these disciplines to lead to better quality than fewer and more concentrated efforts. No systematic appraisal

of this hypothesis has been made either within the EU or in Sweden.

In Sweden, MISTRA has had some difficulty in attracting social science and humanities projects. However, it is unclear in the case of MISTRA if this difficulty may be attributed to programme funding as an instrument or if its MISTRA's unique form of managing this instrument that is the problem. Other confounding factors of a more general nature include demands for sophisticated project management routines and stakeholder involvement rather than disciplinary culture. The overall impact of the emphasis on user involvement and large programme funding is still unclear. There is a need for studies which evaluate what if any impacts are produced by programmes designed to produce knowledge in collaboration with stakeholders.

A further innovation of the research foundations is that through their support and incentivising of commercialisation of research, the foundations have also contributed to the promotion of an entrepreneurial culture in the university sector. Apart from the usual incentives such as tied funding<sup>33</sup>, the foundations have also expressly encouraged researchers to commercialise the results they produce in the context of projects financed by them. The strategic research foundation even provides support for patenting.

An outcome of the interest in the knowledge society has been increased focus on individual mobility as a mechanism for knowledge transfer in innovation policy. This is best exemplified in the fact that one of the foundations is dedicated to the promotion of international mobility within the research sector in Sweden. The fact that STINT funds international mobility and not research explains why it is probably one of the foundations whose importance in the transition from science to innovation policy is often overlooked. Another contributing factor is that STINT itself does not promote its activities in terms that resemble that of any of the other foundations. Its profile is determinedly low and emphasis is on the more immediate effects of mobility such as exchange of knowledge and network build-

---

33. One such example is the KK foundation's special programme which supports collaborative projects with small and medium sized enterprises (SMEs).

ing. There is little or no reference to industry or knowledge exchange except between academics. However, a number of STINT's programmes are of potential importance particularly if they were to be used more aggressively by the research community. These include funding for university teachers to travel for short periods for purposes of renewing curricula, etc., the visiting professor, post doctoral and funds for the repatriation of post doctoral candidates to Sweden after their stint abroad.

All of STINT's programmes represent moments of opportunity for alleviating current pressures on the system as well as providing Swedish universities with the means to access foreign competence and labour. A recent evaluation of STINT's programme for support of postdoctoral studies shows for instance that Swedish researchers who have had the opportunity to do a postdoctoral visit have a wider international network and publish in higher impact journals than their colleagues who have not (Melin, 2003). There remain a number of obstacles to better exploitation of resources of this kind including more proactiveness on the part of individual departments to exploit the contact network developed by individual researchers. Further, more information is needed on how international visitors are utilised by university departments and the attractiveness of Sweden as a possible site for foreign researchers on postdoctoral or sabbatical visits. Although research funding organisations in Sweden have always had a commitment to this area, the role of financing international network building is not well researched as a whole. For instance, apart from STINT almost every research funding organisation in Sweden has some funding available for supporting foreign visits, conferences, etc.

In this sense, the research policy system has always encouraged internationalisation and this no doubt has contributed to the productivity of the research community in terms of publication statistics etc. Other by-products of this systematic networking is that international evaluation is integrated into almost every aspect of academic work in Sweden. This includes research funding as well as appointment of new positions, etc. A more systematic evaluation of this type of funding and how universities use this would be an important knowledge input to understanding the complex relationship between steering instruments and research output.

*Although relatively small, the Swedish research system has traditionally had a strong international orientation. The new strategic research foundations have reinforced this trend*

Finally, the strategic research foundation's pioneering of the idea of betting on individuals is an innovation that has been picked up by some of the research councils including the basic science research council. This instrument is briefly described as a platform which aims to promote excellence and individual achievement. As with technology development, the basic idea is differentiated in a number of ways. For example one variant of the instrument targets promising junior researchers (future research leaders), another, senior researchers who want to try out a new research area, and a third is the addition of a gendered dimension to the future research leaders instrument by setting aside some funds for women in this category. Variations of this basic idea have been adopted by the newly formed research councils. One can also find this idea represented at the European Union level. This supports the notion of convergence between national and regional policy instruments for the research/innovation policy area within the European Union.

*The strategic foundations have had a lasting impact on the research funding landscape. Many of the innovations they introduced have since been mainstreamed*

## The reorganised council system

It is often debated whether the public furore associated with the establishment of the strategic research foundations is really warranted because they are not as radically different in reality as they are presented in rhetoric. Ten years after their initial introduction, this claim is probably more warranted than ever. However, in retrospect one can argue that the reality of the foundations could not possibly match the rhetoric that surrounded their introduction and existence. Many would argue that if the above mentioned are the innovations that stand out most from the foundations' initiatives then they resemble research councils very much. In the next section we shall provide an overview of the new research councils and return to the

issue of if and how the foundations differ from their research council counterparts.

A report produced by the National Audit Office (RRV, 2001) estimated state expenditure on higher education for 2000 at circa 4,6 billion (SEK 43 billion).<sup>34</sup> The reform of the research council sector, through which a substantial portion of this money was previously distributed, is a significant pillar in the creation of innovation policy. This reorganisation took the form of the creation of five large research councils (see figure 2.3 for a graphic depiction of the new system in relation to the old).

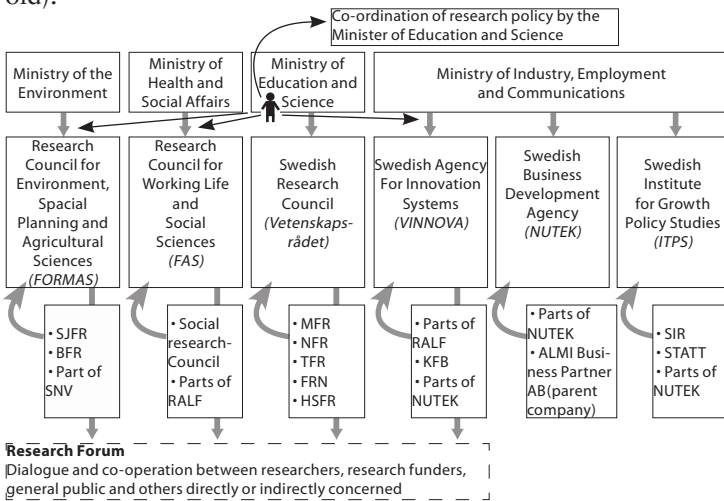


Figure 2.3: The Reorganised Research Council System in Sweden.  
NB. Research Forum has been since disbanded. Source: VINNOVA

The new structure includes the new Swedish Research Council (*Vetenskapsrådet*), which incorporates three separate councils, one for the humanities and social sciences, a second for natural

34. This includes student loans. Figures were taken from National Audit Office 2001, Audit Proposals in Higher Education, Stockholm, Sweden. Also available from [www.rrv.se](http://www.rrv.se) The National Audit office has recently been restructured as a result of a change in status. Formerly the National Audit Office reported to the Government, it is now amalgamated with the Parliamentary auditors and the resulting new entity reports to Parliament. This unfortunately means that reports from the older organization can only be obtained through [www.fritzes.se](http://www.fritzes.se) or the library system.

sciences and technology and a third for medical research. This body is the largest actor within the new structure for funding research in terms of annual budgetary allocations. According to the Central Statistical Office, the Swedish Research Council received (see table 2.3 below) 2,4 billion Swedish kronor for 2003 and allocated almost all of it.

The financing strategy of the Swedish Research Council is one that is explicitly oriented towards funding discipline based basic research. This particular institution represents an unadulterated moment of *laissez faire* science policy in the midst of a framework which at least has a formal ambition to be innovation oriented. By *laissez faire* here we refer not to the

| Research Council  | 2002<br>Allocation | 2002<br>Outlay | 2003<br>Allocation | 2003<br>Outlay |
|---|--------------------|----------------|--------------------|----------------|
| Swedish Research Council<br>Vetenskapsrådet (VR)  | 2 069 762          | 2 069 762      | 2 433 822          | 2 069 762      |
| Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning<br>Forskningsrådet för miljö, areella näringar och samhällsbyggande (FORMAS) | 488 082            | 432 362        | 516 217            | 490 213        |
| Swedish Council for Working Life and Social Research<br>Forskningsrådet för arbetsliv och socialvetenskap: forskning (FAS)  | 268 171            | 268 171        | 283 891            | 242 829        |

Table 2.3: Government appropriations (2002 and 2003), distributed by purpose. Current prices, MSEK

fact that the focus is on basic research but on the lack of any systematic use of familiar instruments for steering basic research such as special programmes, etc. The dominant mode of operation appears to be one of open calls with a few targeted programmes aimed at providing special fellowships for junior and senior researchers.

The overriding objective is to promote competitiveness in the basic research community and this approach has by and large been successful. Although the basic science research council is relatively new, it has retained and perhaps heightened the status enjoyed by the smaller discipline based basic research councils that predated it. Less than 25% of the applications that the council receives get funded. While this gives some idea of the nature of the competition, it is important to point out that this type of funding has always been highly competitive. Given the fact that Sweden is internationally known for having a high publication count in relation to GDP (Henrekson and Rosenberg, 2000, Jacobsson and Rickne, 2004)<sup>35</sup>, one would expect that competition for funding in this category would be tough.

Two additional research councils were formed apart from the Swedish Research Council, one in the area of working life and social sciences (FAS), and the other in the area of environment, spatial planning and agricultural sciences (FORMAS). It should be noted here that while the organizational unit itself is new, the areas of focus are not and have been amalgamated from existing research financing mandates that the older structure retained (refer to figure 3 above).

Before going any further with our description, it is important to stress that social science and humanities research of a basic character is also funded within the Swedish Research Council. FAS funds social science research devoted to the study of working life conditions. A perusal of FAS' website would soon reveal that its funding is skewed towards applied social science of a particular character, i.e. studies closely related to traditional concerns of social welfare such as ameliorating the conditions of disabled people, etc. In fact, FAS' profile remains almost identical to that of its main predecessor (see figure 2.3 above), the Social Science Research Council (SFR). If one looks

---

35. This publication count is relevant only for science and engineering and does not include the social sciences or the humanities. These two areas are with the exception of psychology and economics poor performers, this peculiarity was singled out for special mention in the latest government white paper on research. See "Forskning för ett bättre liv", proposition 2004/05:80, Utbildnings- och kulturdepartementet, Proposition Prop. 2004/05:80

at the overall picture, working life research seems to take up an unusually large proportion of the research budget for applied social science since in addition to FAS, Sweden also has a large research institute which focuses solely on working life research.

FORMAS is an amalgamation of the former building research council, the former research council for forestry and agriculture, and a number of significant others (see figure 2.3). FORMAS' annual budget for the year 2003 was 540 million SEK (figure taken from FORMAS annual report, 2003) which accounts for 2.6% of the total funds available for public research in Sweden. With this money, the council is expected to fund basic and needs driven research in the areas of spatial, agricultural and environmental sciences<sup>36</sup>; in addition FORMAS has four priority areas: forest; environmental toxicology; climate; and foodstuff. FORMAS appears to be the council which has adopted the programme funding form most systematically, perhaps because the nature of its brief lends itself well to this instrument. Also the individual councils that now constitute FORMAS have an institutional history of working with these methods of commissioning and steering research.

It should be noted, however, that FORMAS programmes are relatively modest in size and cost and are not in the same league as those of MISTRA, the strategic foundation that operates in an area that overlaps with part of FORMAS' defined area of responsibility. MISTRA has a more niched objective in that it funds strategic environmental research. This does not in principle imply that projects funded by FORMAS would not suit MISTRA's portfolio, since FORMAS does require that applicants show that their research is interdisciplinary and that there is potential sector relevance.

Two significant differences between MISTRA and FORMAS funding are the fact that MISTRA prefers large long term projects spread over several universities or research providers. MISTRA also appears to have a much narrower notion of what is strategic environmental research than FORMAS.

---

36. See FORMAS Annual report, 2003 for an overview of the organisation's objectives and its own evaluation of its role in the research financing sector. Document available at [www.formas.se](http://www.formas.se)

Here again, the difference is one of degree since FORMAS' mandate is broader by definition, and the blend of basic and strategic research in its mission implies that it can attract proposals that are more diverse.

The third agency in this group is VINNOVA, an organisation founded for the purpose of promoting sustainable economic growth by fostering effective innovation systems in Sweden and by funding university research of relevance to innovation. VINNOVA is comprised of a number of other agencies including the Swedish transport and communications research board (KFB), some parts of the former Swedish business development agency (NUTEK) and part of the research council for working life research (RALF).

The inclusion of Vinnova in this account is slightly misleading from one perspective since it is not strictly speaking an organisation for funding research. In fact it is an organisational form that belongs to the era of sectoral research but its goal is to further innovation policy in the post sectoral research era. If we continue this train of thought a little further, one might also add that VINNOVA embodies the earlier referred to connection between science and innovation policy.

VINNOVA's brief goes beyond innovation research and includes issues such as regional innovation policy and industrial development such as information technology and small and medium sized enterprises. This implies that VINNOVA as shown in the figure above retains some of the functions of the former NUTEK as well as the new function of advisory organ for national innovation policy.

*One important impact of the new policy doctrine is that the degree of control of researchers over what research is funded has been significantly reduced*

The most important qualitative changes that may be observed from this reorganisation of the funding of research are:

*(i) an implicit redefinition of 'strategic research' and (ii) a shift in the balance of funding towards more reliance on competitive mechanisms for financing university research.* This shift in balance has not been accompanied by a change in the proportion of funding that goes to basic as opposed to strategic research which is surprising given the official policy statements

which all suggest increased interest in strategic research. There has however been a qualitative revision of the definition of what constitutes strategic research. Previously, researchers and the research councils have had almost complete control over deciding what is strategic research. The consensus among this group has been to apply the term strategic to research which has some future potential for application. Recent policy shifts can be read as implying a redefinition of strategic research to mean research that has the approval and/or collaboration of specified target groups. Thus far, it is only the foundations that appear to privilege collaboration as a means of securing that research is strategic and as mentioned previously, this policy is not uniformly applied. The research councils tend to accept that researchers can make a case for the relevance of expected results to specific groups except in particular programmes where collaboration is explicitly requested.

*There has been an implicit redefinition of strategic research to mean collaborative research*

Apart from the requirements for collaboration and relevance (none of which is new per se), there has been another move to promote the dissemination of university research. This is manifested in the amendment to the university charter to include a Third Task apart from research and education. This third task states that universities now have an obligation to inform the public about their research and to actively cooperate with other actors in the society to decide research goals and problems (cf. Brulin, 1998). The third task is not further specified, and it is solely up to universities to interpret how they will implement it. However, according to a recent report from the National Board of Higher Education (HSV, 2005), there are three key indicators of collaboration or implementation of the third task. These are: (i) work with profiling, recruitment, communication of research or popularisation of science; (ii) commercialisation and knowledge transfer and (iii) professional education as well as educational offerings which give students exposure to contacts outside of the university.

Since the amendment (1998) there seems to be a definite trend towards interpreting the third task as being mainly about

the commercialisation of academic research. This reading is predominant from the side of the universities, particularly the older established research universities. Judging by the amount of policy attention given to developing linkage institutions and instruments for promoting commercialisation, one might conclude that there is a high degree of state support for this position as well.

*The Third Task has been de facto redefined to mean commercialisation of knowledge*

Although there is still some scepticism towards the research foundations, their contribution to the development of the research system as it now stands is considerable. Further, ten years hence, it is clear that their role has been one of providing seed capital and innovative instruments. Many of these have been adopted and taken further by other agencies, most significantly the other research councils. The foundations have also made a perceptible move from the margins closer to the centre of the research financing system. There is now a discernible level of coordination of instruments between the foundations and the research councils. It should however be borne in mind that the foundations were intended to play a different role in research financing from that played by the research councils.

Briefly, it has been the role of the foundations to provide new ideas and fund the start up of new initiatives. It is the role of other actors to finance the integration of these activities and their future development. While many of the ideas introduced by the foundations have been adopted by other actors in the system, there is very little evidence that the initiatives that the specific foundations have funded have managed to attract financial support from other actors. This could be problematic in the long run for a number of reasons, the chief one being that the sheer input of resources required to acquire foundation funding would mean that not much will be achieved, since researchers will not be rewarded for trying to continue existing projects but only for starting new ones. Another is that researchers may choose to adopt strategies for lowering the entry costs of getting foundation funding by simply dressing up existing initiatives in new clothes or reducing the actual research

component in favour of all the other requirements which the foundations favour.

Some foundations have clearly worked better than others but together they have had some appreciable impact. The number of ideas introduced by the foundations that have been picked up by the rest of the system suggests that there is a role within the system for similar types of actors. If the foundations are to continue to play the role of pioneers or social carriers of new ideas for renewal of the system, two requirements are indispensable. One is that other funders will have to support the continuation of the initiatives started by the foundations<sup>37</sup>. This also assumes the existence of a transparent and rigorous system of evaluation that could select among the best of the projects and programmes so that everything that once got funded would automatically be continued.

A second requirement is that the foundations must constantly renew themselves and their instruments. Thus, future discussion of how their present funding strategies have functioned ought to include analysis and identification of new system functions or ideas which they could promote. This is a difficult challenge since the foundations are governed by legal instruments that do not always allow flexibility.

## Enabling the entrepreneurial university

It was felt that if Swedish universities were going to be able to meet the demand for more interaction with the rest of society, they would have to be assisted by a number of facilitating institutions. The two main arguments motivating this position were: (a) the presence of a cultural divide between the university and the rest of society created by academic values which argue that science should be driven by internalist imperatives rather than society's needs and (b) it was felt that universities lacked much of the competence and resources that would be needed to successfully pursue a more active engagement with the rest of society.

---

37. See Janson, P. (2005) 'Strategisk biomedicin - styrd forskning?' in Sörlin S. (ed.) *I den absoluta frontlinjen*, pp. 128-157.

### Linkage institutions

It was against this background that the Swedish state introduced a new class of institutions known as the technology bridge foundations (now known as *Innovationsbron*). The technology bridge foundations were seven in number and were organized on a regional level with each having some degree of autonomy in defining its mission so as to ensure that region specific needs could be met. For this reason, it is difficult to describe the role of these organisations with anything but the broadest of brushes. Generally, it may be said that they provided universities with the assistance they needed to make the linkages with the rest of society.

As the Swedish university sector is largely public, with most universities being essentially state authorities, it became clear that if the Third Task was going to include commercialisation and commodification activities some legal solution would have to be created in order to overcome this barrier. This led to the creation of a number of university holding companies which were directly charged with the responsibility of providing the support and funding for commercialisation and commodification of knowledge. The holding companies are attached to the universities and provide a mechanism through which universities can conduct various activities such as owning and selling intellectual property, taking equity in spinoffs, etc. This mechanism has been necessary because most universities are state authorities and are therefore prohibited from engaging directly in these types of transactions.

An important aspect of Sweden's innovation policy is the design of measures to facilitate the emergence of an entrepreneurial culture in the wider society and in universities in particular. The Third Task, the formation of the technology bridge foundations, the university holding companies are all part of this general effort. In addition to these efforts, a number of universities have developed entrepreneurship educational offerings (courses). These programmes are becoming more common. At present there are at least four prominent ones located at Chalmers, Jönköping University College, the Stockholm School of Economics and Uppsala University, respectively.

### Foundation universities

One other aspect or block in this structure, which is very seldom discussed, has been the former Conservative-liberal government's experiment with diversifying the ownership structure of some Swedish universities. The attempt at university privatisation was a limited experiment that did not survive the Conservative-liberal government's fall from power, but the universities' that won the right to become private foundations still exist in that form. The history behind their privatisation is interesting from the point of view of framework conditions for university-industry collaboration in two respects. The first is that the approach to privatisation was a policy innovation and the second is that privatisation gave the universities in question an opportunity to be entrepreneurial on an organisational level that is rare in the Nordic context.

The policy innovation was initiated by the then education minister Per Unckel (Conservative) who announced that he would like to try to privatise a Swedish university. Some of the major reasons for this decision included a previous state decision to increase the number of student places at Swedish universities and in particular at engineering universities. Further, it was decided that it would be a good idea to ascertain whether diversity of ownership could improve quality in the higher education sector. In a government proposition entitled *Universities and Colleges: Freedom for quality (Universitet och högskolor: frihet för kvalitet)* a number of guidelines were given for structural reform of Sweden's universities and colleges of higher education, which were to be implemented in parallel with the proposed increase in number of university graduates. It was decided that technical universities and regional university colleges would be the ones eligible for this privatisation. A number of universities competed but none of the major research universities such as Uppsala and Lund was eligible for participation in this competition.

The eventual winners were Chalmers University of Technology and Jönköping University College. The two organisations became private foundations and each received a large sum of money as its capital base which it got the legal right to invest on the stock market. In the case of Chalmers, a fifteen year agreement was set up and the university received SEK 1,5 billion as

base capital. This base capital is not to be used but only the interest earned from investment of the capital. When the fifteen year period has elapsed, it is expected that the base capital sum will revert to the state. The organisation structure which has been used to make room for the changed status is that a private foundation (*Stiftelsen Chalmers tekniska högskola*) owns the university. This foundation is run by a Board of Directors which is comprised of a number of actors from the industrial, public and university sectors. Like other universities, in Sweden, Chalmers has a rector who is elected by faculty.

From the point of the view of the state, the differences between the privatised universities and university colleges and other universities and colleges are:

1. Privatised universities and university colleges have a high degree of autonomy with respect to planning and organisation of their activities relative to that enjoyed by other universities and colleges in the country; and
2. The relation between the state and the privatised universities and university colleges is regulated by an agreement between the state and the university or college.

Chalmers still enjoys all the privileges of other Swedish universities, and the agreement between this university and the Swedish state explicitly states that it should not be penalised or treated differently because of its changed status. Privatisation has meant certain freedoms as well. One of the more important of these is the right to recruit and lay off staff without being governed by the civil service act. One of the reasons for Chalmers entering the competition was that it saw privatisation as a move that would give the university more control over its hiring policy. While the university has taken quite a bit of initiative in using this freedom for building its infrastructure for innovation, the deadly combination of poor management on the departmental level and academic conservatism has meant that there has been less innovation in the area of recruitment.

Even some of the goals that Chalmers set itself in the initial argument for privatisation have not been realised. This is in

part because of a general lack of knowledge among departmental leaders and those who work with management of education and research within the university about the great potential for flexibility written in to the foundation's charter (cf. Jacob, Lundquist and Hellmark, 2003).

*The most discernible impact of privatisation has been improvements at the level of organising the universities in question*

Jönköping university has an organisation structure in which each faculty area in the university is a separate company (handelsbolag). The university has four faculties or schools: health sciences; education and communication; engineering and business. In the context of Sweden, it is a medium sized university with 6 500 full time students and a staff of about 600. Although much is made of Chalmers as an entrepreneurial university, Jönköping is an example that is worthy of attention as well. Further information about the university may be found on its website at [www.hj.se](http://www.hj.se).

The new organizational formats at Chalmers and Jönköping have been in existence for about ten years, there have already been several different types of evaluations and investigations of the activities of these organisations' and they have all reported positive results. Nevertheless there has been no demand from any of the other universities for privatisation and neither has there been any move on the part of the state to extend this policy innovation. The National Audit Office has proposed to conduct an evaluation of the foundation universities with a view to assessing whether the ownership structure makes any difference in how they operate.

The coupling of privatisation and entrepreneurial organizing in this report is a hypothesis; there is still little evidence to evaluate the validity of this argument. A further problem in this regard is that there is no standard definition of entrepreneurialism with regard to universities. A survey of the evidence reveals that different universities have the potential to be entrepreneurial in different respects. What may be gleaned from the evidence available through the yearly reports and different evaluation documents prepared over the last ten years about

the Chalmers and Jönköping foundations is a marked improvement in efficiency in the following areas:

- Overseeing and general improvement of the internal management of the activities of the organisation;
- Change in attitude on the organisational level towards commercialisation and innovative organising;
- Attempts to develop more effective recruitment policies; and
- The development of an infrastructure within the university for commercialisation of knowledge.

While it may be argued that at least three of the above may be attributed to the general policy shift at the macro level, the most noticeable difference is in attitude.

#### **The teacher exemption clause (*lärarundantaget*)**

One of the most visible issues in the debate about the commercialisation of academic knowledge in Nordic countries generally and in Sweden in particular has been the role of the teacher exemption clause in commercialisation. The teacher exemption clause is a simple convention which gives academic staff at universities full entitlement to any intellectual property arising from their research. This is a situation that is not unique to Nordic countries but is a remnant from an earlier time in academic tradition. Many countries such as the USA have gradually taken away such rights as time went by.

The dominant policy position on the teacher exemption clause is that it is an obstacle rather than a facilitator for commercialisation. The reasons given for this are that most researchers and universities lack the interest, time or knowledge to engage in commercialisation of their research despite the fact that they have the legal right to do so.

To the best of our knowledge, there is very little empirical evidence to support this or alternative views. Research conducted by Henderson and others about patenting after the Bayh Dole Act for instance showed that while there was indeed an appreciable increase, few of these patents led to commerciali-

sation or firm formation (Henderson, et al. 1994). University technology transfer offices take an average of ten years before they show profit and patents and licenses represent a small percentage of the actual takings of universities accrued as a result of commercialisation. Companies are also equally slow in their ability to transform patents into new business opportunities, as many of the larger corporations with substantial R&D produce substantially more patents than they create new business opportunities. The reason for this is that the ability to transform research into a business opportunity is determined by organisational capabilities and not just the supply or availability of new knowledge (cf. Iansiti, 1997).

Iansiti's work may be applied to the nation state level to challenge the presumption that has hitherto informed innovation policy, which is that level of R&D investment is an indicator of innovative capacity. Reasoning from Iansiti's work, one would hypothesise that the capacity to commercialise research findings or, to use his language, increase technological yield is a better indicator. This capability, however resides not so much in R&D capacity but in the combination of know how, demand from local industry and infrastructure for commercialisation.

The available evidence therefore suggests that patents and licenses receive an inordinate amount of attention in relation to the actual profits they generate for universities. It is not surprising therefore that Nordic policymakers, like others before them, have zoomed in on intellectual property and the teacher exemption clause as important pillars in their efforts to construct entrepreneurial universities.

Denmark was the first to legislate in this regard with the removal of the teachers' exemption clause for Danish academic staff about three years ago. This was not accompanied by any other measures such as university reform, institutional structures for assisting universities with commercialisation, new funds or any of the usual supporting measures. The new Danish University Law introduced in 2003 has led to the introduction of additional measures for increasing the degree of stakeholder involvement in Danish higher education and research.

Sweden, Norway and Finland have taken a more deliberative stance towards the issue and several studies, debates and reports have been done in these countries about the topic. To

date Norway is the only one of the three that has taken this discussion from debate to legislation and this was also done in 2003. The Norwegian reform is a comprehensive one, at least as it looks on paper. It not only removes the teachers' exemption clause but introduces a whole new institutional structure for realising commercialisation (cf Iversen, 2003). Finland has yet to take a decision (see next section for more on reforms of the different Nordic countries research systems). The Swedish position on this issue is interesting in the light of the available evidence and the fact that Sweden has instituted so much of the supporting infrastructure for commercialisation. After several notable discussions on the issue as well as studies and investigations of the state of the art in other countries particularly the USA (Nordfors, et al. 2003), the Swedish authority (VINNOVA) charged with the assignment of advising the government on this issue has put forward a report suggesting that universities be given the responsibility to assist staff to commercialise their research if requested (Nordfors, et al., 2003).

At the heart of the soul searching on the teachers' exemption clause and the role of universities in the commercialisation of knowledge lie two seldom explicated problems. One is that not all Swedish or even Nordic universities are in a position where such issues really matter to the extent where a national debate is warranted. The discussion in all countries is really about a few leading institutions rather than all. However, it is not 'politically correct' to simply focus on these institutions and begin a debate with them which can then be scaled up to allow for the creation of principles that would hold for all universities if and when the need arises. A second is the resource allocation consequences of the current policy choice to treat the problem as one that affects all universities to the same extent at the same time.

The present approach by focusing on the teacher exemption clause in general rather than on specific commercialisation competences, opportunities and potential skews the discussion in such a manner that if money and competence is to be allocated to universities to assist in commercialisation efforts, all universities would have to receive some regardless of their actual commercialisation potential. The notorious under re-

sourcing of the university holding companies in Sweden is an illustrative case in this regard.

An alternative to this approach would be a more incremental policy based on pilot projects located in some universities but with possibility for staff from other universities to participate if they choose. The benefit of an incremental approach is that available competence and capital for technology transfer could be concentrated on those institutions for a limited time. In this fashion, the limited competence available for commercialisation support could be used to better effect in a few instances giving time and opportunity for experience and best practice profiles to develop. The accumulated knowledge and competence would then be used to benefit latecomer institutions. All of this could be achieved without any regulatory change, the only necessary change would be that those institutions involved in the pilot would be able to offer researchers who are interested resources and competence to assist in commercialisation efforts on a scale that they do not currently possess today. Recent research on Linköping (Braunerhjelm, 2003) and Chalmers (Jacob, Lundquist and Hellsmark, 2003) show that competence rather than capital is perceived by researchers to be the most significant obstacle to commercialisation of academic knowledge.

## A Nordic perspective

Before presenting concluding observations in the final chapter, it seems appropriate to reflect on the Swedish case against the background of what has been taking place in other Nordic countries in the same policy area. This attempt, however, is mindful of the fact that while the Nordic countries share a similar history and ideological framework, the differences that exist among them generally, and those differences which distinguish the Swedish higher education and research system are significant determinants of the utility of such comparisons.

Generally, the Nordic countries are as a group ranked rather high in terms of gross domestic expenditure on R&D (see table 2.1 for figures), Sweden, Finland and Iceland are in the lead although very little is usually said about Iceland in these contexts. Denmark and Norway are both under the 3% targeted by the

OECD as the magic figure in this regard, although Denmark is much closer to that target than Norway. We shall not present any analysis or data on Iceland in this respect although there is an ongoing discussion in Iceland about reform of the university sector. In the wake of the activities of deCode Genetics Inc.<sup>38</sup>, property rights issues arising from the commercialisation of research results and innovation policy are obviously high on the policy agenda in Iceland. Further, discussions about the formation of a Nordic research and innovation area (NORIA) and its implications for Iceland are also prominent.

### Denmark

Not surprisingly, Denmark and Norway are more or less late-comers with respect to reforming policies for higher education and research to emphasise innovation. Denmark was early out on the property rights issue but other aspects including infrastructure for commercialisation are now on the agenda after the introduction of a new university law that came into effect in 2003. Among other things the law was intended to give universities more freedom with respect to management, salaries, etc. One of the more controversial aspects of the new law was that the university board should have a majority of external representation. University Boards have also been given new authority, e.g. it is the Board rather than the collegium that has the power to employ and dismiss the Rector. The Board has also been given the authority to employ and dismiss the university's executive management on the recommendation of the Rector.

It is up to individual universities to decide on the details of the implementation of the university law. However, the guidelines are pretty far reaching since they do touch on management

---

38. deCODE is a biotechnology company involved in research, development and services in the field of genetics, genomics, biodiagnostics and biotherapeutics. The controversial aspect of deCode relates to one of its products, the clinical genome miner<sup>TM</sup> which is a platform for genomic research that brings together a comprehensive collection of genetic markers and genealogical and disease data with bioinformatics for analysis of the genetic basis of more than 30 common diseases. deCode raises similar issues about commercialisation and the public-private connection as Umeå university's UMANGENOMICS.

at the departmental and faculty level. For instance, although the law requires that deans and department heads be selected from applicants with knowledge of the research area of the faculty or the department in question, it is not at all clear that the selection process has to be limited to internal candidates. This suggests that Denmark has taken the step to adopt a practice already widespread in the United Kingdom and to a lesser extent in Germany. This is to institute Executive management. Within the UK, this practice is for the most part restricted to Deans and Vice Chancellors. It implies that a person is hired as a Dean or a Vice Chancellor rather than elected. In Sweden, the practice is at present confined to Vice chancellors and is not used at all universities. Further, Swedish Vice Chancellors are appointed by the state and nominated by the university. Issues such as salary and other terms of employment are negotiated with the state not with the university board<sup>39</sup>.

The Danish reform further requires that department heads leave their academic posts during the period of tenure as headship and become fulltime managers for a period of 5 years. Remuneration for this position will be based on a scale different from that for academic staff. This provides room for the development of a professional management cadre within the university system if universities choose to take the opportunities offered to them in the law.

Apart from the university law, Denmark has also reformed its research council system (see figure 2.4 below). The new system consists of the Danish Council for Strategic Research which is an advisory body consisting of eight members, of whom two are directly appointed by the Minister for Science and Technology (the chair and one other member). The chief task of this body is to support research in politically prioritised research areas and contribute to strengthening interaction between public and private research. The Council for Strategic Research also provides advice to the government as well as pinpointing new research trends. The Council's services are also available to private enterprise. Once the Council makes its

---

39. See HSV 2004 *Högskolans ledare: om rektorsroller och rektors-tillsättningar*, Stockholm, Sweden for a discussion on the present day situation with respect to leadership at Swedish universities.

recommendations, temporary programme committees are set up and these committees actually commission and decide what research to fund.

In addition to the Strategic Research Council there are six councils for financing independent research. These bodies fund and commission research as well as provide advice to the Ministry for Science and Technology. A second new feature of

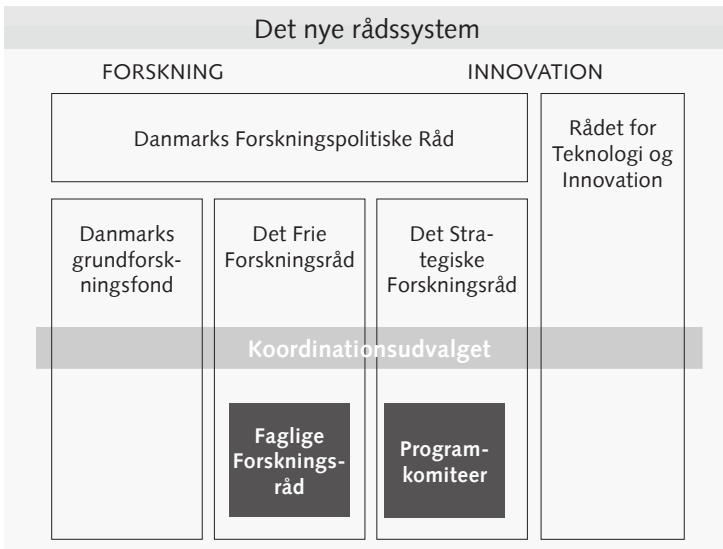


Figure 2.4: The Danish Research Financing System.

Source: The Danish Research Agency. [www.forsk.dk/dfs/dfs\\_dia.htm](http://www.forsk.dk/dfs/dfs_dia.htm).

Index to Figure 2.4

Det nye rådssystem: The new research council system

Forskning: Research

Innovation: Innovation

Danmarks Forskningspolitiske Råd: Danish Council for Research Policy

Rådet for Teknologi og innovation: The Danish Board of Technology

Danmarks Grundforskningsfond: The Danish Basic Research Foundation

Det Frie Forskningsråd: The Basic Research Council

Det Strategiske Forskningsråd: The Strategic Research Council

Koordinationsudvalget: Coordinating Committee

Faglige Forskningsråd: Disciplinary research councils

Programkomiteer: Program committees

the reorganised research financing system is the addition of a council for technology and innovation which like the strategic research council is also an advisory organ. There is a third committee which is intended to coordinate the entire organi-

sation which is the Danish Research Coordinating Committee. The latter is a seven person body, one chairperson and six members. Members are the chairpersons of the other bodies (the Danish Councils for Independent Research, the Danish Council for Strategic Research and the Danish National Research Foundation, the Council for Technology and Innovation), two members from the Danish Rectors' Conference and one member from the Danish Government Research Institutes' Steering Committee. This organisation structure has recently been completed so it is not yet clear how it will function. Plans also exist to move towards the general trend of supporting the development of critical mass in strategic areas such as nano, bio and information technologies. In this regard, it is expected that 4-7 new centres will be created and that these will also emphasise the development and maintenance of linkages between industry and academe. A national entrepreneurship programme (*ivaerksætterakademin*) is also now being planned. This will be a virtual school for entrepreneurship that will support entrepreneurship education in schools, colleges and universities.

### Norway

The Norwegian situation is slightly more complex, or simpler depending on one's perspective, than the Danish situation. Norway is usually presented as the smallest player with respect to R&D spending among the Nordic countries and this includes both business and public R&D. According to the latest available statistics on Norwegian R&D expenditure on R&D (GERD) for 2003 was 1,75% of GNP<sup>40</sup>. This puts Norwegian R&D spending below the OECD average which is 2.2%. The main reasons for this are relatively low levels of business expenditure on R&D and the high GDP. The Norwegian public research sector is quite institute heavy although the universities are increasingly playing a more important role in research.

There is a planned reorganisation of the public R&D sector and a white paper on this issue is expected this year. The institute sector's importance has decreased slowly the last 15 years, it now performs 23% of the total R&D. Norway has

---

40. See OECD (2005) *Main Science and Technology Indicators*, Volume 2005/1, OECD, Paris, France. See also [www.nifustep.no](http://www.nifustep.no) for further information on Norwegian innovation including statistical data.

also begun to focus on the problem of the ‘holy trinity’ i.e. connection between public R&D, innovation and growth. Like other Nordic countries, Norway has zoomed in on commercialisation of public R&D as a critical issue and to this end, as mentioned earlier, new legislation was introduced in 2003. The allocation of funds to commercialisation according to this recent legislation is quite impressive but this has not been accompanied by any reorganisation of the research financing system, perhaps because institutes and not universities are the main targets of this strategy and the former are already dependent on soft money.

### **Finland**

Finland is actually the country now seen as the most important source of best practice examples for Sweden apart from the USA, which has been up to now, Sweden’s favourite source of inspiration for science policy. Three factors may be said to explain the interest in Finland. One is historical and that is the tendency of Nordic countries to use each other as benchmarks in policy areas and the fact that in matters of science policy, Finland and Sweden have traditionally been similar in several respects. One Finnish policymaker explained this relationship in the following way: traditionally Finland copied its science policy ideas from Sweden who had in turn copied from the USA. A second and more important explanatory factor is that Finland is by all standards a best practice example in science policy at the moment. This position is due to the country’s rapid growth rate since the 1990s, a situation which is only in part explained by the success of Nokia and the related ICT cluster. The similarity between the two countries expenditure on R&D is in part the third reason for the Swedish interest in Finland. The general opinion among Swedish policymakers is that Finland’s innovation return on its R&D investment is higher than that of Sweden and thus it may be useful to understand how this investment is leveraged.

In view of the particular focus of policy interest as well as the fact that many of the details of the Finnish R&D situation are either well known or easily available (cf. [www.research.fi](http://www.research.fi)) we shall confine our input to as far as possible outline the characteristics of the Finnish science and innovation policy situa-

tion that could be explanatory. In this respect, it is important to emphasise that Finnish policymakers themselves claim that their country's success cannot be fully explained by the available data and that luck is an important element in the situation.

The more significant contributory factors in explaining the Finnish miracle include the role of a few highly export oriented clusters and the Finnish science policy culture. We shall begin with the role of policy. Lemola (2003) contends that the Finnish transformation process, although often characterized as a miracle, is in fact a gradual change spanning more than three decades of incremental improvements in policy doctrines, institutions, organizations and instruments.

The Finnish science policy system is fairly simple and the main actor is the Science and Technology Policy Council (*Statens råd för vetenskap och teknologi*) which is chaired by the Finnish Prime minister. Once every three years, representatives of key stakeholders meet and create an outline of science and technology policy which is used for future policy making in the area. This policy outline contains suggestions as to resource distribution for public R&D investment. The actual implementation of these suggestions is left to the ministries and agencies. Individual research or technology programmes are not decided by the Council or even by the ministries, but by the implementing agencies.

Apart from the essential simplicity of the structure of the system, the small size of the country and the fact that key players from industry, the public sector, etc are actually involved in making science policy facilitates the development of a system that is responsive to changes in industrial and other policy areas.

The second contributing factor to the success of Finland's science policy may be described as the articulation of science policy doctrine with the reality of the industrial landscape. In this respect, Finland fits the pattern discussed in chapter 1 in so far as narratives such as the systems of innovation perspective and industrial clusters have been integral to the shaping of contemporary Finnish science policy doctrine. These two narratives have a strong complementarity as they both emphasise a systemic view of innovation. Some studies have been made of

this articulation of research on science policy and policy doctrine in Finland (cf. Miettinen, 2002; Lemola, 2002; 2003).

Other explanatory variables in Finland's success include the concentration of resources in one particular sector, telecommunications. This is not to say that Finnish economic growth is explained by the telecom cluster but that unlike other countries, where investments in the future are spread over a number of high technology and capital intensive sectors, Finland seems to concentrate its resources on one. There is a heated debate about the wisdom of this strategy even in Finland itself but it may be a part of the picture that should not be ignored.

## The way ahead: Observations; Indications of the future; Policy conclusions

### Concluding observations

In this chapter we shall make a few observations about the primary mechanisms introduced in Sweden for achieving the three policy goals: enculturating entrepreneurial values; promoting closer university-industry interaction; and commercialising knowledge. Our aim is to add a perspective that may not have been part of the debate before as well as to point to areas that could be developed in the future. The task of commenting on developments in the Swedish public R&D system is similar to trying to catch a moving train, just as one thinks one has grasped hold of it, it generally takes off again. For this reason, we have chosen to include in this chapter some of the new developments that have occurred or were being planned during the period when this report was written.

The attempt to transform Swedish science policy into innovation policy may be seen as both an act of convergence with international trends and a response to local factors, such as an ageing population and a growing need to restructure the national economy. The emphasis on the science system and the universities in particular is a result of at least two important reasons. One is that the public R&D market in Sweden is dominated by universities and university colleges which means that any efforts to use public R&D to kick-start the economy would necessitate a focus on higher education and research. The other, is a belief (one that is shared almost without exception by a

number of influential policy actors in Sweden and internationally) that public investment in R&D is a viable strategy for inducing innovation and promoting economic growth.

Some countries favour a mixed strategy which involves promoting business R&D, through indirect support such as reduced taxes in proportion to increased investment in R&D as well as public R&D. The Swedish approach may also be construed as a mixed approach in that its emphasis on collaboration with industry implies some indirect support of business R&D. In the absence of a large institute sector through which these demands could be channelled, Swedish policymakers are more or less dependent on universities to carry the burden of servicing the research needs of public and private sectors.

At the risk of oversimplifying a complex set of policy initiatives spanning a period of at least one decade, contemporary Swedish research and innovation policy may be said to have three broad objectives:

- (i) to promote the development of an entrepreneurial culture in the higher education and research sector;
- (ii) to promote a greater degree of interaction between the higher education and research sector and the rest of society, but primarily industry; and
- (iii) to increase the pace of commercialization of knowledge produced in the higher education and research sector.

These objectives have been pursued primarily, although not exclusively, through a reorganization of the research financing system to promote more reliance on competitive funding and the development of a cadre of linkage institutions, such as holding companies and other bridging organisations, to tend to affairs arising from commercialization of research.

The introduction of these measures has been gradual and in many instances there has been a spirit of experimentation akin to a type of policy entrepreneurship. By this we mean that although there was a plan of some kind, many initiatives have been sponsored or championed by key individuals working within the research foundations or elsewhere. This spirit has meant that some initiatives were rather bold and were set

into motion before the dependencies in the different parts of the system had been understood. For instance, the holding companies have relatively few resources in comparison to the technology bridge foundations. This has meant that the former are dependent on the latter rather than acting as an additional source of stimulus on the micro level (i.e. individual university) while freeing the technology bridge foundations to focus on initiatives that create added value on a regional level. This dependency is not all negative since it means that the two institutions have been forced to cooperate. This development may have taken a longer time to occur had the university holding companies been allocated enough capital to develop independent portfolios.

The Finnish public R&D system is now seen as the benchmark for others. A cursory examination of the Finnish system would reveal that it is characterised by a centralised structure with a broad based and inclusive process for soliciting stakeholder opinion. The Swedish system is slightly more complex for a number of reasons. One is that responsibility for science and innovation policy is spread over a number of different parts of the governmental system. This allows a diverse range of perspectives from the public sector to influence and to compete for influence on this policy arena. This diversity of public perspectives is not always matched by a similar level of diversity of input from other parts of society because the structure is so difficult to access.

Another property of the Swedish system is its dependence on universities and university colleges. Unlike research institutes, universities and university colleges have a diverse set of missions and stakeholders. There is a general perception that the institutional arrangements that are necessitated to leverage this diversity shapes the kind of knowledge that is produced in the higher education and research sector. A less understood feature is that it also contributes to the institutional inertia that is often seen as characteristic of universities. Put differently, universities may not be the best institutional provider if reduction of the so called innovation deficit is the overriding policy ambition. Apart from the factors mentioned above, there are several well documented studies that show that universities are not the first site that actors in other sectors turn to

for their knowledge needs. It may therefore be that the lesson to be learnt from the last ten years and the Finnish miracle is that a good functioning institute sector may be a necessary part of an innovation system.

With respect to the shift in balance between fixed and competitive research funding, the results are mixed and a number of meso level factors appear to be missing for this approach to yield the desired benefits for policy and for universities. One of these was alluded to in the joint report written by the research councils as part of their advice to the government for 2004 (VR/FORMAS/FAS/VINNOVA/SUHF/KVA/IVA (2003) see [www.vr.se](http://www.vr.se)). This has to do with the impact of the reduction of fixed funding to universities and its implication for how universities use funding from competitive research.

Currently Swedish universities are allowed to charge about 30% administration fees for grants received by their employees to conduct project research. This fee is higher if the assignment comes from a non public source. This money is ostensibly intended to provide support facilities for the project in question. Universities are however unable to deliver these services for a variety of reasons. Some of these are organisational, for example lack of support staff with project management competence, others are financial.

The latter is the issue emphasised by the research councils and this is connected to the squeeze on fixed funding as well as the impact of other significant reforms such as the professor and doctoral student reform. Universities are often now forced to use project funding to maintain their regular activities and this naturally reduces the potential for positive impacts from competitive research funding policy. It is difficult to remedy this situation with 'a one policy fits all' solution since universities differ radically in terms of how they have adjusted to the squeeze on fixed funding. Further, differences may also exist in practices at the faculty level within the same university.

One instrument that suffers the most from the financial problem is collaborative research that requires universities to put up matching money from their own resources. Matching money is quite possibly the most creative new output from academic project managers. This creativity is born from the necessity arising from the dwindling fixed budgets of universi-

ties. Matching funding for instance is often not new money but time allocated from already employed personnel. This practice is sound and works well as long as the skills already existing in the organisation match those required by the new project. If this is not the case, the project or programme is doomed to under perform.

The second part of this story is the competence gap. Most universities lack project management and other day to day support capabilities for contract research and custom built teaching programmes, etc. Part of the problem derives from the nature of the university *qua* organisation. Most Swedish universities can be characterised as two organisations connected by an internal post system. One organisation performs administrative and governance functions, while the other performs teaching, research and any new missions that have been channelled either from the top down or the bottom up.

It is often astonishing how little academic and administrative staff know about each other's competences and activities. Project management is a task that straddles these two organisations; it is an opportunity for creating synergies between the two organisations that constitute the university. By this we mean that much of the institutional overload that is currently being experienced by Swedish universities is tightly linked to the fact that most, if not all, new tasks are allocated to the part of the organisation that conducts research and teaching. The administrative part of the university lacks competence to function as an effective support for projects. As long as research funding remained small scale, the present system was adequate since academic staff could 'manage'.

The advent of large scale programme funding and projects that span several universities and other types of organisations is increasingly pushing the system towards crisis. This problem is not just a question of the limited availability of resources but also because there is no room in the Swedish academic system for professional research assistants and project management staff. This type of task often requires a person with both administrative skills as well as some kind of research training. The two organisation structure in the university makes it difficult to provide an attractive career path for such personnel and this explains why at present the burden of this type of work is

shared between senior academic staff and their doctoral students. This solution is neither desirable nor sustainable for a number of different reasons.

In this respect, a major problem within the Swedish higher education and research system concerns the capabilities and organisational structures supporting the transfer of results to society rather than issues of entrepreneurship and venture capital support. Ideally speaking, the administrative fees that universities charge external financiers could be invested in services of this type. However, for various reasons mentioned earlier, this would be an unthinkable luxury at the present time for many universities.

Thus, one might argue that there is a funding gap in precisely the area that current policy efforts are focused, i.e. “moving research results out” from the universities. This gap is not covered by venture capital, and to the best of our knowledge, this issue has hitherto escaped the attention of policymakers. This policy gap is in part related to the fact that, as mentioned earlier, many changes have been introduced into a system whose dependencies are not always well understood by those charged with the task of increasing its responsiveness.

Research councils could help with this in a variety of ways such as making project management a criterion that all projects have to meet and pass in order to be considered for funding. This would have to go well beyond the current practice of face value acceptance of the project management arrangements that are described in research applications.

A number of simple measures could be introduced to achieve this end without getting into micro management. One such measure is requiring that the financial reports for projects account for how the money deducted for administrative costs were used in support of the project. At present there is a strange collusion between research councils and universities whereby project accounting blackboxes the administrative expenditure that goes directly to the university.

Any measures taken to improve the quality of project management will not be successful without support and competence at the university level. Since project management is a rarely discussed topic in the Swedish higher education and research sector, many readers may see this issue as either unimportant

or have trouble understanding the relevance. For this reason, we would like to point briefly to how it relates to university-industry collaboration and commercialisation issues.

- The rise of competitive research funding means that much of the knowledge work done at universities is conducted within the form of projects, including doctoral education<sup>41</sup>.
- Industry is by all accounts the one of the most favoured new partners for collaboration. One of the chief complaints of this sector about collaboration with the university is the underdeveloped state of project management structures within the university sector. Some typical complaints include the inability of university administrators to convert costs in terms that could be understood in the context of other administrative systems.
- Project management is a means through which one can promote the development of commercialisation capability throughout the entire university.
- Many research projects under perform because of poor resource allocation or other issues that are directly linked to project management.

The increased dependence on soft money has not been without its negative aspects. Universities are faced with new tasks and demands for new competence profiles among its research, education and administrative staff but have limited prospects for developing proactive recruitment policies to address these needs.

The emphasis on competitive research funding has also encouraged a herd mentality in that “everyone” chases after the same money and therefore does more or less the same types of research. In some areas where there is a need to develop critical mass, this policy performs well; it does however draw money and personnel away from other areas. The danger here

---

41. Some universities such as Chalmers have a 60:40 ratio of external project based to fixed funding

is that Sweden may be gambling away its future inheritance by not ensuring a diverse competence base that would guarantee its capability to maintain a high degree of absorptive capacity even in areas which it does not consider prioritised. A number of new instruments introduced by the foundations and the research councils may help to alleviate the situation, e.g. strong research environments, future research leaders, etc. However, the practices such as coupling regional development policy with higher education and research and innovation policy reduce the ability to create efficient resource allocation systems. For example, costs are escalating out of proportion to potential returns because there is too much capacity. There are too many student places and too many providers. The new policy of promoting critical mass and excellent research environments will not be successful unless the excesses

Finally, there is a growing concern that the pendulum may have swung too far to the extreme in so far as collaboration and third mission activities at Swedish universities are now overly focused on industry. Strömberg and Tydén (1999) pointed to the lack of attention to the public sector research needs and development of infrastructure at universities for supporting such collaboration. In summary, the mechanism of competitive funding has a proven record for inducing quality and stimulating a switch to applied research. The available evidence suggests that a diversity of financial sources and enough slack in the system to allow alternatives to develop, survive and thrive are critical to the continued maintenance of quality in such systems. Put differently, it is important that policy does not attempt to drive all actors in the same direction.

The policy effort to promote the development of an entrepreneurial climate is probably the most difficult to evaluate, because of the constant tinkering with the system where new initiatives are constantly being introduced. Further, the goal of creating an entrepreneurial university is rendered more difficult by the fact that there is no one all time definition of what is an entrepreneurial university. Notions of what is entrepreneurial have evolved over time (Keast, 1995). The entrepreneurial university is a term now being used to refer to universities which possess a wide range of new infrastructural support mechanisms for fostering entrepreneurship within the organisation as

well as packaging entrepreneurship as a product. By the latter, we mean phenomena such as courses in entrepreneurship and an organisational structure which allows for the active promotion of entrepreneurship among students and faculty (Jacob, Lundquist and Hellsmark, 2003). Not all Swedish universities have achieved this and even the few, e.g. Chalmers, Jönköping and Karolinska, that are considered to be frontrunners have a long way to go yet. What is already clear from the current profiles of these universities is that there is no one formula for the entrepreneurial university but rather that each university must find its own recipe for entrepreneurship, from its history, future visions and current competence.

There has, however, been a change in attitude, and at universities where entrepreneurship was already a dormant idea, the top down signals in favour of entrepreneurship have been welcomed with fervour. Universities such as Chalmers, Karolinska and a number of others have seized the opportunity to further develop previously existing capacities and ventures. The problem reported in these contexts is that there is still not enough knowledge about how to create and develop firms from academic knowledge. A further problem is that the policy debate is still far too focused on the commercialisation of knowledge. There is an urgent need to broaden the debate to include other equally important models of institutional enterprise.

The decision to promote the development of an entrepreneurial culture is one that fits with the best available evidence of what has worked. By this we mean that most research on commercialisation of academic knowledge shows that individual faculty considerations of the costs and benefits of disclosure are strongly influenced by institutional environments that are supportive or oppositional to the simultaneous pursuit of academic and commercial endeavours. There is still much to be done to ensure that the initial seeding efforts for culturing enterprise at Sweden's universities and university colleges can succeed. Some of the more immediate needs include support for the development of an effective project management structure and skills and the financial resources for recruitment of staff to prepare universities for the demographic shift.

## Some indications of the future

Perusal of recent policy documents suggest that Swedish innovation policy is not by any means in a state of stasis. The next five years will be decisive since a number of important decisions will be made in this period which will determine whether present trends will be deepened or whether there will be a policy roll back.

There has recently been an increasing internationalisation of Swedish research councils in particular the Swedish research council. This organisation has begun working closely with a number of counterparts in Europe. In addition, initiatives such as the Nordic Research and Innovation Area (NORIA) and the European Research Area (ERA) all suggest further internationalisation and coordination of policy on several planes apart from the national. It remains to be seen how this internationalisation will affect the goal of transforming science policy to innovation policy, since hitherto innovation and science policy have been endeavours that are deeply mired in nationalist objectives. This internationalisation of research has been matched by similar efforts in education, with the Bologna agreement being an important change agent for future degree structure, curricula, etc in European universities and university colleges.

Recent studies from the research councils all point to a need to secure basic research competence. This is also supported by the narratives that are used to legitimate policy doctrines that have promoted just the opposite. Thus, perspectives such as Mode 2 and the Triple Helix concur that the boundaries between 'applied' and 'basic', relevance and blue sky remain, perhaps more, fluid than previously. Put differently, while Gibbons et al. claim that transdisciplinarity and social robustness are now defining criteria of knowledge production and Etzkowitz seems to find new and more instantiations of tripartite alliances the world over, these combinations of evidence and hypothesis do not imply that a funding strategy directed exclusively by relevance or blue sky concerns is preferable. In fact, if one must read funding strategies off these hypotheses, they in their separate ways show that it is when relevance and curiosity are allowed to intertwine that innovativeness is induced. A new

set of instruments have now emerged which seem to embody this particular insight. Instruments which promote excellence and the development of particular research environments suggest that some effort is being made to achieve a balance between exploration and exploitation. This is an approach which should be encouraged and further developed.

Finally, we introduced this document by remarking on the fact that the pace and extent of reform has been such that, it is often difficult to assess the main objective of the policies that have been implemented during the period under study. In the light of this review, we may conclude that there is one fundamental issue which remains to be clarified. This is whether the purpose of current policy is to promote the transfer of knowledge from the public R&D sector to the rest of society or whether it is to use public R&D to increase the rate of economic growth. Although these two objectives are not mutually exclusive, a great deal of time and effort could be saved if policymakers were to be clear on which is to be the main objective. One quick example would suffice to both illustrate and explain the danger that lies in confusing the two objectives.

If we assumed that promoting knowledge transfer were the main objective of current policy initiatives, then we would have to recommend that instruments which promote collaboration between universities and other actors in society would be the most efficient means to this end. Licenses, patents, university spin offs would be a small part of this but not a priority. Universities would be encouraged to develop strategies for knowledge transfer that would be based on the user community that they identify as relevant to their profile. Research councils and other funders would then be working in dialogue with universities and stakeholders to develop financing strategies that would suit the kinds of research or education needs that are identified as a result of this collaboration. This approach differs in many respects from the top down visions that have characterised policy making in this sector over the past decade.

If the goal of policy is to use public R&D to increase economic growth then the current policy approach is a rather indirect route to achieving this objective. The Finnish example is perhaps the best practice approach that comes immediately to mind in this respect. In order to emulate this, Sweden may have

to focus on developing a professional research institute sector. In this scenario, universities would be important supporting actors but not the main providers. Moreover, the development of a research institute sector will eventually create a separation between teaching and research which has its own drawbacks in the long run. Further, if increased economic growth is the objective then, the entire policy infrastructure and not just higher education and research will need to be reformed to achieve this goal. There are important unexplored synergies between fiscal and labour market policies and research and innovation policies.

The last decade of research and innovation policy in Sweden has been characterised by a remarkable level of experimentation, individual and organisational initiative. The governance of R&D is a policy activity that needs to mimic the creativity and other attitudes it is trying to coordinate and promote. It is therefore necessary to retain individual and organisational initiative as a permanent feature of R&D governance. One of the drawbacks of the current system that will need to be remedied in the future is the balance of power between the partners in the process of promoting innovation. To date, despite the abundance of rhetoric to the contrary, Swedish industry is not actively involved in innovation policy. More attention will have to be given to how to improve this situation as input from industry is needed not only as co-financier but as a partner in developing the visions that will inform future policy.

## Policy Conclusions

In this section, we shall outline a number of issues that we believe need to be addressed in the future. Our chosen targets for this advice are university management, research councils and policymakers at the ministerial and agency level. It is important to understand that these conclusions are not all deduced from the discussions here but are also developed with an eye to what would be logical next steps given the status quo described in chapter 2. Further, much of our recommendations are not intended in the first hand to promote the commercialisation of research but to provide suggestions to help universities to manage the existing reality.

## *Policymakers*

### **1. Clarify the goal of research and innovation policy**

All policies benefit from having clear objectives. At present Swedish research and innovation policy is confused on the issue of whether knowledge transfer or growth is the immediate objective. Clarity on this issue would be necessary in order to develop appropriate indicators of evaluation.

### **2. Diversify the public R&D sector**

The Finnish example shows that if producing knowledge to promote innovation in the short and medium term is the main goal, then a good functioning institute sector is a better provider than the university. Several studies both national and international show that universities are not the preferred knowledge providers for many firms particularly SMEs. Innovation policy may need to focus not just on ensuring knowledge supply but also on understanding existing demand for knowledge.

Universities serve multiple stakeholder interests and of necessity promote a knowledge culture which is directed at knowledge production for more long term needs. This implies that universities would be better at securing current and future absorptive capacity of the population through their education function and producing knowledge for innovations in the future through their research function. It is important to understand, however, that developing an institute sector in Sweden is not a quick fix to the problem. It may take at least a decade before a professional and well functioning sector emerges that can fulfil the needs of the system.

### **3. Promote the development of skills needed to lead and support the commercialisation of knowledge**

There is a general shortage of the capital (competence and financial capital) needed for Swedish universities to promote commercialisation of knowledge. Institutional solutions such as the innovation bridges and the university holding companies perform well but are not in themselves enough to achieve the goal of commercialisation.

A pilot approach which would allow available financial capital to be concentrated at one or two sites where the competence in commercialisation already exists would be one solu-

tion to improving the situation. The pilot cases could be used to develop experience and as sites from which individuals could develop the necessary skills for leading and implementing commercialisation efforts.

#### **4. Encourage universities to develop a professional administrative competence**

The administrative structure of Swedish universities needs to be re-evaluated. In particular, attention should be paid to identifying the competence and skills necessary to support and not just administer the core functions (teaching, research and knowledge transfer). This process cannot be achieved through policy directives alone but will require support both in terms of capital and continuous dialogue between university leadership and the state.

#### *Universities*

##### **1. Re-examine the role of faculty and departmental leadership**

Leadership and management have become critical issues within universities as a result of their changed circumstances and new missions. Swedish universities are gradually moving towards more a professionalised cadre of management at the vice chancellor level. This however has to be accompanied by similar approach at the other levels such as deans and department leaders. Universities need to be encouraged to lead the initiative to change the way in which academic institutions are led and managed.

##### **2. Develop new management models**

Universities need to search for suitable models for managing institutions of research and education in higher education research and practice primarily. Swedish universities should avoid duplicating the indiscriminate borrowing from the corporate sector that has become the norm in higher education and research in other countries.

### **3. Organisational profiling**

Universities need to focus more on profiling themselves by singling out those competences at which they excel and building on them. The idea that universities should be entrepreneurial is not new although it is certainly new to Sweden. It is however, important to bear in mind that there are several ways in which universities can be entrepreneurial. Commercialising knowledge is one approach and there is no one strategy for commercialisation that each university must follow. There are several other paths to the entrepreneurial university, including taking a broader approach to knowledge transfer than patents and spin offs. Whatever, the path chosen, it should be grounded in a realistic assessment of the current competence of the organisation, local demand and its future potential.

### **4. Explore the possibility of institutional integration**

The current market for higher education and research in Sweden is oversaturated. Policy has been preoccupied with finding reasons for supply based on ideological motives rather than on basing the supply of student places on an assessment of demand trends. It may therefore be necessary for Swedish universities to imitate some of their counterparts in the UK by promoting institutional integration. Strategic mergers or partnerships with other universities in the same geographic region need to be investigated as a potential solution. Swedish universities are limited in their ability to take advantage of this option in the fashion of their UK counterparts but alliances and shared offerings may be possible assuming resource allocation problems can be surmounted.

### **5. Use individual incentives to promote new organisational goals**

Incentives are very rarely used as mechanisms for introducing organisational and attitudinal change in Swedish universities. Even the universities that are legally able to innovate in this sector such as Chalmers, are surprisingly uncreative in this regard. The dominant approach has been legislation and new steering rules. Experimenting with prizes and other types of positive incentives to individuals and institutions, that represent qualities which are seen as exemplary or future oriented,

can be one approach for future policy. Staff and other stakeholder communities should also be encouraged to submit suggestions for what kinds of incentives would be appropriate and what kind of attitudes and performance that are not currently covered in the incentive system that they would like to lift out as exemplary.

### *Research Councils*

#### **1. Support the improvement of project management**

The linking of research with innovation policy taken together with EU initiatives such as the European Research Area mean that the governance of research is now a multilayered policy task. Research councils may have to at least for an initial period promote the development of management skills at universities. This could be done by demanding accountability from universities for the administration of projects.

#### **2. Use internationalisation to increase benchmarking and innovation in commissioning strategies**

Research council commissioning policies and infrastructure for the development of such policies need to be benchmarked against that of other countries with a view to identifying possible sources of learning and innovation. The research councils in Sweden are increasingly becoming internationalised because of the multilayered nature of research and innovation policy. This implies increasing cooperation across national boundaries and even funding of transnational projects that may include partners outside the Nordic or EU regions. This is a new source of knowledge that could be exploited and used to the national benefit in a systematic fashion.

## References

- Adams, J.D., Black, G.C., Clemmons, J.R. and Stephan, P.E. (2005) 'Scientific teams and institutional collaborations: Evidence from U.S. universities, 1981–1999', *Research Policy*, 34(3) pp. 259–285.
- Asheim, B. T. and Isaksen, A. (2001) 'Regional Innovation Systems: The Integration of Local 'Sticky' and Global 'Ubiquitous' Knowledge', *Journal of Technology Transfer*, 27(1) pp. 77–86.
- Ben-David, J. (1972) *American higher education: Directions, old and new*, Carnegie Commission on higher education, Sponsored research studies.
- Benner, M. (2001). *Kontrovers och konsensus: vetenskap och politik i svensk1990-tal*, Stockholm: Institutet för studier av utbildning och forskning (SISTER)/ Nya Doxa, Stockholm.
- Bercovitz J., Feldman M., Feller I. and Burton R. (2001) 'Organizational Structure as a Determinant of Academic Patent and Licensing Behavior: An Exploratory Study of Duke, Johns Hopkins, and Pennsylvania State Universities', *The Journal of Technology Transfer*, 26(1/2), pp. 21–35.
- Blumenthal, D., Campbell, E.G., Andersson, N. et al. (1997) 'Withholding research results in Academic Life science- Evidence from a National Survey of Faculty', *Journal of the American Medical Association*, 277(15) pp. 1224–1228.
- Boldrin, M. and Levine, D.K. (2004) 'The case against intellectual monopoly', (2003 Lawrence Klein Lecture) *International Economic Review*, 45(2) pp. 327–350.
- Braun, Dietmar (1994) *Structure and Dynamics of Health Research and Public Funding*, Kluwer, Dordrecht.
- Braunerhjelm, P. (2003) *Academic Entrepreneurship: a weak link in European innovation systems – evidence from Sweden*, Working Paper, SNS (Centre for Business and Policy Studies), Stockholm.
- Breschi S. and Lissoni, F. (2001), 'Knowledge Spillovers and Local Innovation Systems: A Critical Survey', *Industrial and Corporate Change*, 10(4) pp. 975–1005.
- Brulin, G. (1998) *Den tredje uppgiften: högskola och omgivning i samverkan*, SNS and Arbetslivsinstitutet, Stockholm.
- Carlsson, B., Jacobsson, S., Holmen, M. and Rickne, A. (2002) 'Innovation systems: analytical and methodological issues', *Research Policy*, 31(2) pp. 233–245.
- Carlsson B. and Stankiewicz, R. (1991) 'On the nature, function and composition of Technological Systems', *Journal of Evolutionary Economics*, 1 pp. 93–118.
- Carlsson, B. ed. (1995) *Technological Systems and Economic Performance: The Case of Factory Automation*, Kluwer, Dordrecht.
- Carlsson, Bo ed. (1997) *Technological systems and industrial dynamics*, Economics of science, technology and innovation Series, Boston, Mass., Kluwer Academic, London.

- Clark, B.R. (1995), *Places of Inquiry - Research and Advanced Education in Modern Universities*, University of California Press, Berkeley.
- Cohen W. and Levinthal, D. (1989) 'Innovation and Learning: The Two Faces of R&D', *Economic Journal*, 99(397) pp. 569–96.
- Cohen W., Florida R. and Goe R. (1994) *University-Industry Research Centres in the United States*, Technical Report, Center for Economic Development, Carnegie-Mellon University.
- Colyvas, J., Crow, M., Gelijns, A. et. al. (2002) 'How do university inventions get into practice?' *Management Science*, 48(1) pp. 61–72.
- Cooke, P. (2002) 'Regional Innovation Systems: General Findings and Some New Evidence from Biotechnology Clusters', *Journal of Technology Transfer* 27 pp. 133–145.
- Danish Research Agency (2004) [www.forsk.dk/dfs/dfs\\_dia.htm](http://www.forsk.dk/dfs/dfs_dia.htm)
- Dasgupta, P. and David, P. (1994) 'Towards a new economy of science', *Research Policy* 23 (5) pp. 487–521.
- David, P., Foray, D. and Steinmueller W. E. (1999) 'The Research Network and the New Economics of Science: from Metaphors to Organisational Behaviour', in Gambardella, A. and Malerba, F. (eds), *The Organisation of Economic Innovation in Europe*, Cambridge University Press, Cambridge.
- David, P., Mowery, D. C. and Steinmueller W. E. (1992) 'Analyzing the Economic Payoff from Basic Research', *Economics of Innovation and New Technology*, 2(4) pp. 73–90.
- Demeritt, D. (2000) 'The new social contract for science: Accountability, relevance, and value in U.S. and U.K. science and research policy', *Antipode*, 32 pp. 308–329.
- Dietz, J. and Bozeman, B. (2005) 'Academic careers, patents, and productivity: industry experience as scientific and technical human capital', *Research Policy*, 34(3) pp. 349–367.
- Edquist, C., ed. (1997) *Systems of Innovation: Technologies, Institutions and Organizations*, Pinter Publishers Ltd, London.
- Elzinga, A. (1980) 'Science policy in Sweden: Sectorization and adjustment to crisis', *Research Policy*, 9(2) pp. 116–146.
- Elzinga, A. (1993) 'Universities, research, and the transformation of the state in Sweden', In Rothblatt, S. and Wittrock, B. (Eds.), *The European and American University since 1800: Historical and sociological essays*, Cambridge University Press, pp. 191–233.
- Etzkowitz, H. and Webster A. (1991) *Academic-Industry Relations: The Second Academic Revolution?* Science Policy Support Group, London.
- Etzkowitz, H. and Leydesdorff, L. (1997) 'Introduction to special issue on science policy dimensions of the Triple Helix of university-industry-government relations', *Science & Public Policy*, 24.
- Etzkowitz, H. and Leydesdorff, L. (1999) 'The Future Location of Research and Technology Transfer', *The Journal of Technology Transfer*, 24(2/3) pp. 111–123.
- Etzkowitz, H. and Leydesdorff, L. (2000), 'The Dynamics of Innovation: From National Systems and "Mode2" to a Triple Helix of University-Industry-Government Relations', *Research Policy* 29(2) pp. 109–123.

- Etzkowitz, H. and Webster, A. et al., (2000) 'The future of the university and the University of the Future: evolution of ivory tower to entrepreneurial paradigm', *Research Policy* 29(2), pp. 313–330.
- Etzkowitz, H., (2005) *Trippelhelix - den nya innovationsmodellen*, SNS förlag, Stockholm
- European Union (2002a) *Innovation Tomorrow – Innovation policy and the regulatory framework: Making innovation an integral part of the broader structural agenda*, Prest, UK and ANRT, France – Innovation papers no. 28 EC DG Enterprise
- European Union (2002b) *Towards a European Research Area, Science Technology and Innovation: Key Figures 2002*, European Union, Brussels.
- Felsenstein, D. (1994) 'University-Related Science Parks 'Seedbeds' or 'Enclaves' of Innovation?' *Technovation* 14 (2) pp. 93–110.
- Fisher, D., Grosjean-Atkinson J. and House, D. (2001) 'Changes in academy/industry/state relations in Canada: the creation and development of the networks of centres of excellence', *Minerva*, 39, pp. 299–325.
- Franklin, S.J., Wright, M. and Lockett, A. (2001) 'Academic and Surrogate Entrepreneurs in University Spin-out Companies', *Journal of Technology Transfer*, 26, 127–141, 2001.
- FORMAS (2003) Annual Report available at [www.formas.se](http://www.formas.se)
- Freeman, C. (1995) 'The "National System of Innovation" in historical perspective', *Cambridge journal of economics*, 19(1) pp. 5–24.
- Geuna, A. (2001) 'The Changing Rationale for European University Research Funding: Are There Negative Unintended Consequences?', *Journal of Economic Issues*, 35 (3) pp. 607–632.
- Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. and Trow, M. (1994), *The New Production of knowledge: The Dynamics of Science and Research in Contemporary Societies*, Sage, London.
- Gibbons, M. (2003) 'Globalisation and the Preservation of University Values', Paper delivered at the Nordisk forsknings- och utvecklingskonferens, HSS 03 – Högskolor och Samhälle i Samverkan, Ronneby 14–16 maj 2003, paper available at [www.bth.se/extr/hss03.nsf](http://www.bth.se/extr/hss03.nsf)
- Godin, B. and Gingras, Y. (2000) 'The place of universities in the system of knowledge production', *Research Policy* 29(2–3) pp. 273–278.
- Goldfarb, B. and Henrekson, M. (2003) 'Bottom-up versus top-down policies towards the commercialization of university intellectual property', *Research Policy*, 32(4) pp. 639–658.
- Granstrand, O. and Sigurdson, J. eds, (1985) *Technological innovation and industrial development in telecommunications : the role of public buying in the telecommunication sector in the Nordic countries*, Nordic Co-operative Organization for Applied Research (Nordforsk), Stockholm, Research Policy Institute (RPI) [Forskningspolitiska institutet], Lund, Sweden
- Guston, David and Keniston, K. (1994) *The Fragile Contract: University Science and the Government*, MIT Press, Cambridge, MA.
- Hakala, J. and Ylijoki, O.-H. (2001) 'Research for whom? Research orientations in three academic cultures', *Organization* 8(2), pp. 373–380.
- Henderson, R., Jaffe, A. and Trajtenberg, M. (1994) 'Numbers Up, Quality Down? Trends in University Patenting, 1965–1992', paper presented at the CEPR Conference on "University Goals, Institutional Mechanisms

- and the Industrial Transferability of Research, Stanford University, March 18–20.
- Henrekson, M. and Rosenberg, N. (2000) Incentives for Academic Entrepreneurship and Economic Performance: Sweden and the United States, Research Institute of Industrial Economics, Working Paper Series 530, Stockholm.
- Henrekson, M. and Rosenberg, N. (2001) 'Designing Efficient Institutions for Science-Based Entrepreneurship: Lessons from the US and Sweden', *Journal of Technology Transfer* 26 pp. 207–231.
- Hicks, D., Breizman Sr, A., Hamilton, K. and Narin, F. (2000), 'Research Excellence and Patented Innovation', *Science and Public Policy*, 27, pp. 310–320.
- Humanistisk-samhällsvetenskapliga forskningsrådet (HSFR) (1999) Sektorsforskningen inom kulturområdet: delrapport. Problemanalys och preliminära förslag, HSFR, Stockholm.
- Håkansson H. and Snehota, I. (1995) *Developing Relationships in Business Networks*, Routledge, London.
- Högskoleverket (HSV) (2004) Uppdrag och kontakter, Stockholm. Also available at [www.hsv.se](http://www.hsv.se).
- HSV (2004) Högskolans ledare: om rektorsroller och rektorstillsättningar, Stockholm. Also available at [www.hsv.se](http://www.hsv.se).
- HSV (2004) Högskolan Samverkar, Stockholm. Also available at [www.hsv.se](http://www.hsv.se). Rapport serie 2004:38.
- HSV (2005), Högskolan Samverkar: Goda exempel, Stockholm. Also available at [www.hsv.se](http://www.hsv.se). Rapport serie 2005:9.
- Hörstedt, F. (2000) *Strategic Management of Resource Allocation to Applied Research - Towards a Holistic Approach*, PhD thesis, Chalmers University of Technology, Department of Industrial Dynamics. Göteborg.
- Iansiti, M. (1997) 'From technological potential to product performance: an empirical analysis', *Research Policy* 26, pp. 345–365.
- Iversen, E. (2003) 'Country Report: Norway' In Jacob, M. et al. *SMEs and the new role of academic research in four Nordic countries*, Report from Institute for the Management of Innovation and Technology, Chalmers, Göteborg.
- Jacob, M. (1997) *Life in the Triple Helix: The Contract Researcher, the University and the Knowledge Society*, *Science Studies*, 2 pp. 35–49.
- Jacob, M., Lundqvist, M. and Hellsmark, H. (2003) Entrepreneurial transformations in the Swedish University system: the case of Chalmers University of Technology, *Research Policy*, 32(9) pp. 1555–1568.
- Jacob, M., Iversen, E., Kutinlahti, P., Munk-Birkeholm, K. Gry Knudsen, Line, Wennerberg-Barlebo, Søren (2003) *SMEs and the new role of academic research in four Nordic countries*, Report from Institute for the Management of Innovation and Technology, Chalmers, Göteborg.
- Jacob, M., Lundqvist, M. and Hellsmark, H. (2003) 'Entrepreneurial transformations in the Swedish University system: the case of Chalmers University of Technology', *Research Policy* 32 pp. 1555–1568.
- Jacobsson, S. and Rickne, A. (2004) 'How large is the Swedish 'academic' sector really? A critical analysis of the use of science and technology indicators' *Research Policy* 33 (9) pp. 1355–1372.

- Jaffe A. (1989) 'Real Effects of Academic Research', *American Economic Review*, 79(5) pp. 957–970.
- Janson, P. (2005) 'Strategisk biomedicin - styrd forskning?' In Sörlin, S. (ed) (2005) *I den absoluta frontlinjen - En bok om forskningsstiftelserna, konkurrenskraften och politikens möjligheter*, Boxförlaget Nya Doxa pp. 128–157.
- Johansson, M., Jacob, M and Hellström, T. (2005) 'The Strength of Strong Ties- University Spin-offs and the significance of historical relations', *Journal of Technology Transfer*, 30 pp. 271–286.
- Kaufmann, A. and Tödting, F. (2002) 'How effective is innovation support for SMEs? An analysis of the region of Upper Austria', *Technovation*, 22 pp. 147–159.
- Keast, D.A. (1995) 'Entrepreneurship in Universities: Definitions, Practices, and Implications', *Higher Education Quarterly* 49, pp. 249–266.
- Keeble, D. (1992) 'Small firm creation, innovation and growth and the urban-rural shift', Working Paper No. 24, September, Small Business Research Centre, University of Cambridge.
- Klevatorick, A., Levin, R., Nelson, R. and Winter S. (1995), 'On the Sources and Significance of Inter-Industry Differences in technological Opportunities', *Research Policy*, 24(2), pp. 185–205.
- Kommittén för översyn av den svenska forskningspolitiken, (Forskning 2000) (1998) *Forskningspolitik: slutbetänkande av Kommittén för översyn av den svenska forskningspolitiken*, Fritzes, Stockholm.
- Lamoreaux N.R., Solokoff K.L. (1997), 'Location and technological change in the American glass industry during the late nineteenth and early twentieth centuries', *NBER Working Paper 5938*, February.
- Lee Y. (1996) 'Technology transfer' and the research university', *Research Policy* 25, (6) pp. 843–863.
- Lemola, T. (2002) 'Convergence of national science and technology policies: the case of Finland', *Research Policy* 31(8-9), pp. 1481–1490.
- Lemola, T. (2003) 'Transformation of Finnish Science and Technology Policy', *Science Studies* 16(1) pp. 52–67.
- Leydesdorff L. and Guoping Z. (2001) 'University-industry-government relations in China: An emergent national system of innovation' *Industry and Higher Education*, 15(3) pp. 179–182.
- Leydesdorff L., Cooke P., Olazaran M. (2002) 'Technology Transfer in European Regions: Introduction to the Special Issue', *The Journal of Technology Transfer*, 27(1) pp. 5–13.
- Leydesdorff L. And Meyer, M. (2003) 'The Triple Helix of university-industry-government relations', *Scientometrics*, 58(2) pp. 191–203.
- Liesbeskind J., Oliver, A., Zucker, L. and Brewer, M., (1996) 'Social networks, learning, and flexibility: sourcing scientific knowledge in new biotechnology firms', *Organization Science* 3, 783–831.
- Lindmark, S. (2002) *Evolution of Techno-economic Systems: An Investigation of the History of Mobile Communications*, Chalmers tekniska högskola, Göteborg.
- Link, A.N., Siegel, D.S. (2005) 'Generating science-based growth: an econometric analysis of the impact of organizational incentives on university-industry technology transfer' *European Journal of Finance*, 11(3) pp. 169–181.

- Lundvall, B.-Å. (1992) *National systems of innovation: towards a theory of innovations and interactive learning*, Pinter Publishers Ltd, London.
- Lundvall, B.-Å. and Johnson, B. (1994) 'The learning economy', *Journal of Industry Studies*, 1 pp. 23–42.
- Lundvall, B.-Å. (2002) 'National systems of production, innovation and competence building', *Research Policy*, 31 pp. 213–231.
- Malerba, F. (2002) 'Sectoral systems of innovation and production', *Research Policy*, 31(2) pp. 247–264.
- Mansfield, E. (1995) 'Academic Research Underlying Industrial Innovation: Sources, Characteristics and Financing', *Review of Economics and Statistics*, 77 pp. 55–65.
- Mansfield, E. (1998) 'Academic research and industrial innovation: an update of empirical findings', *Research Policy*, 26(7-8) pp. 773–776.
- Mazzoleni, R. and Nelson, R. (1998) 'The Benefits and Costs of Strong Patent protection: a Contribution to the Current Debate', *Research Policy*, 27(3) pp. 273–284.
- Melin, G. (2003) 'Effekter av postdoktorala utlandsvistelser', SISTER, Stockholm, Working paper 200329.
- Metcalfe, S. (1995) 'The Economic Foundations of Technology Policy: 'Equilibrium and Evolutionary Perspectives'', in Paul Stoneman (ed.): *Handbook of the Economics of Innovation and Technological Change*, Blackwell, Oxford, UK and Cambridge, USA pp. 409–512.
- Miettinen, R. (2002) *National Innovation System: Scientific Concept or Political Rhetoric*, Edita, Helsinki.
- Mobjörk, M. (2004) *En kluven tid? En studie av idéer och föreställningar om vetenskap och kunskap i Stiftelsen för miljöstrategisk forskning*, MIS-TRA, PhD thesis, Linköping University, Linköping, Sweden.
- Mowery, D.C. and Rosenberg, N. (1998) *Paths of Innovation: Technical Change in 20<sup>th</sup> Century America*, Cambridge University Press, New York.
- Mowery, D.C., Nelson, R.R., Sampat, B. and Ziedonis A. (2001) 'The Growth of Patenting and Licensing by US Universities: an Assessment of the Effects of the Bayh-Dole Act of 1980', *Research Policy*, 30(1) pp. 99–119.
- Mytelka, L. and Smith, K. (2002) 'Policy learning and innovation theory: an interactive and co-evolving process', *Research Policy*, 31(8–9) pp. 1467–1479.
- Narin, F. Hamilton, K. and Olivastro, D. (1997) 'The Increasing Linkage between US Technology and Public Science', *Research Policy*, 26 (3) 317–330.
- Nelson, R. (2001) 'Observations on the Post-Bayh-Dole Rise of Patenting at American Universities', *Journal of Technology Transfer*, 26(1) pp. 13–19.
- Nelson, R., Winter, S. (1977) 'In search of a Useful Theory of Innovation', *Research Policy*, 6 pp. 36–76.
- Nordfors, D., Sandred, J. and Wessner, C. (2003) *Commercialization of Academic Research Results*, VFI 2003:1, Vinnova, Stockholm (Downloadable from [www.vinnova.se](http://www.vinnova.se)).
- Nowotny, H., Scott, P. and Gibbons, M. (2001) *Re-thinking science: knowledge and the public in an age of uncertainty*, Polity Press, UK.

- Nybohm, T. ed. (1989) *Universitet och samhälle: om forskningspolitik och vetenskapens samhällseliga roll*, Tiden, Stockholm.
- Odehn, B. (1991) 'Research training and the State: Politics and University Research in Sweden', in M. Trow and T. Nybohm (Eds), *University and Society: Essays on the social role of research and higher education*, pp. 143–155, (Jessica Kingsley Publishers, London).
- OECD (1963) *Science and policies of the governments*. Paris: OECD.
- OECD (1971) *Science, growth and society, a new perspective*. Paris: OECD.
- OECD (2003): Main Science and Technology Indicators, 2003:1, OECD.
- OECD (2005) *Main Science and Technology Indicators*, 2005:1 Paris, OECD.
- Pavitt, K. (1996) 'National policies for technical change: Where are the increasing returns to economic research?', *Proceedings of the National Academy of Sciences* 93(23) pp. 12693–12700.
- Pavitt, K. (2001) 'Public Policies to Support Basic Research: What Can the Rest of the World Learn from US Theory and Practice? (and What They Should Not Learn)', *Industrial and Corporate Change*, 10(3) pp. 761–780.
- Persson, B. (2001) *Motsträviga myndigheter. Sekorsforskning och politisk styrning under 1980-talet*, SISTER Rapport 2, Stockholm.
- Piore M. J. and Sabel, C. (1984) *The second industrial divide: possibilities for prosperity*, Basic Books, New York.
- Rip, Arie (2002) 'Regional Innovation Systems and the Advent of Strategic Science', *Journal of Technology Transfer*, 27 pp. 123–131.
- Rosenberg, N. (1976) 'On Technological Expectations', *The Economic Journal*, 86, 343, pp. 523–535.
- Rosenberg, N. and Nelson, R. (1994) 'American Universities and Technical Advance in Industry', *Research Policy* 23, pp. 323–348.
- Riksrevisionsverket (RRV), (2001) *Audit proposals in the field of higher education*, National Audit Office, Stockholm.
- Ruin, O. (1991) 'Bending with the Breeze'. Political Preferences and Institutional Reforms in the Modern University System – A Case Study in M. Trow and T. Nybohm (Eds), *University and Society: Essays on the social role of research and higher education*, pp. 47–58, Jessica Kingsley Publishers, London.
- Sandström, U. (1999) 'Utvärdering av forskningens produktivitet och kvalitet', SISTER Working paper 9 (Available in Swedish at [www.sister.nu](http://www.sister.nu)).
- Sandström, U., Heyman, U. and Hällsten, M. (2004) *Svensk forskningsfinansiering - inriktning och styrning*, The Swedish Research Council, Stockholm. Also available at [www.vr.se](http://www.vr.se).
- Schild, I and Hanberger, A. (2000) *Industrial research schools: a real-time evaluation of the Swedish Knowledge Foundation's research school programme*, Umeå Centre for Evaluation Research, Umeå.
- Schild, I and Sörlin, S. (2002) 'The Policy and Practice of Interdisciplinarity in the Swedish University Research System', SISTER Report Series, [www.sister.nu](http://www.sister.nu).
- Sequeira K. and Martin B. (1996) 'The Links between University Physics and Industry, Science Policy', Report to the Institute of Physics Research Unit, University of Sussex.

- Siegel, D., Waldman, D. and Link, A.N. (1999) 'Assessing the Impact of Organizational Practices on the Productivity of University Technology Transfer Offices: An Exploratory Study', NBER Working Paper No. 7256, July.
- Slaughter, S and Leslie, L., (1999) *Academic Capitalism: Politics, Policies, and the Entrepreneurial University*, The Johns Hopkins University Press, Baltimore.
- Stankiewicz, R. (1997) 'The Development of Beta Blockers at Astra-Hässle and the technological system of the Swedish pharmaceutical industry', In Carlsson, Bo (ed.) *Technological systems and industrial dynamics*, Economics of science, technology and innovation Series, Boston, Mass, Kluwer Academic, London.
- Statistiska Centralbyrån (SCB)(2003) *Statliga anslag till forskning och utveckling 2003*, Örebro, Sweden: Publikationstjänsten.
- Stephan, P. (2001) 'Educational Implications of University-Industry Technology Transfer', *Journal of Technology Transfer*, 26 pp.199–205.
- Stevrin, P. (1978) *Den samhällsstyrda forskningen: en samhällsorganisatorisk studie av den sektoriella forskningspolitikens framväxt och tillämpning i Sverige*, Liber, Stockholm.
- Strömberg, U-B and Tydén, T (1999) *Spännande möten mellan forskare och praktiker*, Svenska Kommunförbundet, Stockholm.
- Sörlin, S. and Törnqvist (2000) *Kunskap för välbästand: universiteten och omvandlingen av Sverige*, SNS förlag, Stockholm.
- Sörlin S. (ed) (2005) "I den absoluta frontlinjen" *En bok om forskningsstiftelserna, konkurrenskraften och politikens möjligheter*, Boxförlaget Nya Doxa, Stockholm.
- Teknisk Framsyn (2004) *Inspiration till innovation: teknik och kunskapsområden mot 2020*.
- Thorpenberg, S. (2000) *On Science Indicators*, Stockholm: Byggeforskningsrådets vetenskapliga nämnd, BVN-skriftserie, 1.
- VR/FORMAS/FAS/VINNOVA/SUHF/KVA/IVA (2003) *Gemensam skrivelse: En nationell strategi för högre utbildning, forskning och innovation*, Available in Swedish only at [www.vr.se](http://www.vr.se) (accessed latest 2004/10/26).
- Weinberger, H., (1996) 'Nätverksentreprenören: en historia om teknisk forskning och industriellt utvecklingsarbete från den Malmska utredningen till Styrelsen för teknisk utveckling', Avd. för teknik- och vetenskapshistoria, Tekniska högskolan, Stockholm.
- Zuboff, S. (1988) *In the Age of the Smart Machine: The Future of Work and Power*, Basic Books. New York.
- Zucker, L. and M. Darby (1996) 'Virtuous Circles of productivity: Star Biologists and the International Transformation of Industry', *Proceedings of the National Academy of Sciences, USA*, 93, pp. 12709–12716.