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Quick Scan (on the use of PPPs in) focus, mass and valorisation in scientific research in eight European countries

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1. Introduction

1.1 Background, goals and central research questions

The Advisory Council for Science and Technology Policy (further AWT) is currently preparing an advice on the use of public private partnerships (PPPs) in relation to focus and mass in the Dutch research infrastructure and valorisation of knowledge. In the Dutch context the role of PPPs is on the rise. PPPs seem to be increasingly perceived as solutions to derive at a less fragmented and more strategically pointed research infrastructure as well as a way to better exploit knowledge generated within the available knowledge infrastructure. However, PPPs are only one way to attain those policy goals and various other mechanisms or policy interventions are available that might be used as well.

In order to better understand to what degree PPPs can be used for realising focus and mass and valorisation AWT requested a consortium of Dialogic and Technopolis to perform a quick scan in eight selected European countries. The aim of this quick scan is twofold:

1. Appreciate how and the degree to which a selection of comparable European countries are dealing with the process of focus and mass in and valorisation of scientific research.
2. Gain insight into the role played by PPPs in these two processes in countries selected.

Focus and mass (in Dutch: zwaartepuntvorming) in research refers to the processes of preventing disintegration of research and the creation of a clear direction in terms of strategy in the research at hand. Mass refers to scale both in terms of budget and human resources involved. Valorisation– following the definition as used in Dutch Science policy – can be defined as 'transforming the results of scientific research into economic value´. This definition covers both the pure economic interpretation of commercializing or better exploiting scientific knowledge as well as the wider societal use of knowledge. Problematic with regards to PPPs is not perse the definition of the term as well as fact that delineation between the public and private domain is largely defined historically which makes it hard to internationally compare PPPs1.

The quick scan reported here will address the following four research questions:

1. What institutional arrangements are being used and what trends can be observed in the countries selected regarding focus and mass in the knowledge infrastructure?
2. What institutional arrangements are being used and what trends can be identified in the benchmark countries regarding (the support for) valorisation of knowledge derived from publicly financed scientific research?
3. What role do PPPs play in processes of focus and mass and valosarisation and how do PPPs work out in terms of co-financing and co-steering of scientific research?
4. To what degree do individual countries anticipate on or react to European initiatives[2] aimed at focus and mass and valorisation?

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[1] AWT has described the key concepts in a discussion paper, see Baggen P. and B. van den Bergh (2006), PPS voor focus/massa en valorisatie' (PPSs for furthering focus & mass and valorisation), AWT, The Hague.

[2] European initiatives are mostly EU-initiatives such as the Lisbon/Barcelona 3% objectives, the consecutive EU Framework Programmes and developments such as the creation of a European

1.2 Research methodology and selection benchmark countries

The research methodology of this quick scan taking place over the period August-December 2006 was straightforward. In consultation with the principal a format for reporting the eight country studies was defined (see chapters 2-9) as well as an understanding of the most relevant European initiatives (see footnote 2). Subsequently the actual case studies were performed through desk research and by way of involving local experts. The latter could be involved in the form of interviews by telephone, by drawing up (parts of) the case study itself, by reviewing and adding to the draft version of the country studies or a combination of these. In a first round two country studies were performed (Ireland and Denmark) and discussed with the principal. In a second round the improved versions of the country studies on Ireland and Denmark were discussed as well as draft versions of the remaining countries. During this second round some main overall findings as well as a format for discussing these were discussed. The project group discussed these overall finding on several occasions. This draft overall report was presented in a final meeting with AWT in early December 2006 and on the basis of comments received reworked into the final report presented here.

In consultation with the principal seven benchmark countries were selected, namely: Austria, Belgium (and within Belgium mostly Flanders), Denmark, Finland, Ireland, Sweden and Switzerland. Further it was decided during the project to describe the Dutch case as well as to be able to make a proper comparison. There was a preference for European countries, with a comparable size and level of economic development as the Netherlands. A practical argument was that the research team had access to various experts in these countries.

1.3 This report

In this report we systematically present the country studies (chapters 2-9) as well as present some overall findings (chapter 10). In the individual country chapters we present – after a brief introduction – in a nutshell the institutional setting needed to understand the S&T system in the country at hand. Here we typically discuss the key players in STI policy, some of the most recent developments in STI policy and the degree to which national research policy is aligned with EU research policy (or not). Then we deal with the topic of focus (if possible at the levels of the federal government, the level of research groups and the level of institutions) and mass and the type of valorisation policies used to further valorisation of research. Each country study has a separate concluding section. In the overall analysis we more systematically compare the eight countries on how the institutional setting is changing, trends and issues regarding focus and mass and valorisation and the role played by PPPs. In the concluding section of chapter 10 we draw some overall conclusions and take stock of some of the examples that might serve as a source of inspiration for Dutch research policy. Before we dive into the subsequent chapters we present some background statistics on the financing of R&D in the countries selected.

Research Area (and linked to this European Research Council, European Science Foundation) and European Technology Platforms.

1.4 Background information R&D performance selected countries

Gross Domestic R&D expenditures

Table 1.1 below present the main R&D characteristics (both in absolute figures, € millions and relative to GDP) of the selected countries using the OECD Science and Technology Indicators. Reliable OECD figures for 2005 are not yet available and therefore figures for 2003 are used (for Austria and Switzerland figures from 2002). For Flanders (a region within Belgium) figures from "Vlaams Indicatorenboek 2005" are used[3]. In the individual country cases more recent figures on R&D expenditures are shown, but based on other sources than the OECD, which makes comparison between countries more difficult.

Table 1.1 Expenditure on R&D in constant prices (2000 PPP) - by sector of performance - in m€ and as percentage (%) of Gross Domestic Product (GDP)

Country	Year	BERD		GOVERD		HERD		PNP		GERD	
		M€	%	M€	%	M€	%	M€	%	M€	%
Austria	2002	3.325	1,4	283	0,1	1.344	0,6	22	-	5.974	**2,12**
Denmark	2003	2.865	1,8	280	0,2	935	0,6	22	-	4.107	**2,56**
Finland	2003	3.469	2,5	477	0,3	946	0,7	29	-	4.921	**3,48**
Flanders	2003	2.116	1,6	232	0,2	591	0,4	32	-	2.972	**2,18**
Ireland	2003	1.006	0,8	119	0,1	378	0,3	-	-	1.504	**1,16**
Netherlands	2003	4.653	1,0	1.175	0,2	2.282	0,5	58	-	8.112	**1,76**
Sweden	2003	7.368	2,9	346	0,1	2.190	0,9	39	-	9.944	**3,95**
Switzerland	2000	4.159	1,9	74	0,03	1.286	0,6	108	-	5.627	**2,57**

Source: OECD Main Science and Technology Indicators 2006-1. Latest figures available

BERD Expenditure on R&D in the Business Enterprise Sector
GOVERD Government Intramural Expenditure on R&D
HERD Expenditure on R&D in the Higher Education Sector
PNP Private Non Profit Institutions
GERD Gross Domestic Expenditure on R&D

Sweden's R&D expenditure, both in absolute and relative figures, is the highest among the reviewed countries and clearly reflects Sweden's ambition *to remain a leading county in high quality research*. In addition Sweden and Finland are the only countries that meet the Barcelona objectives (R&D expenditure 3% of GDP of which 2/3 originates from the private sector).

Countries like Austria and Ireland (and Flanders to some extent) have shown low levels of R&D investments in the past (yet combined with good economic performance), but in the last five to ten years these countries have significantly increased their (public) R&D

[3] Steunpunt O&O Statistieken (2005), Vlaams Indicatorenboek 2005.

expenditures. In Ireland the amount of public R&D expenditures is still low compared to the other countries, although it has also significantly increased during the last decade.

Switzerland shows a high level of business R&D expenditures and a low level of government intramural R&D expenditures. This implies that Swiss research and innovation policy is mainly focused on supporting R&D activities at the higher education sector.

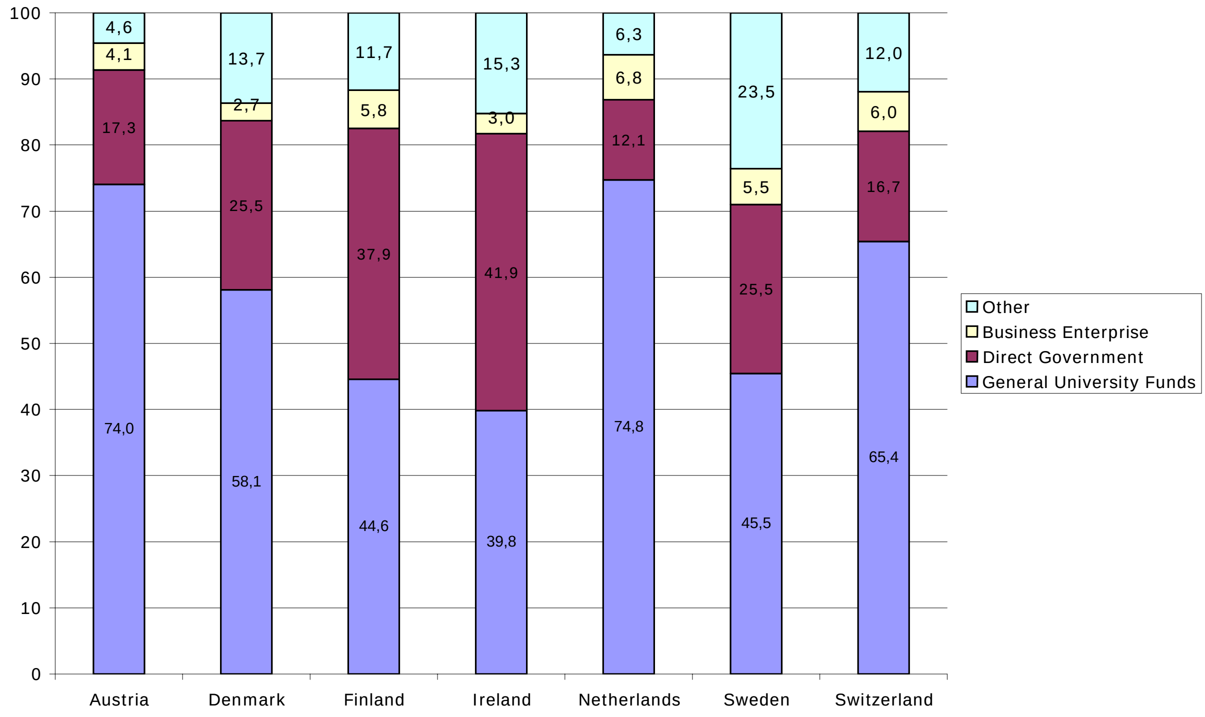
R&D expenditure as share of GDP in the Netherlands is among the lowest of the reviewed countries. It is mainly driven by the public sector as is shown by the relatively high share of government intramural expenditure on R&D (15% of total) and the low share of private R&D expenditures (BERD), which is with 57% of total R&D expenditures among the lowest in Europe and well below the Barcelona target of 66%.

R&D expenditures in the higher education sector

A large amount of the public money available for R&D is spent in the higher education sector. The share of R&D expenditures in the higher education sector that is funded by public sources in the benchmark countries is between 70% and 90% (Figure 1.1). Other main sources of financing are the private sector (business enterprises) and sources from abroad (to a large extent this is EU funding).

The occurrence of focus and mass within these figures can partly be determined by looking at the ratio between the share of public R&D funding which goes to so-called ‘General University Funds’ (GUF) and the share which goes to direct government funding. GUF is allocated within the universities, and in most STI systems its distribution is by and large set by educational priorities. Policymakers can hardly influence spending of this budget. On the other hand, DGF (including - quality controlled - grants from research agencies or foundations) can be employed in a much more selective way than GUF. This gives policymakers potential instruments to influence research priorities of higher education institutes. *Hence, a large GUF, compared to other public funding sources, implies that policymakers have limited capabilities to influence research priorities within the higher education sector.*

Figure 1.1 Expenditure on R&D in the Higher Education (HERD) - by source of funds – as percentage of total



Source: OECD Main Science and Technology Indicators 2006-1. Latest figures available (i.e. for DK, FI, IE, NL and SE 2003; for AU and Swiss 2002). Figures for Flanders are not available.

GUF is by far the biggest item in public R&D funding in the higher education sector. However the share of GUF varies considerably among the reviewed countries (Figure 1.1).

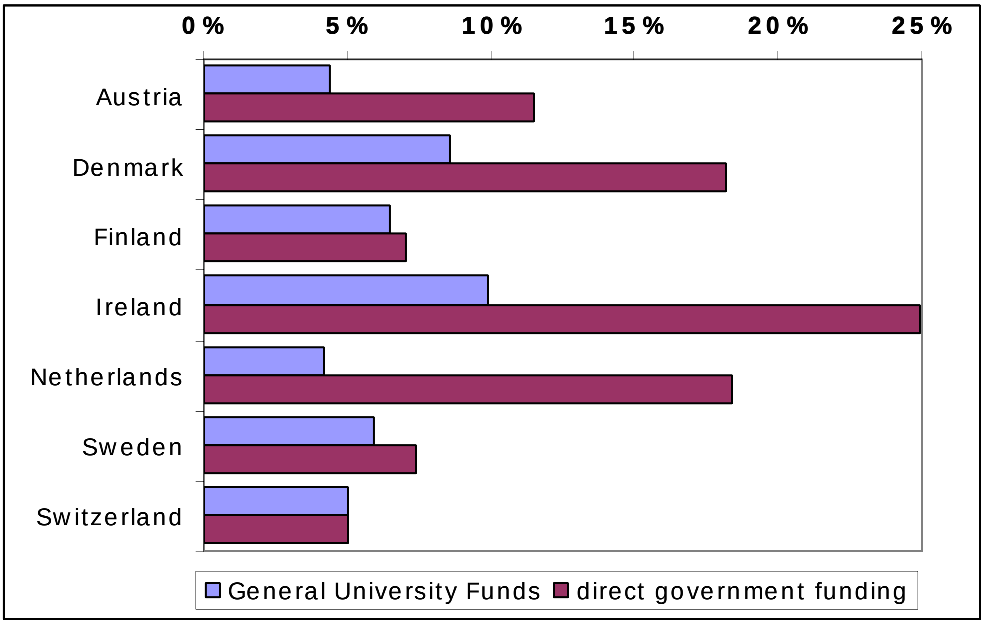
Austria and the Netherlands have a high share of GUF (in fact the highest in all OECD countries) together with a relatively low share of direct government funding. This implies that STI-policymakers in these countries have limited possibilities to influence R&D priorities within the higher education sector.

Ireland on the other hand shows a very large share (42%) of direct government funding. This is mainly due to significant under-funding of the Irish research base in the nineties (i.e. limited amount of money in GUF and relatively high share of EU funding) and the launch of competitive funding programmes in the late nineties and 2000[4].

Although GUF still comprise the largest share of public R&D funding in the higher education sector, direct government funding has generally become much more important during the last decade (see figure 1.2). The average growth rate for direct government funding (13.2%) was two times higher than that of GUF (6,4%). In Finland, Sweden and Switzerland the growth of direct funding was relatively modest and followed the trend of GUF. In the Netherlands on the other hand the growth rate for direct government funding (18,4%) was over four times higher than the growth rate of GUF (4,2%) – that is twice above the average ratio for all benchmark countries. This suggests that the Netherlands is swiftly developing to a more average 'score' with regard to direct government funding.

[4] For instance, the PRTLI programme and Science Foundation Ireland.

Figure 1.2 Compound Annual Growth Rate (CAGR) General University Funds and direct government funding, 1998 - 2003



Source: OECD Main Science and Technology Indicators 2006-1, adapted. Latest figures available (DK, FI, IE, NL, SE 2003; AU, Swiss 2002). Figures for Flanders are not available.

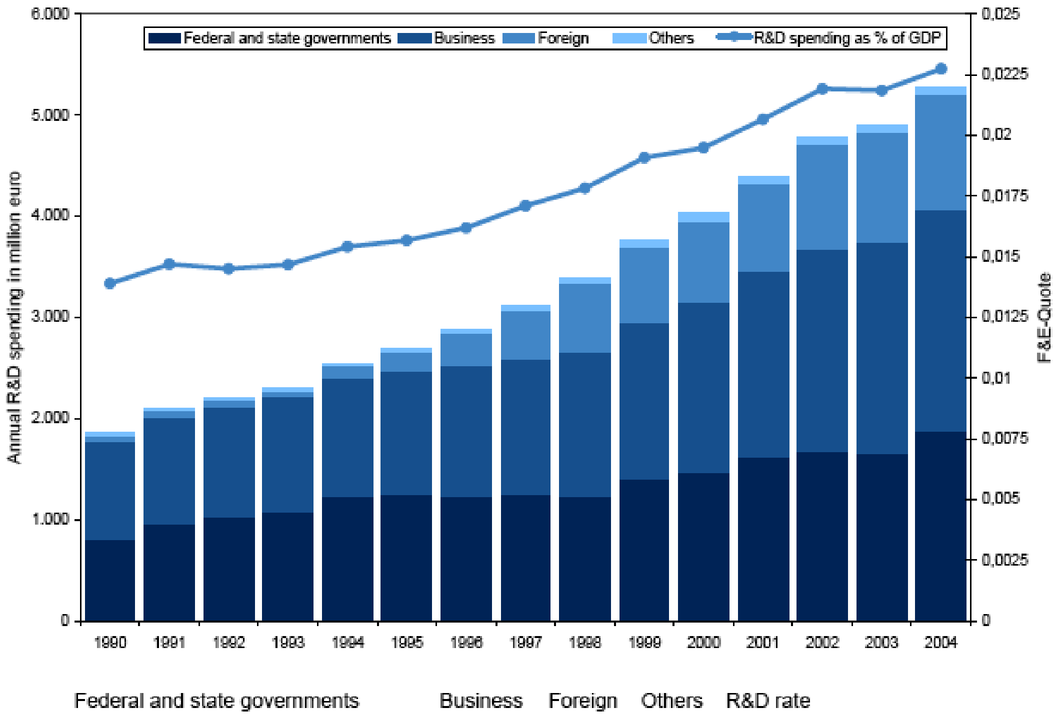
2. Austria

2.1 Introduction

A first sight on the Austrian STI-performance of the last two decades shows the reverse of the 'European paradox'. Rather than high R&D and low economic performance, Austria has had good economic performance while performing comparatively little R&D. The Austrian industry is specialized in low and medium R&D-intensity industries and has a structural bias towards SMEs.

Since joining the EU came onto the national agenda, Austria has made significant strides towards reaching EU levels of R&D activity. The R&D expenditures as a percentage of GDP rose from 1,91% in 1999 to 2,27% in 2004, of which 1,42% is spent by the business sector. The total volume of R&D spending in Austria is about €5.3 billion (2004)[5]. An overview of R&D expenditures in time is presented below.

Figure 2.1 R&D expenditures in Austria over the period 1990-2004



Source: *Statistik Austria* (2004).

The Austrian government perceives science and research as central to the challenge of raising productivity and improving welfare. It is committed to ensuring that science plays its full role in supporting innovation, and it also supports the European Lisbon and Barcelona agendas.

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[5] Austrian Research and Technology report 2004. Federal Government

2.2 Institutional setting

2.2.1 Main developments in STI policy

Research policy plays a central role in the general policy agenda of Austria and is formulated by the government, especially by the three ministries that are responsible for research, technology and innovation policy, in conjunction with the Ministry of Finance.

Although Austria's STI policy is federally organised and has been a de facto monopoly of federal policy making, the provinces (Lander) have also developed some activities in this area. We will focus mainly at STI policy at the Federal level.

In the last decade the national science and innovation system in Austria has changed dramatically. There was a shift in responsibilities between the ministry of science and the ministry of technology and at the agency level a couple of reorganisations and mergers resulted into the newly formed agencies Austrian Research Promotion Agency (FFG) and Austria Wirtschaftsservice Gesellschaft (AWS). Together with a new governance body (RTD Council) the level of fragmentation in the systems is reduced, but still it is rather complex[6].

Some key documents have been published by the Austrian RTD council in order to develop a more strategic approach towards STI policy making. In addition the council has tried to target a number of priorities for research funding. These documents are "Research and Innovation Plan" (2002) and "Strategy 2010" which is a follow-up of the plan. The University reform act (2002) is an other major development that reforms the university structure and has an impact on university research funding as well.

2.2.2 The key players in STI policy

Appendix B provides an overview of the Austrian Science, Technology and Innovation system. The most important actors will be described below.

Policy making – Ministries

The three most important ministries responsible for innovation policy are:

- The Ministry for Education, Science and Culture (BMBWK), which governs the higher education sector including universities, polytechnics and the academy of science. It bears the main responsibility for basic research in Austria. For this purpose it manages approximately two thirds of the government's total research budget.
- The Ministry for Transport, Infrastructure and Technology (BMVIT), which is responsible for the major non-university research organisations and most technology programmes. BMVIT manages the biggest public budget in applied research. It holds a 50% stake in the Austrian Research Promotion Agency (FFG), to which it contributes the majority of application-oriented research funding, and is the majority shareholder in the Austrian Research Centers (ARC). Moreover, BMVIT is also responsible for the Austrian Science Fund (FWF) as the most important instrument for funding basic research.
- The Ministry for Economics and Labour (BMWA) supports a range of organisations of the Austrian innovation support infrastructure for SMEs and has set up several

[6] See for more information about the changes in the Austria STI system: Jorg, L. (2004), *Policy profile Austria - Input paper for the OECD NIS MONIT Network*. A study commissioned by Technology Information Policy Consulting TIP, Technopolis Austria.

programmes in support of technology transfer, innovation management and mobilisation of equity capital for high-tech start-ups. It holds the remaining 50% of the FFG, through which it handles its Competence Centres program. BMWA is also responsible for the Christian Doppler Research Association.

The Ministry of Finance (BMF) is not directly involved in financing STI-activities, nevertheless plays an important role because it governs the allocation of financial resources. In this context the establishment of the Council for Research and Technology Development in 2000 was important[7]. The RTD Council advises the federal government and, upon request, all ministries and provincial government involved in science, research and development. It is consulted on all major programme initiatives at national level before the final decision is taken. Even though the council's mandate does not foresee formal decision power in approving proposed programmes or initiatives, it received it de-facto as the BMF committed itself to follow the recommendation brought forward by the council. Thus the council has been become the central body de-facto allocating additional financial resources made available by the government.

In addition the Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW) organises extensive research activities under the heading Pfeil 05 (programme for research and development).

Programme implementation agencies

To reduce fragmentation on the agency level a number of technology agencies, responsible for cooperative and firm level R&D, were integrated in 2004 into one large body, the FFG (Austrian Research Promotion Agency). FFG operates different programmes. The general bottom-up research programme of the FFG is the most important source of public finance for research and development projects carried out by industry. Structural programmes aim at strengthening the infrastructure for research and innovation. And finally, thematic programmes follow selected national priorities to encourage research on future key topics. Main objective is to build up critical mass for these topics having a strategic impact on the economy by developing new technologies.

The Austria Wirtschaftsservice Gesellschaft (AWS) is the result of a merger of three agencies in 2003 and provides financial support to innovative SMEs (loans, bank guarantees, start-up financing, etc).

The Austrian Science Fund (FWF) has not been merged with other agencies. It provides funds for basics research, is open to all scientific fields, and program selection is based on research excellence. FWF receives its main resources from the ministry responsible for technology (BMVIT) and from the Ministry for Education, Science and Culture (BMBWK), as well as from the National Research Fund, providing extra-budgetary funds. Between 1999 and 2004 the funding volume of the FWF rose 34% from €69.6 million to €111.8 million[8].

Recently the National Research Fund ("National Foundation for Research, Technology and Development") is newly established in 2004 to allocated extra-budgetary funds in order to help increase R&D expenditure in Austria. It will concentrate on medium- and long term goals of research and technology policy and funding of high quality projects. The fund is endowed by the Austrian National Bank and the ERP-Fund and will distribute annually approx. €125 million to research promotion institutions at the national level.

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[7] Trend Chart Country Report Austria. 2005. European Commission

[8] http://www.fwf.ac.at/de/portrait/budgetentwicklung_tabelle.html

Research performers

Research is performed by a variety of public institutions and private companies. The most important publicly funded institutions will be described briefly below.

Universities

The higher education sector traditionally has a strong position in Austria. In 2002 the universities spent €1.2 billion on R&D[9]. Section 2.3.1 provides more details on financing of Higher Education R&D. There are 9 universities in Austria, the most important ones in Vienna, Graz and Innsbruck.

Austrian Research Centres (ARC)

As Austria's leading non-university research establishment, the Austrian Research Centers operates at the interface between basic research and companies, ensuring that Austrian industry benefits from its research. It does so through research contracts from companies, technology transfer in small and medium-sized enterprises, its project partnership with industry in national, European and international research programs, and by training young researchers. Moreover, ARC supports policy-making in various areas (RTD, Environment, Transport, Energy, IST, Life Sciences, etc.) at national and European level, and in various functions.

Christian-Doppler-Society

The establishment of Christian Doppler (CD) Laboratories in 1998 has been an interesting attempt to directly link scientific research to industry needs. In a joint effort of the responsible ministry (BMVIT) and the Austrian industries (holding of state owned industries) a cluster of laboratories along technological fields of strategic relevance for the state owned industries has been set up. The majority of the so called Christian Doppler Laboratories were hosted by universities. Financing was provided in a public-private partnership model carried by the ministry and industry partners. Even tough reorganisation of state own industries as well as tight budgets put the future perspective of CD-laboratories under question three years ago they have managed to position themselves successfully as a institutionalised form of industry lead scientific research. More information on CDG in section 2.4

Joanneum Research

As an innovation partner for business, industry and public administration Joanneum Research focuses on applied research and technological development in cutting-edge key technologies. There are 14 research institutes. At present, 32% of contract revenues originate from business enterprises and 48% from public authorities. The percentage of research contracts from international organisations amounts to 20%.

Austrian Academy of Science

The Austrian Academy of Sciences is a legal entity under the special protection of the Federal Republic of Austria. According to the statutes of the Academy its mission is to promote the sciences and humanities in every respect and in every field, particularly in basic research.

Austrian Cooperative Research

Since its foundation in 1954, ACR has offered specialised heterogeneous research and technology competences especially for the benefit of small and medium sized enterprises.

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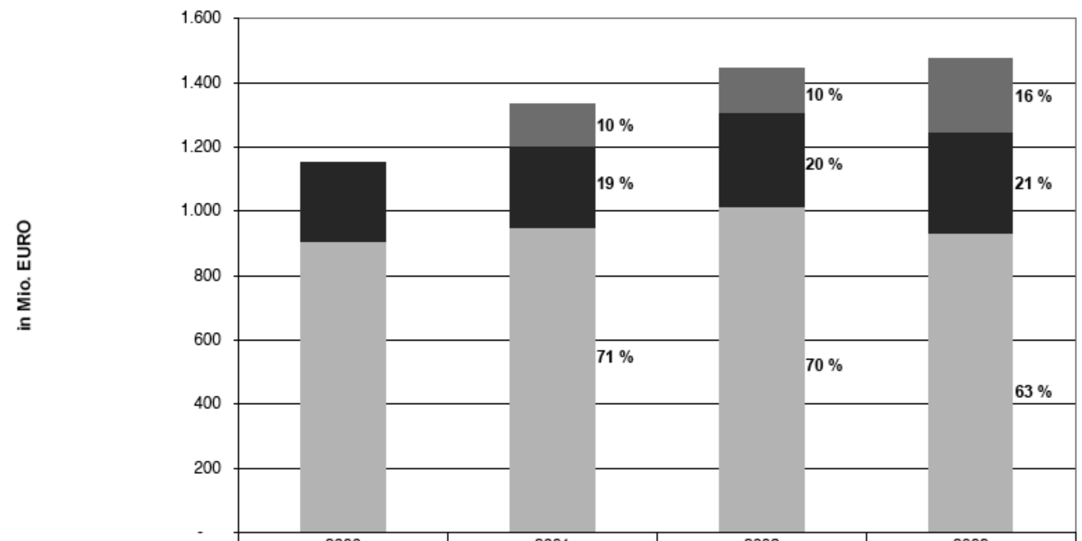
[9] Austrian Council (2005), *Strategy 2010 – Perspectives for Research Technology and Innovation in Austria – Further development of the National research and innovation plan and OECD*.

ACR stimulates and enables innovation within trade and industry, thus improving the competitiveness of the Austrian economy. Currently, ACR has 18 full members. In 2003, they had a total of 435 full time equivalent employees and a turnover of €39,4 million out of which 86,3% with SME. ACR is supported by the BMWA.

Federal research funding

Although it is difficult to get an accurate and overview of federal government spending on research and development some figures are available. These figures are however not mutual exclusive. According to “Strategy 2010” the federal government spends €1.74 billion on R&D in 2005. Schibany and Jörg (2005) estimated that total federal spending on R&D in 2003 is about €1.450 million. They make a distinction between indirect funding (tax measures), direct funding (programme funding) and institutional funding to universities and institutes. This is shown in Figure 2.2 below. The figure clearly shows that indirect funding and direct funding has become more important over time, but institutional funding still compromises the biggest part of government funding[10].

Figure 2.2 Level of federal R&D funding



	2000	2001	2002	2003
Indirekte Förderung	k.A.	130,0	140,0	230,0
Direkte Förderung	247,5	253,6	294,5	313,2
Institutionelle Förderung	904,2	948,3	1012,3	931,4

Quelle: Jahresberichte FFF, FWF, TIG und AWS; BMF[13], eigene Darstellung

Figure 2.3 below shows that 82% or €765 million of federal institutional funding (2003 data) is allocated to the universities (and mainly allocated in the General University Fund, see section 2.3.1), 4% or €41,4 million to non-university research organisations (mainly to the Austrian Research Centres group, ARC), 5% to the Academy of Science, 6% to international organisations and 2% elsewhere.

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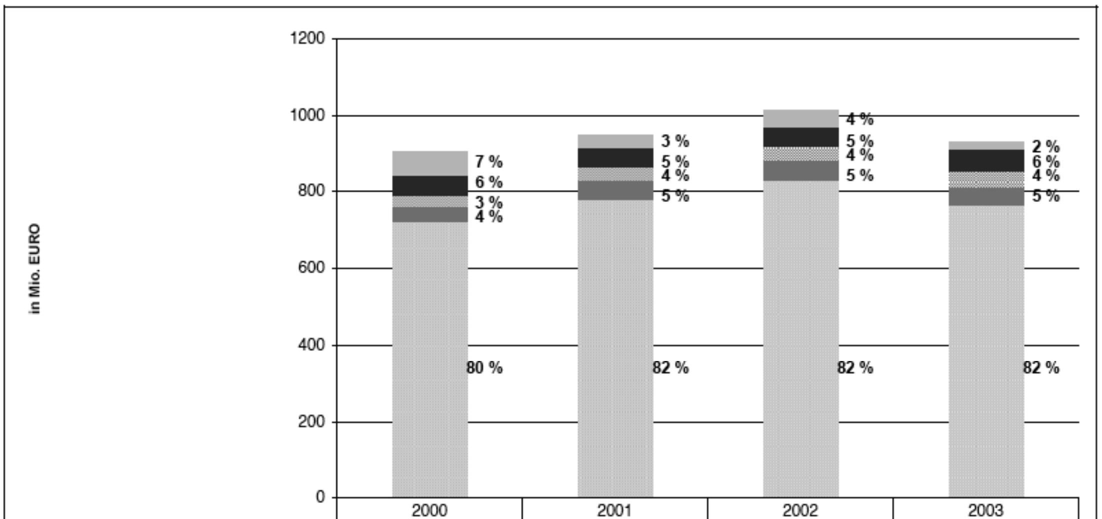
[10] A. Schibany, L. Jörg (2005), *Instrumente der Technologieförderung und ihr Mix*, Joanneum Research and Technopolis

Additional to federal funding, some public research centres receive regional funds, like Joanneum Research in Styria or Salzburg Research in Salzburg. Moreover, the FTE-Nationalstiftung has started to co-fund ARC (Austrian Research Centres), the Academy of Science and Christian Doppler Gesellschaft (CDG) in 2005.

Figure 2.3 Institutional funding



	2000	2001	2002	2003
sonstige	59,2	31,6	41,8	21,0
Beitrag internationale Organisationen	55,7	52,0	52,3	56,2
außeruniversitäre FE (ARC)	27,6	36,0	35,8	41,4
ÖAW u.a. wissens. Institute	39,2	48,3	53,7	48,0
Universitäten	722,5	780,5	828,7	764,6

Quelle: Jahresberichte FFF, FWF, TIG und AWS; Beilage T, eigene Darstellung

2.2.3 Regional research policy

Austria's RTI policy is federally organised and has been a de facto monopoly of federal policy making. In recent years, the provinces have increasingly recognised RTI as a policy field of their own and have set clear accents in this area. This has manifested itself in increased budgets and the development of separate (development) agencies and specialised (research) institutes in the provinces. Major parts of these activities are autonomously defined and implemented (and funded either on their own pocket or through EU Structural Funds). As far as RTI policy is concerned, the main focus is, fom good reasons, more on the innovation side. The main pillars throughout most of the Federal States are (i) incubators, (ii) cluster initiatives, and (iii) co-financing of federal programmes.

This development raised the question about how the federal innovation policy interacts with its regional counterparts. No clear model has evolved yet because of the seemingly high level of diversity between the regions. Whereas some regions rather follow a strategy of additionally, others focused their resources on supplementary funding to top up federal funding activities.

An interesting example of how federal innovation policies can interact with regions is the K-Plusprogramme launched by the BMVIT. The competence centres programme supports the establishment of research platforms bringing together scientific research and innovative firms. Public funding is provided jointly by the federal state and the regional government. The aims of the programme and the rules for implementation are set and defined by federal innovation policy sets.

A second example is the introduction and rapid implementation of Fachhochschulen (FH) (Polytechnics). The regions are playing a prominent role both in definition and in governance of the respective programmes. In the beginning, the field has been extremely fragmented. In the course of time, many of the Federal States have moved towards the policy of one FH per Federal State.

2.2.4 Response to EU policy

Lisbon agenda

Austria is making great efforts to integrate itself in the Lisbon process and is actively involved in shaping the European Research Area.

Austria is one of the few European countries that is well on track towards the Barcelona targets, both in terms of the 3% target and in terms of the 2/3 share of private sector R&D funding.

The National Research and Innovation Plan, published by the Austrian RTD Council was an Austrian initiative or strategy to fit in the European Unions Lisbon Strategy 2010 (see appendix A for main priorities).

FP participation[11]

Through its Framework Programmes, the EU has exerted a strong influence on the definition of thematic priorities in Austrian research and technology policy. Apart from the recurrent argument of ensuring a "juste retour" from the Framework Programmes, the adaptation of national priorities to European ones has also been driven by the interest in facilitating the integration of Austrian research in what since 2001 has been called the European Research Area. Moreover, reference to European developments has been used successfully to generate support and legitimacy for national initiatives.

An evaluation of the 5th Framework Programme furnishes the following features and impacts: network effects and additionality of the research projects carried out within FP5 in Austria were substantial – as had been the case in former Framework Programmes. The benefits from participation exceeded its cost, and participants mostly achieved their own goals. The projects were mostly of great strategic importance for participants and seen as part of a larger-scale project portfolio. However, a relatively large number of projects carried only a low technological and commercial risk and was relatively small-dimensioned.

Austria enjoys an excellent position in the 6th Framework Programme for Research and Technological Development. As to the relative results of Austria's participation, the situation is much more successful than in the 5th Framework Programme. Austrian institutions currently contribute 2,6% of participations and 3,3% of co-ordinators. When it comes to grants, the Austrian share is higher than the country's share of member state contributions to the EU budget. It should also be noted that many of the applicants from Austria are new to the game and did not apply for the 5th Framework Programme.

Concerning Austrian participation to the 6th FP, the total amount of funding for Austrian participants is €304 million. About half of these funding come from thee programs: IST (€76,5 million), LSH (€ 29 million), NMP (€24 million), followed by ENERGY (€18 million), Transport (€15 million) and mobility (€ 13,6 million). 39% of European funding for

[11] Erawatch.

Austrian participants or coordinators go to universities, 25% to non-university research centres, and further 25% to industry[12].

In order to better coordinate and bundle activities of different Austrian industrial, research and policy actors, the RTD Council has suggested developing a national strategy in respect to FP7, cooperation of research funds and intermediaries and a focus on strategic cooperation.

Participation in European Technology Platforms

Through its ministries and agencies, Austria is involved in 42% of all ERA-Nets that are supposed to pave the way for the mutual opening of national research programmes and are regarded as a first step towards a ERA.

Although being industry-led, Austrian R&D policy is also getting increasingly interested in the European Technology Platforms (TPs), which are supposed to define strategic research agendas in key technology areas. Currently, Austrian representatives are involved in 33 TPs[13].

2.3 Critical mass and focus of research

As we have seen in section 2.2.2 the Austrian STI policy system is rather fragmented and complex. The establishment of Austrian RTD Council and various reorganisations and mergers at the agency level has contributed to the incorporation of existing funding programmes into a coherent research strategy. Moreover, by publishing the documents "Research and Innovation Plan" and "Strategy 2010" th up funding by the FWF and FFG forms an exclusively quality-oriented, non-theme-specific basis for free basic research and industrial research irrespective of existing Austrian and European priority programmes (see section 2.3.1).

Thematic priorities. In the area of thematic programmes with multi-year financing, support is given to national and European key areas. The main emphasis is on the creation of critical masses, preparation for European programmes and social policy objectives (see section 2.3.2).

Functional priorities. In the area of infrastructure programmes, support is concentrated upon co-operation between science and industry with a medium to long-term focus (see section 2.4).

The main elements of Austrian research policy refer to (without any ranking)[14]:

- the enhancement of science-industry relations, supported by several programmes launched during the last decade;
- a high level participation in European project;
- reorganisation of the university-sector, as well as of the support structure for research;
- introduction of a excellence strategy;

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[12] Proviso – Statusreport – 6. RP Aktuelle Ergebnisse 2002-2006. Stand Fruhjahr 2006. http://www.bmbwk.gv.at/proviso

[13] Trendchart/ERA-Watch.

[14] ERA-Watch

- support of women into science;
- increase of global budgets for R&D.

2.3.1 Bottom-up funding of university research

The General Research Fund

The higher education sector traditionally has a strong position in the Austrian

Innovation System and spends about €1.2 billion on R&D in 2002. The sources of R&D funding are shown in the table below.

Table 2.1 Financing of Higher Education R&D (HERD)

	Total (million €)	**Share of total**
Direct government funding	210,6	17.3%
General University Fund	899,7	74.0%
Business funding	7,9	0.6%
Funds from abroad	49,3	4.1%
Private non profit	47,6	3.9%
Total	**1.215**	**100%**

Source: OECD, Science & Technology Indicators, 2002

Most of the federal R&D funding to universities goes directly to the ‘general university fund (GUF)’. This money is allocated within the universities and its distribution is strongly influenced by educational priorities. Policymakers can not influence spending of this budget.

Direct government funding, which can be employed in a much more targeted fashion than GUF, for R&D at the universities are small compared by international standards. In fact, Austria (together with the Netherlands) has the highest rate of GUF in all OECD countries, namely 74%[15]. In other OECD countries typical rates would be 50 to 80% for GUF.

Due to its bottom up character Austrian university research is fragmented. For a long time Austrian science policy was reluctant to actively encourage the creation of critical mass in selected scientific fields. The university sector has relied to a high extent on general university funds, which created not the environment to develop patterns of scientific specialisation. Fragmentation and mediocre scientific output were the results of this hands-off approach[16].

Austrian science has improved in the last decade (as it has in most countries), approaching average EU levels but not yet in most fields moving beyond them. There are important individual ‘high points’ in university research performance, but the university system as a whole continues to suffer from fragmentation (too few centres of excellence or large concentrations of capabilities in specific fields within the research-performing

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[15] OECD (2002), Science & Technology Indicators, OECD, Paris.

[16] Arnold, Erik, et al. (2004), Synthesis report: Evaluation of the Austrian Industrial Research Promotion Fund (FFF) and the Austrian Science Fund (FWF), 2004.

institutions) and lock-ins to traditional disciplines (because there are too few incentives to bypass old structures). Women remain under-represented in the universities and research institutes (Arnold et al., 2004).

Direct government funding

The most important source of direct government funding of research activities at universities comes from the Austrian Science Fund (FWF)[17]. FWF operates three types of programmes:

- individual (basic) research grants;
- large projects and research networks;
- thematic programmes.

About 70% (approx €75 million, 2004) of the funding budget of FWF is allocated to individual (basic) research projects at universities. There is not any thematic restriction and grants are awarded according to the bottom-up principle; every university researcher can apply for a grant. As a result the universities or individual researchers themselves determine the research focus. The grants are solely awarded on the basis of scientific quality and therefore FWF funds are an important quality assurance instrument for university research. In addition, the large projects and research networks are also developed on a bottom up bases at universities.

The amount of FWF funding available for thematic research funding is limited. The most important thematic FWF programme is in the area of nanotechnologies. Other thematic programmes are in cooperation with the European Science Foundation.

University reform act

The University Act 2002 introduced a range of governance mechanisms to enhance priority setting and professional management at universities. The Universities Act 2002 subjected the universities to a far reaching reform with the aim of improving quality, increasing their focus in terms of content and granting extensive autonomy. In addition compensatory funding has been provided that is used, for example, to finance infrastructure, and support profile development and cooperation with non-university institutions and industry.

Although the impact of the University Act is not clear yet, it is expected to have a substantial impact on university research. Firstly, it gives universities more freedom to develop focal points in research. Secondly universities have become more aware of the economic value of there research resulting in more explicit IPR strategy. Thirdly, policymakers have forced universities into collaborative research with companies. There are many funding programmes that require cooperation with the private sector (see section 2.2.4).

To conclude, compared to the "general university fund" the impact of research grants from FWF and other agencies like FFG is limited in terms of "building critical mass and focusing university research priorities". Despite their limited budget, FWF has the funding instruments to focus university research in a number of scientific themes. In practise however most of the funding is (still) allocated using the bottom-up principle. This means there is, from a policy perspective, no thematic focus on key research areas. The

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[17] About 90% (approx €96 million, 2004) of the funds available to FWF is allocated to the universities according to the Austrian Council, 2002, National Research and Innovation Plan. Vienna. http://www.rat-fte.at/

university reform act provides incentives to universities to develop a strategic research plan and create focus and create critical mass, but it is too early to see any immediate effects.

2.3.2 Thematic priorities

Thematic priorities have been formulated most explicitly by the RTD Council and include on the one hand frontier research areas like biotech-life sciences, ICT and nanotechnology, but on the other hand also thematic areas of a more problem-oriented nature like transport technology, or sustainable development. Also the social sciences – humanities and cultural sciences, which have a long-standing research tradition in Austria, are important research areas.

Specific funding programmes, mainly implemented by FFG, address these thematic research priorities. The main objective of these programmes is to supports the building up of critical mass in areas of national priority, that have a strategic impact on the economy by developing new technologies[18].

These national priorities are reflected in the following funding programmes that are currently running:

- Aeronautics (TAKE OFF);
- Information & Communication Technologies (FIT-IT);
- Intelligent Transport Systems & Services (IV2S);
- Microtechnology Initiative;
- Nanotechnology Initiative (NANO);
- Safety & Security;
- Sustainable Development (Nachhaltig Wirtschaften).

These funding programs are expected to support the development of critical mass in research. Ultimately programmes should increase the level of organisation among research performers.

2.4 Valorisation of research results

Functional priorities is the third pillar of Austrian STI policy and include support for R&D collaboration between industry and universities and the transfer of technology and innovation to small and medium sized enterprises (SMEs).

Various researchers, including the OECD, have analysed the RTDI system in Austria and report that the main deficiencies in the Austrian system relate to:

- low level of science-industry co-operation;
- short term R&D planning in industry;
- dominance of SMEs in R&D in Austria;
- lack of critical mass in research;
- low international visibility of many R&DI efforts.

These observations have led to discussions among Austrian policymakers and to address these problems many programmes are launched to stimulate public-private cooperation and improve technology transfer from universities to companies. Some of the bigger and

[18] Website FFG. http://www.ffg.at/index.php?cid=12

more successful instruments are described below using the following categories:

- research-industry co-operation and exploitation of research results (i.e. IPR);
- technology transfer by spin-offs.

2.4.1 Research-industry co-operation and exploitation of research results

There are three major funding programmes in Austria aiming to improve (among others) public-private cooperation. These are:

Kplus Programme	The Kplus competence centre programme aims to build long-term co-operative research initiatives between public institutions and private companies. K*plus* competence centres are selected in a competitive process according to specific quality criteria and established for a specified time-span (4+3 years).	Since 1998
Kind/Knet Programme	The Kind/Knet programme serves the development and strengthening of internationally competitive technology clusters by supporting competence centres and networks with the purpose to advance, develop and transfer application-oriented technological knowledge, jointly run by business enterprises and universities/public science and research enterprises on a long-term basis (4+3 years).	Since 1999
Christian Doppler Laboratories	Christian Doppler Laboratories (CDL) perform application-oriented basic research on topics of interest to member companies. They provide member firms of the Christian Doppler Research Society with early and direct access to new scientific and technical knowledge. The latter invest on a long-term basis in specific basic research fields and participate in the labs	Since 1989, new form since 1995

To some extent the creation of two competence centre programmes (Kplus and Kind/net) instead of one is also the result of institutional factors. In particular, it is hardly conceivable that there would have been two programmes if competencies in S&T policy were concentrated in one ministry. The role of CD labs is somewhat different, but still there is overlap with the other programmes.

Christian Doppler Laboratories

The Christian Doppler Laboratories (CDG) conduct application-oriented fundamental research with a view to find solutions for industrial problems. It aims to play a key role as an institution for science and technology transfer in the Austrian research and technology landscape. The labs are set-up in universities or non-university research institutions in collaboration with companies. This enables member companies to have a direct access to new knowledge. The funds for a CD lab are provided by the member companies and than doubled by the federal government (matching funding).

Initiating a CD-Laboratory is usually a bottom-up process, stimulated either by an industrial partner or an university member or both. Before granting a CDL, an appropriate research plan must be submitted. The duration of a CDL is generally 7 years. The quality and feasibility of the proposed plan will then be reviewed by anonymous, international peer-review. If the project is accepted, an initial research contract is concluded for 2 years. If progress is proved to be satisfactory by means of an intermediate evaluation, the contract will be prolonged for a maximum of 5 more years.

There are now 37 CD labs is many different area's like nanotechnologies, chemistry, biotechnology, mathematical modelling, ICT, mechatronics and mechanical engineering[19].

Kplus programme

The main goal of the K-plus programme is to perform research that is highly relevant for both the academic world and industry and to develop human capital in areas that are either multi-disciplinary or which are relevant for a number of sectors/companies in Austria. Other goals are:

- improve long-term co-operation between science and industry;
- improve transfer of know-how;
- define new areas of research through bottom-up approaches;
- reaching focus and critical mass in research;
- use public funding to trigger additional private/industrial expenditures.

New centres are established via competitive application procedure. To date 18 joint-research centres are operational (as a result of 3 calls) in different research areas like bio-energy, applied electrochemistry, polymers, software, virtual reality, etc[20].

The annual budget of a centre is typically in the range of €2 to 4,5 million. The centres are financed by the federal government, the scientific partners and the industrial partners. The federal funding comes from BMVIT via FFG (35% of total). Up to 20% comes from other public sources, mainly the regional governments. A minimum of 5% comes from the scientific partners and minimum of 40% comes from industrial contribution (by at least five partners). The funding period for a centre is 7 years.

Kind / net programme

The Kind/net programme is more innovation-oriented and industry driven than the K-plus programme. The main objective of the Kind/net programme is to develop industrial clusters in certain technology fields and to ensure that research results are swiftly implemented into industrial processes. The Kind/net programme consists of two action lines:

- Centres of Excellence (K ind): These industrial competence centres (13) aim to develop and strengthen internationally competitive technology clusters. In most cases, they build upon the existing technological competences of a number of enterprises. The idea is to concentrate the R&D activities of a number of enterprises and the activities of research institutes and universities working in the same field.
- Networks of Excellence (K net): These competence networks (10) consist of a number of competence nodes from the fields of science and industry in those areas of technology where there is competence and/or demand in different locations. The prerequisite is that the individual nodes complement one another in terms of their thematic orientation. Existing regional R&D institutions (e.g. university institutes, CD Laborato-

[19] http://www.cdg.ac.at

[20] http://www.tig.or.at/en/fundingprogramms/Kplus/programme/

ries, polytechnic colleges, joint venture research institutes) should be included as partners.

In the Kind/Knet programme the maximum federal government grant (BMWA) is 40% of eligible cost. The province or provinces (regional government/lander) where the centre/network is located are expected to provide at least half of the sum granted by the federal government. At least 40% of the total eligible costs must be contributed by the private sector. In order to qualify for fixed term grants, projects must demonstrate the broad and long-term participation of both the enterprise and the scientists of the participating research institutes. The duration of the funding period is maximized to 4 years, but can continue after an evaluation of the centre/network.

To summarise, the establishment of (different types) of public-private research centres with mixed participation by science and industry has aimed on the one hand at creating critical masses of research competence in freely selectable thematic areas and to achieve excellent results. The other objectives were to support the universities in focusing research activities, to encourage industry to engage in more strategic R&D and to improve links between the two systems. International experts unanimously agree that the competence centres initiative has helped change the culture of co-operation between industry and science in Austria (Strategy 2010).

2.4.2 Technology transfer by spin-offs

The Academia Business Spin-off Programme (A plus B programme) aims to address the low percentage of newly founded firms in general and of innovative, technology- and knowledge-based firms in particular and poor co-operation between science and industry. The programme is managed by FFG and aims to bring about a sustainable increase in the number of innovative, technology-oriented spin-offs from the academic sector.

Networks of regional partners (universities, research centers, regional support agencies, firms, qualification agencies etc.) compete for national support on the basis of their specific models of academic start-up centers. The minimum number of partners is two, of these, one must be an academic institution and the other must have verifiable know-how in supporting and monitoring research-intensive company start-ups. The centres not only provide help in the process of setting up a firm but also focus on a general fostering of entrepreneurship in the academic world. The programme runs from 2002 until 2009 and has a budget of €20 million for the first two calls.

2.5 Conclusions

It is clear that the Austrian STI policy system is rather fragmented and complex. However, the establishment of Austrian RTD Council and various reorganisations and mergers at the agency level has contributed to the incorporation of existing funding programmes into a coherent research strategy. Nowadays, the national research promotion system essentially consists of bottom-up funding and specific programmes that set both thematic and structural/functional priorities. Bottom-up funding remains however the main source of funding.

The higher education sector traditionally has a strong position in Austria, but is suffers from fragmentation (too few centres of excellence or large concentrations of capabilities in specific fields) and lock-ins to traditional disciplines. The share of “General University Fund” in total financing of R&D at universities is among the highest in all OECD countries and hence the share of direct government funding is very low. This implies that policymakers have limited capabilities to influence research priorities at universities. In recent years policymakers have launched various funding programmes in order to influence and steer research priorities, but despite these efforts research funding is still to a large extent driven by the bottom-up principle.

To address the situation described above (different types) of public-private research centres have been established in Austria (e.g. Christian Doppler, Kplus, Kind/net). The programmes have aimed on the one hand at creating critical masses of research competence in freely selectable thematic areas. The other objectives were to support the universities in focusing research activities, to encourage industry to engage in more strategic R&D and to improve links between the two systems. International experts unanimously agree that the competence centres initiative has helped change the culture of co-operation between industry and science in Austria and led to more focus in university research.

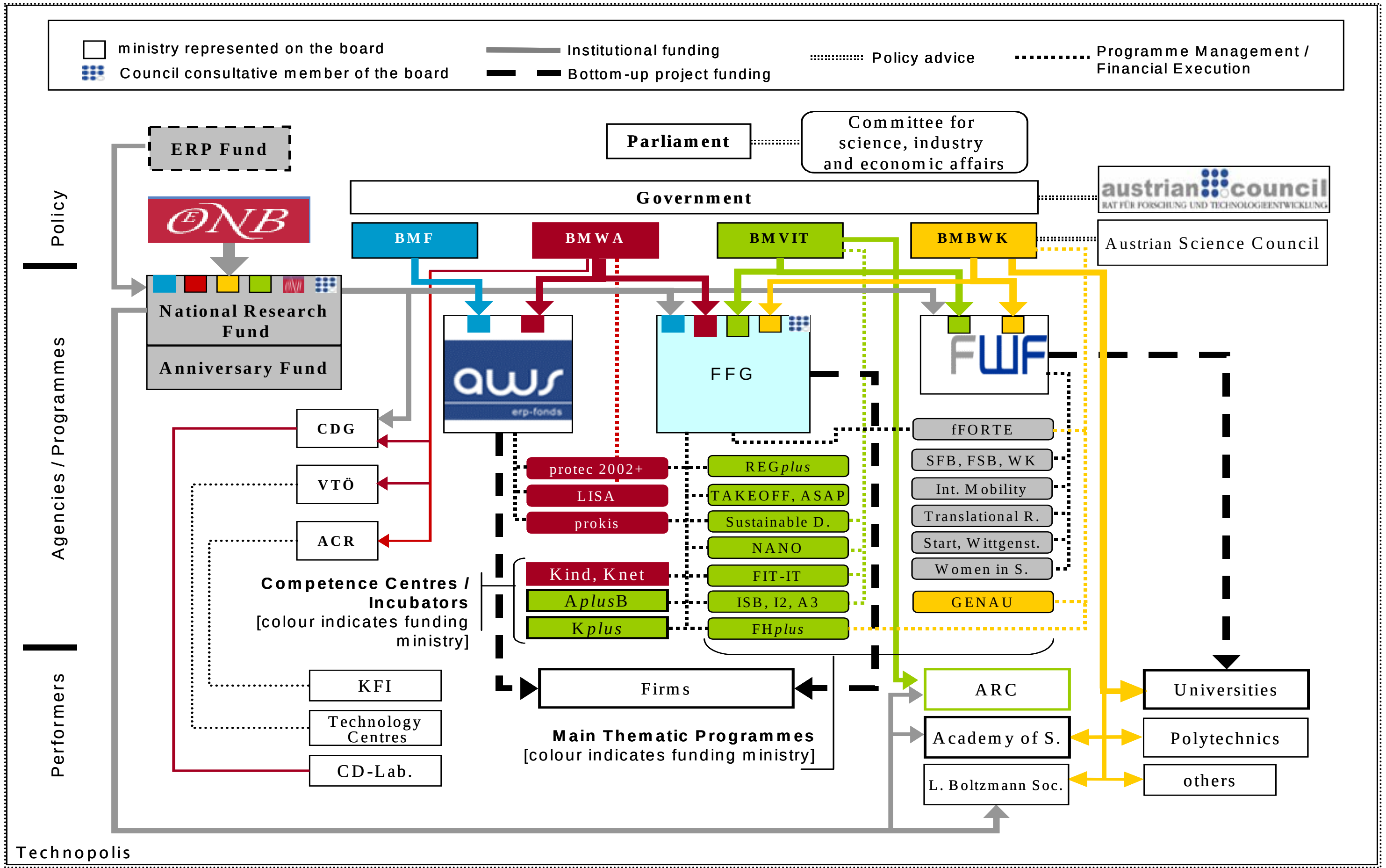
Appendix A Priorities formulated in the National Research and Innovation Plan published in 2002 by the Austrian RTD Council

Its goal is the improvement of the Austrian research and innovation landscape. In this plan six fields were defined: ICT, Environment & Energy, Life Sciences, Nano- and Micrortechnologies, Mobility and Transport, Socialsciences & Humanities. These priority fields are 1) Bio science, 2) Genomics and bio technology, 3) Technologies of the information society, 4) Nano technologies, 5) Multi functional materials , 6) New methods of production, 7) Aeronautics, 8) Food quality and safety, 9) Sustainable development, 10) Global change and 11) Ecosystems.

Furthermore, the Austrian Council for Research and Technolgy Development recommended following strategic lines:
1) Increasing quality and capacity of services of the existing information instruments
2) Increased allocation of funds for additional financing
3) Increasing of the contingent of Austrians in international organisations
4) Abolishment of juristical barriers for researchers and
5) Examination of the previous used instruments.

The Council for Research and Technology Development defined 10 main principles:
1) Boosted **concentration** on activities with high leverage of public to private funds,
2) Reaching of **critical mass**,
3) Accentuation of economic elements,
4) Promotion of excellence in basics research,
5) Close alliance of research, technology and innovation relevant questions,
6) Improvement of the cooperation between the different R&D producing sectors,
7) Simplification of the complex institutional and organisatorial funding structure,
8) Improvement of the cooperation between the state and the federal states,
9) Planning security for programmes and initiatives and
10) Quality securing systems for research, technology and innovation initiatives.

Appendix B The Governance of Austrian science, technology and innovation policy



BMBWK: Ministry of Education, Science and Culture

BMVIT: Ministry of Transport, Infrastructure and Technology

BMWA: Ministry of Economy and Labour

AWS Austria Wirtschaftsservice GmBH

FWF: Fund for Promotion of Scientific Research

FFG Forschungsförderungsgesellschaft

3. Denmark

3.1 Introduction

Over the last years the economic performance of Denmark has been very strong. GDP-growth is above the EU25-average, there is a trade surplus, inflation is low, public debt has been reduced, the public budgets are balanced, savings are adequate, the currency is stable, and interest rates follow the European lead. Meanwhile employment rates have remained relatively low, employment participation is one of the highest in the world, and the world-class quality of the social welfare system has been retained. These economic and social successes have indeed been so impressive that 'the Danish model' is increasingly gaining international recognition as an exemplar – and perhaps as a successor to the 'model' of the fellow Nordic country Finland[21].

There is no clear explanation underlying the success of 'the Danish model'. The particular setup of the Danish labour market – a unique combination of high mobility between jobs with a comprehensive social safety net for the unemployment and an active labour market policy ('flexicurity') – might be one of the drivers. However this is just a partial explanation. It remains to be seen why such a small country with a corporate sector which chiefly consists of many SMEs in low-growth industries (e.g., agriculture) has remained one of the world's richest countries for decades now.

There are, nevertheless, some serious shortcomings in the current national innovative framework conditions. In general, entrepreneurship (and esp. high-tech entrepreneurship) is weak. Few new companies are started and even less are grown into internationals. Within firms, few original products are being developed. Consequently, the industrial base is very narrow, with just a handful of big firms. At the S&T-side, public expenditure on RTD remains relatively modest[22], advanced education is not well-coordinated with business needs, there is a persistent shortage of supply of S&T-graduates, and collaboration between universities and companies is weak.

Although the Danish innovation system is generally regarded as a strong and rather well-functioning system the few weaknesses it has concentrate precisely around the most fundamental growth conditions – human resources and future companies[23]. The concern

[21] In the past few years Denmark has been collecting superlatives. It was ranked number one in Europe by the World Competitiveness Yearbook for labor regulations and top five of its class in skilled labor availability. The Economist and IBM recently positioned Denmark as World best in e-readiness and The World Economic Forum titled Denmark as the world's second best infrastructure environment. Not to mention Denmark has been cited as the top test market, best producer of medical devices, and as housing the world's happiest people [...] The frequent global praise of Denmark encouraged the 2006 ranking by Economist Intelligent Unit that "Demark will be the best place in the world to conduct business over the next five years." This is no fluke, as the same award was granted by the EIU last year and the World Bank has determined that Denmark is the "World Champion in Foreign Business."

[22] That is, compared with other Nordic countries (total of HERD and GOVERD is 0.78% of GDP, compared to 1.02% in Finland (2004) and 1.01% in Sweden (2003). It is slightly above the average of the set of benchmark countries (0.74%) and just above the total for The Netherlands (0.76%). Over the period 1998-2004 expenditure on HERD shows a relatively strong growth but expenditure on GOVERD a strong decline. Public funding innovation scores low on the EIS 2005 indicators.

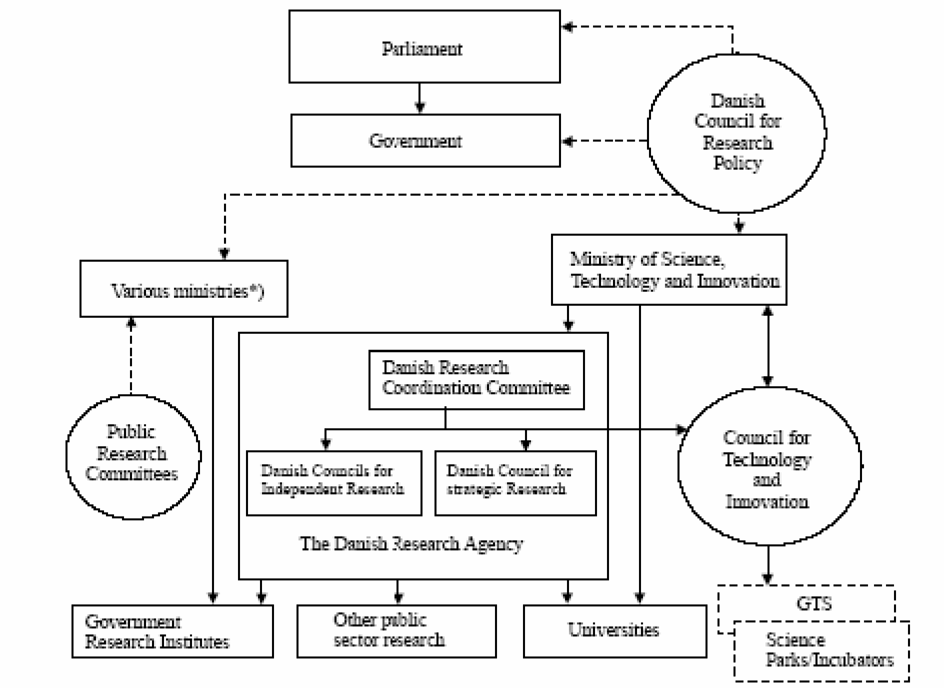
[23] Here again, compared with Finland en Sweden Denmark might fall behind but these are absolute frontrunners. However in an overall comparison within the EU (EIS), Denmark is performing well

that these flaws might undermine the present success of the 'Danish model' has moved innovation policy and the co-ordination of the innovation system to the top of the political agenda. Thus Denmark is currently in a luxury position. The challenge is to spent the current massive budget surplus in such a way that the present strong international position can be maintained[24].

3.2 Institutional setting

Following the adoption of the 2002 Act on Technology and Innovation the Danish STI system has undergone a major restructuring of its whole innovation system in the last couple of years. To strengthen coordination and the overall function of the research and innovation system the responsibility for both research and innovation was for the first time centralised in a single ministry.

Figure 3.1 Overview Danish National Innovation System



Source: Trend Chart Country Report Denmark 2005

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above the average. In the first perceived weakness mentioned (number of S&E graduates) for instance Denmark is exactly on the EU-25 [102] average [indexed to 100] but much higher than the Netherlands [60]. A similar picture emerges with regard to the second perceived weakness. In terms of firm dynamics Denmark is not performing below average and clearly above the Netherlands.

[24] Denmark already has a government surplus for a long time. The current (2005) surplus has reached a staggering 3.5% of GDP, approximately €5 billion Euro.

3.2.1 Key players in STI policy[25]

The main task of the new Ministry of Science, Technology and Innovation (MSTI) is to promote the interaction between business, industry, research, and education, as well as to coordinate innovation and entrepreneurial policy measures [4]. Innovation related policies and measures were transferred from the Ministry of Economic and Business Affairs (MEBA) and the former Ministry of Trade and Industry. However issues in the traditional industrial sector, including the support of entrepreneurship, clustering policy and IPR, are still the responsibility of MEBA.[26] The administration of the university sector was transferred from the Ministry of Education to the Ministry of Science, Technology and Innovation. All in all MSTI manages about 75% of the government appropriations to research and innovation.

With the establishment of a high profile group on the challenges of globalisation in 2005 coordination between the various ministries involved in the STI policy has been formalized.[27] The group deals explicitly with a number of key innovation policy areas[28]. In addition to this ministerial group, the Prime Minister established a so-called Globalisation Council which unites the above-mentioned Ministers with representatives from central stakeholder groups, e.g. Industry, Labour unions and knowledge institutions. The Council, which has been appointed for three years, had assisted the ministerial group in formulating a new globalisation strategy ('Progress, Innovation and Cohesion'). It has recently (spring 2006) published its final report and has now been disbanded.

Another high profile advisory board is the private think tank Innovation Council, which was founded in October 2003 upon the initiative of a Danish magazine[29]. The Innovation Council is based on co-operation between private companies, ministries (Education, STI, and Trade) and public institutions. The House of Monday Morning and FORA, the analysis unit of the Ministry of Economics and Business Affairs, are responsible for running the Innovation Council secretariat. The Innovation Council aims to discuss and encourage innovation in the Danish economy. It has been quite influential in the formulation of the national growth strategy (Globalisation Council)[30]. It has also been successful in setting up various extensive public-private partnerships in the field of strategic research, most notably the so-called 'multi million industries'. These are consortia of private firms and public institutes (e.g., universities, GTIs) centered around specific societal needs (e.g., 'housing for the elderly').

The Danish Council for Research Policy (Danmarks Forskningspolitiske Råd) is the main advisory council in the Danish STI policy system. The Council advises the MSTI on matters concerning research policy – the secretariat from the Council is also based at that ministry. The Parliament and other ministers may also ask for the Council's advice. Advice may be

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[25] This chapter is heavily indebted to the TrendChart Country Report Denmark 2005.

[26] MEBA is turn has delegated most of the issues to the *National Agency for Enterprise and Construction* which focuses on entrepreneurship and innovation policies. The latter cooperates with actors from business associations, the corporate sector and the public sector. There is no official forum for coordination between the ministries and the agencies; this is done continuously on an ad-hoc basis whenever necessary.

[27] The group is chaired by the Prime Minister himself and consists furthermore of the Minister for Economic and Business Affairs as deputy chairman, the Minister of Education, The Minister of Finance and the Minister of Science, Technology and Innovation.

[28] Such as public research (universities and GRIs), competition policy, and entrepreneurship.

[29] Mandag Morgen, http://www.mm.dk/default.asp?emne

[30] The chair of the Innovation Council has also chaired the Globalisation Council.

given upon request or on the Council's own initiative. The tasks of the council include giving general advice on Danish and international research policy for the benefit of society including advice on:

- the framework of research;
- appropriations for research;
- major national and international research initiatives;
- development of national research strategies;
- Denmark's role and position in international research cooperation;
- Training and recruitment of researchers.

The primary task of the Council for Technology and Innovation, which is also under MSTI, is to direct funding to the Technology Service Institutes (see hereafter). Three other main funding agencies are especially geared towards the funding of public research (universities and Government Research Institutes.

The Danish National Research Foundation (Danmarks Grundforskningsfond, DG), which has the status of an independent fund, funds larger research activities based on researchers' own ideas, and contribute to the development of Centres of Excellence[31]. Presently 36 of such centres are funded.

The Council for Independent Research (Det Frie Forskningsråd, DFF) is the umbrella organisation of the (five) research councils in Denmark. The councils support research projects based on the researchers' own research initiatives. The structure of the councils has recently been changed to reflect the interdisciplinary nature of modern design. However in practise the new structure is still very much akin to the older structure albeit with other labels[32].

Whereas DFF is geared towards basic public research and funds the own initiatives of researchers, the Council for Strategic Research (Det Strategiske Forskningsråd, DSF) supports research based on politically defined programmes. DSF has an obligation to contribute to an increased co-operation between public and private research. To ensure 'societal relevance' of projects, applicants, to be eligible for funding, are to specify more immediate or direct success criteria of the project such as number of jobs created as a result of the project. Furthermore, a special monitoring group involving the business sector will be attached to each project to ensure that the goals are achieved. DSF does not in and by itself have competence to give grant. Therefore it works through temporary ad hoc programme committees for each politically chosen programme[33]. DSF also runs 10 so-called Innovation Accelerating Research Platforms (IARPs) – a recent initiative to focus

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[31] The Foundation has at its disposal a capital of €270 million. Initially, it was expected that only the income from the capital should be used for funding the Foundations' activities. However, a later revision of the legislation has enabled the Foundation to extend its use of capital. Still the effective budget of the Foundation is about 1/10th of its capital. €27 million accounts to about 1% of overall public expenditure on R&D (2005) which is about the size of the DSF's budget (€47 million) and less than a quarter of DFF's budget (€124 million). With 36 Centres of Excellence the average annual funding per Centre is about €0.75. The budget is more or less evenly distributed among the Centres, ranging from €0.5 to €0.9 per year.

[32] The five new research councils are respectively 'Culture and Communication', 'Nature and Universe', 'Society and Trade', Health and Illness' and 'Technology and Production'.

[33] Currently (2005) there are five programme committees: for food articles and health, for energy and environment, for nanoscience and technology, biotechnology and IT, for non-ionising radiations, and for welfare research.

funding on a limited number of areas in which Denmark has both internationally recognised research environments and internationally competitive business environments.

In a similar fine, the newly established Foundation for High-Tech Development will fund strategic high-tech projects in areas in which Danish research and industry have high qualifications (ICT, biotechnology and nanotechnology)[34]. Most observers see the Foundation as a political prestige project (meant to make R&D funding more visible), rather than driven by a clear need for (yet) another agency. The Foundation is a top-up fund. A central characteristic of eligible projects is that they involve interaction between public knowledge institutions and companies. The studies that have been conducted in the Technological Foresight pilot programme during the period 2001-2004[35] are an important input to the distribution of funds from the Foundation.

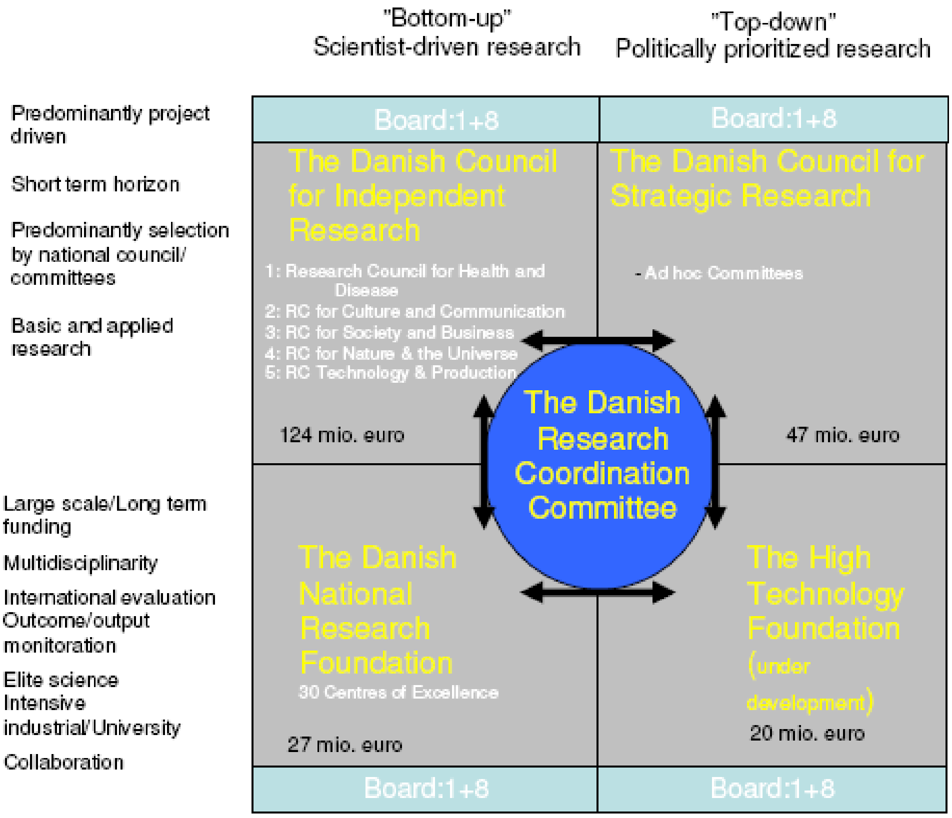
To promote coordination and cooperation between the research councils and the other parts of the research and innovation system the Danish Research Coordination Committee (KUF) was established in 2003.

There is a neat division of labour between the four funding agencies, as depicted in the figure below.

[34] The financial set-up of the Foundation is rather peculiar. A usual way to set it up would be as a foundation and to use the income from the initial capital to fund projects (cf. National Research Foundation). However to maximise political control over the Foundation its budget is allocated on an annual basis instead. Thus although the Foundation is very well endowed (with an estimated capital of 2 billion DKK) the Ministry of Finance dictates that it can only use of fraction of that capital (3-5%) on research funding.

[35] The five foresight studies covered pervasive computing, bio- and healthcare technology, future green technologies, hygiene, and nanotechnology.

Figure 3.2 Overview Danish Public Research Funding Agencies (2005)



The major research units within the public sector research system are [12] universities[36], [3] academic hospitals and [16] Government Research Institutes (sektorforsknings-institutioner)[37]. As a linking pin between these knowledge institutions and Danish industry (with a special emphasis on SMEs), [9] Technology Service Institutes or GTS-institutes (Godkendte Teknologiske Serviceinstitutter) have been established [38]. These are independent, non-profit institutions which provide knowledge and competencies to Danish business and industry on commercial basis to enhance the development and application of knowledge related to technological, managerial and market issues. The institutes are

[36] Only 5 of these 12 universities has several faculties – of which the University of Copenhagen is by far the biggest. The biggest six universities account for 87% of overall R&D FTE. There is a heavy geographic concentration. About two-third of all R&D FTE are based in the greater Copenhagen area. In 2003, Danish universities received about €525 million in basic grants for research. This money is directly allocated by MSTI according to the Financial Act. Basic funding comprises over 60% of all receipts, second-tier financing for about 22% (€210M), and external financing for the remaining 16% (€135M). To put these figures into perspective, the total first-tier funding for university research is about the same as the budget of the biggest Danish firm, Novo Nordisk (biotech & pharmaceuticals). The research budget of the second biggest firm, Lundbeck (also in biotech and pharma) is about the same as the budget from the University of Copenhagen (€220M). In turn, this equals the total second-tier funding.

[37] Measured by expenditure, the universities carry out roughly 60 percent of public research, whereas hospitals and Government Research Institutions and carry out 15 and 20 percent respectively. Most of the GRIs will be merged into universities (see 3.1.3)

[38] Total turnover of the GTS-institutes is DKK 2.2 billion (€ 290 million). Together they employ about 3,000 people.

intended to encourage firms to take innovative action. The GTS institutes play a major role as producers and transmitters of application-oriented and technological knowledge, especially for small and medium-sized enterprises, which the Institutes are encouraged to pay special attention to. As the industrial structure in Denmark is characterised by a large number of small and medium sized companies which on average do not engage in large-scale research and development, it is essential that they have easy access to knowledge from knowledge institutions. A system of public certification enables the GTS-institutes to apply for 'basic funds', which co-fund parts of the institutions[39]. This funding is directed towards the creation of a knowledge base and competencies on which the institutes draw to transmit information to private firms.

3.2.2 Main developments in STI policy

The Danish innovation governance system is currently in the early implementation phases of a major reform and restructuring process. The Act on Technology and Innovation, which passed Parliament in 2002, gives the legal framework for a whole string of initiatives to foster innovation. The Act aims specifically to facilitate:

- Co-operation and dissemination of knowledge between knowledge producing and knowledge using institutions and companies.
- Innovation, development, diffusion, utilisation, and commercialisation of research results, new technology, organisational and market related knowledge.
- Start-up and development of knowledge and technology-based companies.
- Provision of finance and competency for knowledge and technology-based companies.
- International co-operation on utilisation of knowledge and technology.

In the following year, MSTI launched an ambitious program to redesign the entire Danish STI system ('The Danish Knowledge Society'), which included plans to reform universities, the research advisory system, and the government research institutions. Implementation of the program was further specified in several Action Plans, of which the one for Public-Private Partnerships on Innovation is the most important.

- The university reform includes a change in university management, as universities will be managed by a board with an external majority. Knowledge exchange is also added to the university mission in addition to research and education. It is laid down in the Act that development contracts (agreement between universities and the ministry) will include strategies for national and international benchmarking of the university concerned as regards research, education, knowledge exchange, technology transfer and mobility.
- The reform of the advisory system includes a clearer separation between bodies that advise on general research policy issues and bodies that fund and advise applicants and other partners on scientific questions. In the same reform, The Council for Strategic Research (DSF) and the Research Coordination Committee were established.
- The 'Action plan for Public-private-Partnerships on Innovation' has a special focus on opportunities and incentives to establish mutual co-operation both among and between knowledge institutions and business enterprises. Central issues will be concerned with the future interface between the technological service system, science parks, incubators and the government research institutions on the one hand, and trade and industry

[39] The Council for Technology and Innovation directs the funding through a set of three-year contracts. The total funding has ranged in recent years from €35 million to €40 million.

on the other. The aim is that more enterprises, especially SMEs, will have faster and easier access to knowledge. The action plan is focusing on six areas:

- cooperation on research and innovation;
- access to competencies;
- Commercial utilisation of public research;
- New framework conditions for universities interplay with society;
- Focus and prioritising in public research;
- Access to qualified technological service and counselling.

Although a lot of new initiatives and reforms were already set in pace, in the 2004 parliamentary elections research was one of the major themes. There was a broad consensus among all political parties that more investment was needed in research. Also after the election research as a theme and especially the funding of research have been on the political and public agenda[40].

The current high political profile of research and innovation has finally culminated into a very ambitious all-compassing national globalization strategy that has just been published by the Globalisation Council, 'Progress, Innovation and Cohesion'. The strategy focuses on improving the efficiency of public spending on education and research, in particular allocating more public funds in open competition, and on increasing competition and internationalization in the Danish economy as a whole[41]. It contains of 350 specific initiatives, which together entail extensive reforms within the fields of education, training and research as well as substantial improvements in the framework conditions for growth and innovation in all areas of society. A considerable number of the core set of initiatives explicitly refer to focus/mass and valorisation and are further elaborated in the respective paragraphs.

3.2.3 Response to EU policy

There is currently no co-ordination at the national level with regard to the EU research programs – although the lack of coordination has recently been recognised as a policy issue, at least by the research councils. So far participation in EU programs has mainly occurred bottom-up. The initiation in ERA-NETs and so on is initiated by individual researchers or research groups and only then approved by the research councils. Formally DSF is in charge of the EU research policy but its focus is very much on industry-driven research. Basic (EU) research has little priority within DSF.

[40] More precisely, how to organise public funding of private research and private funding of public research. In any case there is a clear shift away from basic public research to industry-driven RTD.

[41] The IARPs from DSF is one of the examples of already running initiatives that fit neatly into the framework of the Globalisation Strategy. DSF has defined 10 concrete criteria that must be met before a field can be regarded as a focus area for far-sighted, strategic investment – and thus worthy to be funded. The criteria were grouped under the following six headings:

- International position of strength;
- High level of research;
- Growth potential;
- Need for new solutions;
- Public interest;
- Integration, dialogue and collaboration.

Lisbon and Barcelona objectives

The Barcelona objective has played an important role in the aftermaths of the 2004 elections. Although overall Denmark is in the absolute front in terms of macrostructures overall R&D investments are still modest compared to the Barcelona objective. In the public discussion following the publication of the draft national budget for 2006 serious doubts were expressed about the ability of the government to provide 1% of GDP for research[42]. In the Globalisation Strategy paper the government explicitly committed itself to the Barcelona objectives, by stating that in 2010 public-financed expenditure on R&D should reach 1% of GDP, and private expenditure 2%. However the recent changes have only restructured but not increased public funding of research[43]. The government is said to have set aside 1 billion DKK (€145 million) but it uses a rather broad definition of R&D (including projects aimed at SME development). It is unlikely that public expenditure would complement an eventual deficit in private expenditure.

The (Conservative) government has declared that is will earmark considerable funds for research. However it has also stressed the importance of value for money. It feels that in the current structure there is too little competition for research funding, that the funding is often spread too thinly, that investments in laboratories and equipment have not been given enough priority, and that there is no tradition for measuring and evaluating the quality of research. Consequently, there is need for a sweeping reform of public sector research – rather than an increase in funding per se.

Nevertheless, it will be political suicide for the government not stick to the promised 1%-target. The issue is not such much whether but rather when the additional funds will be available. The research agencies have strongly pleaded for an immediate but gradual increase of the budget, rather than a sudden huge increase in 2010. Budgets for public research have been very tight ever since the end of the 90's. Also, the research system has a limited capacity to absorb additional funding (for instance because there is currently a lack of qualified researchers) hence the ratio of an incremental strategy. Ultimately in the spring of 2006 the incremental strategy has been officially adopted by the government.

EU Framework Programme

The success of the Framework Programmes crucially depends on whether leading enterprises and universities research institutions consider the research programmes one of the most important sources of their development and modernisation. This is clearly not the case in Denmark. Overall, the share of international sources (of which the EU Framework program has the lion's share) within total public expenditure has remained modest and has even declined during the last couple of years. Despite the fact that several smaller Danish research groups have performed better than expected in the competition for EU-funding,

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[42] Already for a long time (at least since the early 90's) public expenditure on R&D has remained at a constant 0.8% of GDP. At the same time private expenditure has shown a constant growth but seems to be leveling off lately at about 1.8% of GDP. Raising public expenditure to 1.0% would certainly signify a trend break. Nevertheless in its review of the Danish National Reform Program the Commission concludes that the 2010 target of 3% seems realistic – assuming Denmark maintains its current strategy and increases public R&D as intended. Next the to 1 billion DKK for 2007, it is expected that there will be other additional funding until 2014 summing up to 10-14 billion DKK (€1,5 - €2,0 billion)

[43] All observers expect that the target will nevertheless be met because the government already put so much prestige into the Globalisation project.

bigger groups have opted out. They think the extensive bureaucracy limits the advantages of participation considerably.

The bias towards smaller groups is perceived as a serious threat given the fact that the EU is now moving away from the distributional principles that have been employed in later Framework Programs towards focus areas such as "Networks of Excellence." – and these require big conglomerates. In the Globalisation strategy paper two measures are formulated to increase participation in the EU research programs. Both relate to the rules of Danish research councils. First, the councils should be allowed to allocate funding support towards international research cooperation. Second, the councils should have to opportunity to use funds for national co-financing in order to promote Danish participation in EU framework programs and other international activities.

Meanwhile, in its official position on the FP-7 program the Danish government has stressed the importance of reducing the administrative burden on of the participants as much as possible. It is therefore also rather sceptical towards the massive use of new instruments.

In terms of themes the focus of the Danish government is not particularly original (biotech, nanotech and ICT, see hereafter) but it adds explicitly that these three fields are in line with the national growth strategy and also show great potential in those core areas that are of particular importance to Denmark (food and health, environment and energy – which are for instance reflected in the IC and DSF strategies).

European Research Area

The Danish government has played in instrumental role in the development of the ERA. During the Danish presidency in 2003, the European Research Council Expert Group (ERCEG) was set up as an initiative of the Danish Minister of STI. The key recommendation from ERCEG was that a European Fund for Research Excellence should be established, with an adjoining European Research Council (ERC) to manage the fund. In a recent position paper on FP-7 the Danish government has stated that it is of utmost importance to link the decision to establish an ERC with FP-7. A substantial amount in the vicinity of 2 billion Euro should be reserved on an annual base. The budgetary space for the ERC should come from a doubling of the current 5 billion EU R&D budget at the start of FP-7 (in 2007). Selection of ERC projects should be exclusively based on scientific quality. Seemingly it is thought that the present relatively modest share of Danish research groups in the FP-program is not due to a lack of quality but rather to a lack of interest – hence the stress on simplification of the administrative processes.

3.3 Focus and critical mass of research

3.3.1 Focus

Focus at the level of the federal government

Both in the restructuring of the Danish STI system and in the national Globalisation strategy the issues of critical mass and focus and valorisation play a prominent role and are closely connected. The Globalisation strategy gives a clear and pivotal role to research and innovation. It could be regarded as a concerted effort to focus public and private research on those areas in which Denmark wants to play a leading role in the world or, in other words, to achieve (or maintain) mass tout court in those research fields (e.g., biotechnology and nanotechnology) that matter in the world. It has been argued that the choices for these fields are not particularly original and do not distinguish Denmark from many other countries. On the other hand, if Denmark wants to be the best in the world it should exactly focus on the areas that are on the top of the global research agenda.

The focus on research and innovation per se assumes substantial improvements in the STI system across the board. Hence the objectives of the Strategy is to have top education, top research, top entrepreneurship, and top innovation. These ambitious objectives were initially not accompanied by a significant increase in public funding. Instead the key instruments are to improve the efficiency of public spending on education and research, and to increase competition and internationalisation in the Danish economy as a whole. It was only after a lot of political pressure that the budget will eventually be increased in the short run.

Although the Globalisation Council eventually came up with a massive list of policy recommendations the focus is very much on the functioning of the national system of innovation, rather than the content. Thus with regard to focus in research it does not define concrete research directions but rather the process of the selection of these directions. One of the recommendations is that once every four year a catalogue should be compiled of themes for strategic research, based on a broad-based survey into new (global) societal and business developments as well as the capabilities of Danish research institutes to meet these needs. This is directly inspired by the strategy of the Innovation Council. But whereas the latter has resulted in the establishment of a number of concrete consortia around specific societal needs (the emergent 'multi million industries') the actual content for the strategic public research (DSF and the Foundation for High-Tech Development – the right column in Exhibition 2) is derived from an earlier foresight exercise which was actually the sole survivor of the comprehensive growth strategy of the previous government ('DK21')[44]. The research agendas from DSF and the Foundation are not very well adjusted to each other – some informal coordination occurs but there is still al lot of overlap. Although recently a co-ordination body has been put into place ('Danish Research Coordination Council') is has no official decision-making power and has so far merely functioned as an advisory body to the government.

As for the list of policy recommendations – the heritage of the one-off exercise of the Globalisation Council – there is no priority among the items and no formal mechanism in place to monitor the progress in the actual implementation of the recommendations[45]. Right now the follow-up on the list is very much in the hands of the Ministry of Finance (...) which will decide how much budget will be allocated to which recommendation. Whatever the choices of the Ministry of Finance, the further implementation of the Globalisation strategy will face substantial resistance in the Parliament because the traditional ally of the Conservative party (the right-wing nationalist party) is strongly opposed to the overall aim of the strategy to tie public research to industry needs.

Focus at the level of research groups

One of the main trusts of the Globalisation strategy is to introduce more competition within the public research sector. An increasing part of public research funding will be tied to a

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[44] For instance, the five key areas (green technology, sanitation, pervasive computing, medical & health technology, nanotechnology) are neatly reflected in the selection of the IARPs from DSF. Further research in these fields is also supposed to come from the Foundation for High-Tech Development

[45] This monitoring of the progress has now been taken up by the Innovation Council. As a private think tank is has no formal role in the evaluation process. However since it is allied to a widely read national magazine it can exert considerable political influence via that channel.

limited number of big demand-driven research projects. The allocation of these funds is based on an open competition between research groups. This competition is either directly between research groups or indirectly via the institutions of which they are part (see 3.1.3).

The basic idea is that competition will bring about bottom-up consolidation. Research groups can only survive if they are part of bigger strategic agglomerates, and they are only admitted to such agglomerates if they both meet certain quality requirements (that is, if their research is up to international standards) and their research agenda/profile fits the overall profile of the agglomerate.

Although the actual outcome of the strategy is yet unknown many research groups are already anticipating on the industry-driven and much more competitive environment. For instance, the government has announced that it will decrease the share of basic funding from 65% to 50%. Currently it appears that a majority in the Parliament is against the proposal. Nevertheless, at the institutional level there is a fear that there will be financial consequences if the plans of the government are opposed. Thus in reality the national strategy plays an important role even if there is no direct incentive (or punishment) for institutions at the moment.

The aim to limit the number of research directions – and to tie them to industry needs – is diametrically opposed by the strategy of DFF and DG (the agencies in the left column of exhibit 2). During the last couple of years fundamental public research has basically been starved out of funds[46]. Rather than concentrating the scarce resources on a selected number of recipients DFF has explicitly decided to give shorter and smaller research grants to a larger number of research groups and researchers – 'survival funding'. Their argument was that from a long perspective it would be unwise to close down high quality research centers and groups. It is exactly the variation in basic research that gives Denmark the flexibility to adapt to changing circumstances[47]. The strategy of the DG is more selective than DFF. Nevertheless its focus is not driven by industry need but by scientific excellence and it still supports a wide range of research initiatives (e.g., 30+ Centers of Excellence).

Ironically, now that there will be more money drummed into the system as a whole – and everyone has sufficient money to survive – DFF can transcend the short-term survival strategy and bring some focus in its budget allocation (e.g., longer and larger funding for the "peaks in the plateau"). This also implies a shift from short-term individual to longer-term institutional support. During the last years, universities were really tight on their budgets. They are fully funded from (shrinking) public funds and had no other means to attract funding (e.g., charging tuition fees, attracting private funding). Basic research is an obvious candidate to cut off, and esp. non-core activities such as travelling abroad. DFF had to fill the gaps. But the intention is that universities shall take over now.

To sum up, the trust of the government strategy is to shift money from universities to firms and from basic to applied research and development. The basic instrument is to introduce competition by defining a limited number of industry-driven clusters. However with the exception of IC's 'multi million industry' consortia it is not yet clear how these clusters will look like. Meanwhile the overall increase of public research expenditure

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[46] At the end of the 90's, several funding channels have been closed but no new ones have been put into place. Ever since then up until now public expenditure has remained constant. Meanwhile there has been some crowding out by education.

[47] For instance, the survival of the Arab language center came in very handy at the time of the cartoon crisis earlier this year – also and especially for industry needs.

enables DFF to bring a focus in its budget allocation which is exactly opposite of the government's industry-driven focus and DG to extent the number of Centres of Excellence.

Focus at the level of institutions

the 2003 University Act gives universities a greater degree of self-governance and institutional autonomy. For instance, a proportion of the funds that are currently awarded to individual researchers and research groups will instead be allocated in competition between universities. In these competitive bidding processes universities can submit proposals for large-scale, long-term research projects. Furthermore, these grants should fully cover the costs of the institutions and not just partly. In other words there are few prices to be won but those that are on the market are big ones. To give the management of universities more clout in the strategic selection of research and education activities, the University Act has also changed the managerial system of universities. Each university now has a board of external members which appoint the rector. Deans and heads of departments are also appointed instead of elected and collegial bodies are abolished. Furthermore universities are now allowed to attract additional external funding, for instance by establishing elite Master's programs (and raise tuition fees) and advanced training courses in private enterprises. They can also pay highly talented researchers in a flexible way, and hire 'super professors' with independent management responsibility.

At the same time, one of the key topics is the sustainability of many small institutions in changing framework conditions with increased internationalisation, interdisciplinary approaches and demands on quality development and cooperation with the private sector. All these trends require an increase in scale (see also 3.3.2). Thus although universities enjoy greater degrees of autonomy then before they are simultaneously forced to use this new freedom to form strategic alliances with other universities, GRIs (see hereafter), or firms.

The joining up of GRIs with universities actually goes much further than strategic alliances. One of the key recommendations of the Globalisation strategy is that GRIs should be integrated in universities. The merger of the GRIs with universities is supposed to give the latter a more market-oriented outlook. The other way around, the research of the GRIs should underpin the study programs at the universities.

All in all there will be a major consolidation in the Danish public research sector, with (most of) the 16 GRIs dissolved into the (12) universities and the remaining entities competing in a limited number of shifting grand coalitions.

3.3.2 Mass

Mass tout court

The Globalisation strategy obviously aims at creating mass tout court. It is a comprehensive strategy to focus the entire STI system – not just research – on a coherent way on a number of strategic areas. Whether other countries are also investing heavily in the same areas seems to be of lesser importance. The overall aim of the strategy is to come up with science-driven solutions for a number of societal problems that are equally important to a large number of countries (e.g., sustainable energy, safe food, aging). In this respect the Globalisation strategy gives mass to the STI system as a whole – it wilfully and purposefully uses the STI system to reap the full benefits of globalisation and to be(come) one of the most competitive nations in the world.

Critical Mass

Critical mass is a big issue in Denmark. Not only will the GRIs be absorbed within the universities, the resulting entities will in turn be merged into six universities. This is mainly for efficiency reasons – it is assumed that the operation will generate substantial cost-savings – and partly to get more focus – e.g., the synergy that will presumably occur between the applied research from the former GRIs and the fundamental research at the universities[48].

One of the recommendations of the Globalisation strategy is also to set aside a special research grant pool in the state budget for investments in large-scale, shared research infrastructures. Hitherto there was no investment in such mega-infrastructures because they were too large to be borne alone by an individual university. The establishment of such infrastructures underpins the consolidation of the public research sector.

At the level of research groups, the grant award procedures of both DFF and DSF will be revised with the aim of increasing the proportion of large, long-term research grants. The stress on multi-disciplinarity and professionalism also favours bigger groups. For instance, inspired by the wish to obtain more EU-funding DG is pushing research groups to organise themselves into a more structured form (such as a Centre of Excellence). Parts of DG's funding will therefore be allocated to the management of research rather than the research itself. Based on the experiences with the current Centres of Excellence, it is thought that the establishment of dedicated administrative units will foster collaboration between research groups, both at a national and international scale. In the latter case, the administrative units will enable the strongest Danish groups to be the driving forces in network association processes within the FP-programs, for instance to be the main contractor in Networks of Excellence rather than just a minor subcontractor (as is often the case right now).

3.4 Valorisation of research results

There is general consensus in Denmark over the fact that public research should be better linked to private development – although how that should exactly be done is still hotly debated. Bridging the gap between public research and private development is of course closely related to the issue of valorisation: how to get most value out of research. In the Danish context, value is not limited to the narrow economic interpretation. The Globalisation strategy has both an economic ("strong competitive power") and a social aim ("strong cohesion") aim. Indeed the overall drive of the strategy ("to be among the most attractive countries in the world to live and work in") refers to a rather broad societal interpretation of value.

Having said this, it should be noted that Nordic countries have always allocated relatively high proportions of their research to social development and services. During the period 1996-2001 (thus under the previous government) Denmark put even by far the highest priority to social development and services in comparison with any other country. However since the conservative government came to power the attention paid to this research area has decreased drastically in the Danish budget allocations. Nevertheless healthcare and to a lesser extent environmental issues remain high on the national research agenda. This is not only driven by a broader societal demand. The Danish industry (e.g., Novo Nordisk) has strong commercial interests in the further development of these particular areas. The

[48] The robustness of the efficiency claims remains to be seen. The merger is basically limited to the combination of several boards into one – no physical concentration is involved. Thus the presumed returns to scale will be fairly limited.

same can be said about the relatively strong presence of social sciences in the research agenda. This is mainly due to the prominent position of user-driven innovation programs which combine engineering science and business economics with anthropology, ethnology, psychology, and design. 'User-driven innovation' is not just a fad but a particular strength of the Danish culture on which its industry can capitalise[49].

Especially since 2001 the recognition that the relationship between public research and private development should be significantly strengthened has been on the top of the political agenda. Recurrent themes in recent policy documents are:

- Strengthening co-operation between knowledge institutions and the private sector;
- Strengthening the transfer of technology between knowledge institutions and the private sector;
- Improving commercialisation of research results in public knowledge institutions;
- Increasing the investments in R&D, especially in the private sector;
- Strengthening entrepreneurship.

These objectives have been translated into several concrete large scale initiatives, most notably the Act on Technology and Innovation (2002), the University Act (2003), the Action Plan for Public-Private Partnership (2003), and the Action plan from DSF (2004).

The Act on Technology and Innovation is a framework act for a number of initiatives fostering innovation, in particular: Technology Service – GTS, Technology incubators, Industrial innovator Scheme, Industrial researcher-scheme, Innovation Post Doc, Centre contracts, Regional growth centres and Technology foresight. The Act aims specifically to facilitate:

- Co-operation and dissemination of knowledge between knowledge producing and knowledge using institutions and companies.
- Innovation, development, diffusion, utilisation, and commercialisation of research results, new technology, organisational and market related knowledge.
- Start-up and development of knowledge and technology-based companies.
- Provision of finance and competency for knowledge and technology-based companies.
- International co-operation on utilisation of knowledge and technology.

In the University Act, dissemination of research knowledge to society is added as the third mission of universities, in addition to research and education. IPR is one of the key ingredients of this knowledge transfer. Already in 1999/2000 the Law on Inventions was changed in such a way that patents based on academic research belonged to public research institutes (universities, GRIs) rather than to individual researchers/employees. In return universities and GRIs are obliged to promote the commercial use of the inventions. This has spurred the establishment of patent offices at universities. However soon after that a major conflict between a group of researchers and a Danish based international company arose which has effectively halted progress for years. Only recently the Minister

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[49] The Innovation Council has particularly pointed at the unique trait of the Danish culture to continuously generate *social* innovations (rather than technological ones, RtV): "[through history], this human and social ability to innovate has created a number of movements and institutions that have provided – and continue to provide – a unique Danish competitive edge. The folk high school movement secured political and, in turn, economic stability in a period of political revolution in Europe; the cooperative movement was an effective response to America's cheap agricultural output; the labour movement paved the way for un upgrading strategy that has produced the world's best educated workforce; and the welfare movement activated women, so that Denmark today has the world's highest participation rate. These are social innovations that all rest on a view of humanity involving respect, competence, and collaboration."

of STI and the Danish Conference of Rectors (the new style appointed ones, see 3.1.3) have drafted guidelines for co-funded research projects. The guidelines are to work as a check list for which matters shall be regulated in cooperation agreements between universities and private businesses.

A recent evaluation of the 1999 Act of Innovations at Public Research Institutes revealed that IPR remains a weak spot in the Danish IST system. The findings showed that overall the GRI – just like the universities – have not yet been able to establish effective support structures for the commercialization of public inventions. The 'multi-million industry' consortia from the Innovation Council are also very much plagued by the same problem. IPR turns out to be one of the major challenges in the establishment of proper legal structures for the consortia.

The Action Plan for Public-Private Partnership on Innovation ('Turning science into business') is mostly directed towards SMEs. The programme has a budget of €37 million. Further, a substantial tax deduction (50-150%) has been introduced and can be obtained only by companies collaborating with public research institutes. The plan focuses on six areas:

- cooperation on research and innovation;
- access to competencies;
- commercial utilisation of public research;
- improvement of framework conditions for universities' interplay with society;
- public research; and
- access to qualified technological service and counselling.

Despite the bold title the Action Plan does hardly contain any new elements. Most of the steps are already taken in other initiatives (esp. the previous two Acts). It is yet too early to assess impact of the Action Plan. The latest trend figures on the performance of GTS institutions (2003) showed a growth in annual turnover but a decline in the number of SMEs collaborating with the institutions. Thus the policy measures to improve relationships between SMEs and public research institutes (at least when measured at the interface layer of GTS) do not seem to be very effective[50].

The recently established Council for Strategic Research (DSF) might play a crucial role in creating more focus in strategic research and in improving the valorisation of public research. Immediately after its conception it has published an Action plan ('Research that counts') of which the most relevant measures are:

- to identify research that can lead to value-generating (...) innovation for the Danish society in order to ensure that Denmark has the necessary knowledge mass (...) and innovative power in the short and long run;
- to select proposals for the Innovation Acceleration Research Platfoms (IARPs). These platforms are established in areas in which Denmark has internationally recognised business environments, internationally competitive business clusters, and a clear need for research-based solutions and opportunities for technology-based innovative breakthroughs (see 3.3.1.);

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[50] An audit of business incubators at universities had a slightly more positive outcome, with three out of eight incubators performing well compared to some international best practices. However the incubators seem to be caught in a chicken and egg situation. They need a good entrepreneurial infrastructure to thrive but at the same time play an important role in the very development of such infrastructures. In the case of the three incubators that performed well a relatively mature entrepreneurial infrastructure was already in place.

- to run initiatives to build up so-called Centres for Strategic Research that focus on collaboration between public research institutes and society in general;
- to map the use and need of Danish research institutes for research infrastructure, and to recommend strategies for collaboration and prioritisation of research infrastructure (see 3.3.2.).

Again, it is too early to evaluate the effectiveness of the set of measures. In terms of participation, at least the IARPs are a major success, with over 200 proposals submitted in a relatively short span of time.

3.5 Conclusions

From a glance, the current Danish S&T policy seems to be exceptionally coherent with a strong shared vision and a clear division of labour between the various key actors. There is a broad consensus that public research should be geared towards the needs of the private sector. The Innovation Council matches the (long-term) research needs of the Danish industry with emerging global trends and translates these into concrete policy recommendations. The policy recommendations are forwarded to the Globalisation Council which defines the strategic research agenda (of Council for Strategic Research and the High-Tech Foundation). The consolidation of the public research sector and the simultaneous introduction of more competition for funds finally will force the universities to increasingly orient their research agendas towards strategic research. Ultimately, then, all actors in the STI system are working closely together to reap the full benefits of globalisation and to make Denmark one of the most competitive nations in the world.

At closer distance, reality strikes back. The Innovation Council has been quite successful in establishing a number of consortia which do connect global societal needs and particular industrial strength of the Danish industry. Yet this is a rather isolated effort, based on the track record of the Innovation Council (read: Mandag Morgen) to set up public private partnerships. It remains unclear how and to what extent the concept of the 'multi million' industries is linked to the rest of the national strategy.

The Globalisation Council appears to be the central actor in the implementation of the national innovation strategy yet it is only a temporary institute. During its three years of existence it has not translated the recommendations of the Innovation Council into a concrete research agenda but has rather focused on process – the functioning of the STI system as a whole – rather than content – the elaboration of a national strategic research agenda. The one-off exercise has resulted in an extensive list of recommendations to improve the functioning of the national STI system. What the concrete follow-up of that one-off exercise will be remains to be seen. The items of the list have not been prioritized which basically leaves it in the hands of the Minister of Finance to decide. Also there have been no formal instrument put in place to monitor the actual implementation of the recommendations.

The actual formulation of the national strategic research agenda is very much driven by a foresight exercise which is a leftover from the innovation strategy of the previous government and which has been done largely in parallel to the activities of the Innovation Council. The research agendas of DSF and the High-Tech Foundation do neatly reflect the results of the foresight exercise. Hence there is some focus here – but it is not (at least not directly) derived from the national strategy.

Much to the credits of the Globalisation Council it has managed to make R&D one of the top national priorities but to a certain extent this has had a perverse effect on the attempts to gear public research to industry needs. Under much political pressure the strategic importance attached by the government to R&D had eventually to be accompanied by a significant increase in the funding of public research. This partly offsets the attempt to introduce more competition into public research and will for instance enable basic research funding agencies to built their own strategic agendas which are rather geared towards scientific excellence rather than industry needs. The assumed link between strategic research and fundamental research thus appears to be rather problematic. There is also much less of a shared vision on this matter than was initially thought. Whereas the government wants public research to be tied to industry needs, the opposition – including the usual ally of the ruling party – stress the importance of independent public research.

In short, there seem to be at least three loci of focus in the Danish research landscape (MMIs, IARPs, CoE). None of these three is directly related to the strategy of the Globalisation Council and there is also little co-ordination between the three areas. There is also no common policy on EU research programs. So far the decision to initiate participation in these programs has been left to individual researchers and research groups. DSF, which is supposed to deal with the EU dimension, pays little attention to the area.

The policy issue of valorisation is largely parcelled out in a similar way. The bold definition of innovation by the Innovation Council ("something new with a market value") is certainly not shared by DFF and the NRF. Whereas the Innovation Council explicitly states that many public research institutions are not carrying out "research of any real use" DFF for instance argues that the true value of basic research to society is exactly not being tied to concrete industry needs. Thus while in the growth strategy from the Globalisation Council and the Innovation Council the ability to quickly adapt to changing global circumstances is said to come from the focus on a limited number of strategically chosen application areas, DFF and NRF have argued that flexibility comes from keeping open as many as possible research directions – provided that excellent research is being done.

Although it remains to be seen to what extent the globalisation agenda has brought focus to the Danish research and put forward a common understanding of valorisation, with regard to critical mass it has brought about a major consolidation of the public research sector. One of the few recommendations of the Globalisation Council that has already been followed up is the merger of government research institutes with universities. In a second step in the consolidation process, the number of universities will be reduced to six by the end of 2006. This process has predominantly been driven by economic motives (efficiency, returns to scale). Whether the organisational concentration also leads to more synergy and/or focus depends on the position of the research groups and individual researchers. The crucial issue is to what extent the management of the universities, that has increasingly been brought under control by the government, can in turn control the research groups. The position from 'the managers' vis-à-vis 'the researchers' has certainly been strengthened ever since the early 2000s. Much depends on the ability of the government to redirect money from basic funding to strategic research, and from researchers and research groups to universities.

The Danish government policy is based on the idea that it is not possible to get the most out of public research without having focus and mass. However, this view is currently discussed in Denmark and so far there has been no documented evidence for the beliefs that bigger is better, that competition raises quality, or that increased strategic steering will yield greater outcomes of the public investments in R&D.

4. Finland

4.1 Introduction

Within a decade after it saw one of the worst recessions any European country has seen[51] (triggered by the collapse of the Soviet Union), Finland worked itself to the top of the league tables: the most competitive country in the world, first in the world on educational performance, second-highest share of R&D spending in the EU (after neighbour Sweden). During the second half of the 90s GDP expanded at an annual rate of nearly 5%. These were the heighdays of the 'Finnish miracle'. With the global downturn in 2001 economic activity slowed down significantly – although it remained steady above the EU average. GDP growth has however picked up again after 2004 and it currently increasing rapidly. Furthermore, due to its prudent fiscal policy, Finland has been running proportionally the biggest fiscal surplus in the Euro area for years now. Thus concerns that the Finnish miracle might be collapsing under its own success seemed to be premature, and there is still unconditional support for the model.

The success of the Finnish model has been caused by an extreme focus on high tech and high knowledge. Even in the depth of the recession, when construction companies hammered by lost Soviet contracts begged the government to bail them out, Finland chose instead to spend its money on retaining technology workers. The strong focus on high-tech – with the incredible performance of Nokia as its impressive showpiece – came at a price. High unemployment remains a structural trait of the Finnish economy, especially among low-skilled and older workers, and growth of labour productivity per worker has remained relatively low[52]. Also, the high-tech driven economic growth has been concentrated in a few areas that already have a relatively strong economic base[53]. In short, although the socialist system has mediated some of the negative effects of the high-tech growth strategy slumbering social unrest remains a threat to the Finnish model. Despite the continual top scores in international competitiveness rankings and relatively good economic growth figures over the past decade, the standard of living in Finland is only on an average level among the industrial countries[54].

The high-tech side of the success story also has some structural flaws. The commitment to research is not fully reflected in terms of creating innovative products and especially services. The current National Reform Program (NRP) therefore aims to broaden the innovation policy to the service sector. However, although the gap between value-added in high-tech and medium/low-tech manufacturing is also growing the NRP continues to strive for increasing excellence in cutting edge research. Although the relative proportion of

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[51] In 1991 and 1992, GDP *decreased* with 7% and 4% respectively. Unemployment rose to a staggering 20% in 1993.

[52] The unemployment rate has stayed at a constant 9% for years – also during the height of the miracle -- although it has lately declined slightly.

[53] More than 70% of all R&D spending is in one the two growth regions in the south (Helsinki and Tampere) or in the north (Oulu).

[54] GDP per capita in PPP (2004, indexed to 100 for the EU25) was 113 for Finland, which shared the modest position with co-R&D champion Sweden (118). Belgium is at 119, Denmark at 122, Austria at 123, and the Netherlands at 125. Switzerland (132) and especially Ireland (138) fare significantly better than the other benchmark countries.

private spending in R&D is similar to that of the other benchmark countries, within private R&D spending the share of the giant Nokia remains exceptionally high.

4.2 Institutional setting

4.2.1 The key players in STI policy

The supraministerial Science and Technology Policy Council (SCTP) – which is widely regarded as the one of the decisive factors in the success of the Finnish model – plays a key role in promoting research, technology and scientific education. It develops and co-ordinates science and technology plans and proposals. The Council is chaired by the Prime Minister – the Ministers of Education and of Trade and Industry are vice-chairs. The Council is further composed of representatives from all other Ministries, funding organisations (e.g., Academy of Finland and Tekes), universities, research institutes (e.g., Sitra), business and industry, and labour unions.

At the ministry level there is a conventional institutional division of labour between the Ministry of Education and the Ministry of Trade and Industry (cf. The Netherlands). The Ministry of Education remit includes education and science policy, whereas the Ministry of Trade and Industry is responsible for industrial and technology policy.

The Academy of Finland, which resides under the Ministry of Education, is a major source of funding for scientific research. Its role is to raise the quality and visibility of Finnish scientific research through competitive funding. Most of the Academy funding is channelled to university research. The Academy finances research projects and programmes, Centres of Excellence in Research, researcher posts, postgraduate education, and international cooperation. The Academy has four Research Councils, which decide on research funding in their respective fields.

The Finnish Funding Agency for Technology and Innovation (Tekes) is under the Ministry of Industry and Trade. With an annual budget of about €400 million, it funds over 2,000 projects and 20 Technology Programmes (see hereafter) per year. About a quarter of its 350 people staff is based at one of the 15 regional Centres for Employment and Economic Development.

Together the Academy and Tekes account for 42% of all public research funding which is exactly the same amount that is allocated directly to universities and state research institutes.

A somewhat different type of public funding agency is the Finnish National Fund for Research and Development (Sitra), which is an independent body directly subordinate to Parliament. Sitra could be regarded as a government-owned venture capitalist. Its main activities are in research and training, innovative projects, business development and corporate funding.

Competitive funding (Academy and Tekes) has experienced by far the strongest growth during the last 15 years. In the period 1991-2005, in real terms funding of the Academy grew with 28% and funding of Tekes with 29% against a total growth of less than 12%. The same figures for universities and state research institutes were respectively 5% and -4%. This trend will continue in the period 2007-2011. According to the proposed budget, from the overall €400 million increase in public research funding, €110 million (28%) will go to the Academy, €145 million (36%) to Tekes, €120 million (30%) to universities, and only €25 million (6%) to state research institutes. In terms of use, the lion share of the €400 million will go to the international Centres of Excellence (€130 million or 33%), with

€60 million (15%) for additional competitive funding and an equal (sic!) amount for basic university funding.

Table 4.1 R&D Funding in the State Budget (2005, € millions)

	R&D Funding	Share (%)
Universities*	455	28.5%
Polytechnics	6	0.4%
Academy of Finland	224	14.1%
Tekes	448	28.1%
State research institutes	259	16.2%
Other research funding	202	12.7%
Totals	1,594	100%

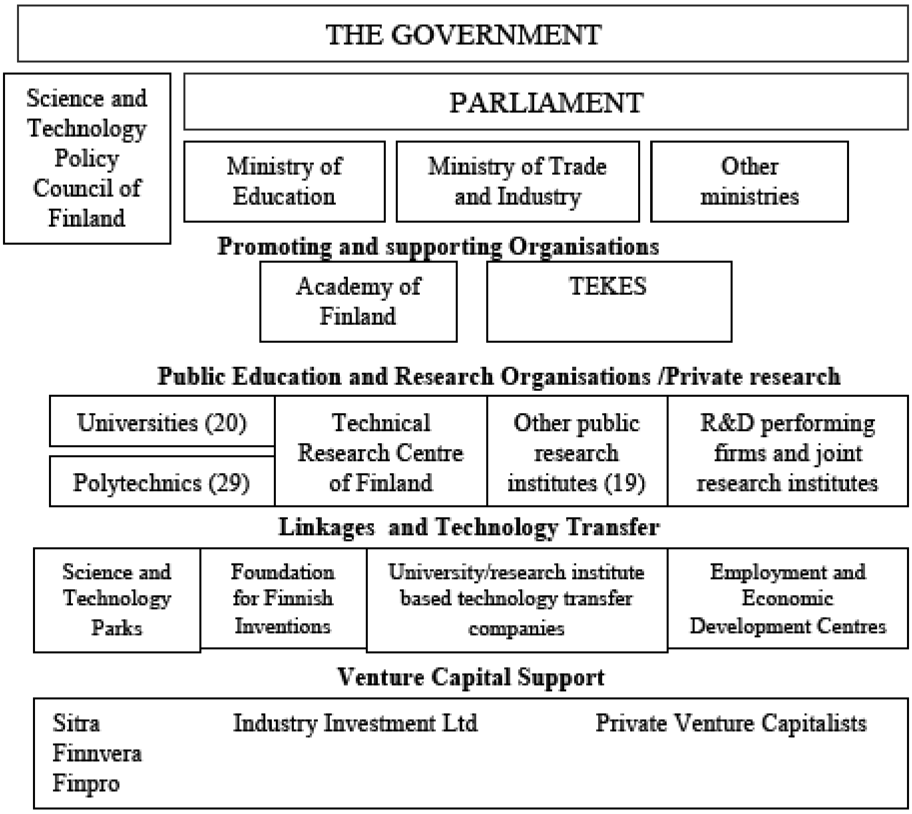
* of which university central hospitals €38 million (2.4%)

Most research is being conducted by universities and state research institutes (of which VTT is by far the biggest). There are 20 universities in Finland. They are all state-owned and spread around the country. The level of university core funding is guaranteed by law. About half of university R&D expenditure comes from sources outside the university budgets. Most of that funding is still government funding – albeit competitive. The division of labour between the Ministry of Education (via Academy and universities) and the Ministry of Trade and Industry (via Tekes and the state research institutes) becomes increasingly blurred down the line. A significant part of university research funding, for instance, comes from Tekes (thus not only from the Academy).

Research by polytechnics has expanded in recent years but its overall share remains modest. Most of the funding from the polytechnics comes from provinces; the contribution of the national government is limited (see Table 4.1)[55].

[55] Polytechnics have only recently been established – the first polytechnic became operational in 1996. The establishment of the polytechnics reflects the aim of the Finnish government to further broaden the national innovation system. The growth of polytechnics has been remarkably fast. Right now there are 29 polytechnics and the total number of students (over 130,000) is already almost on par with that of the universities (about 150,000).

Figure 4.1 Overview Finnish National Innovation System



Source: Trend Chart Country Report Finland 2005

4.2.2 Main developments in STI policy

The national innovation system has a central in the government program (2003-2007) in which the main goal is to further the use of scientific knowledge and technology in development of economy, employment and society in general.

Finland is at the forefront of national innovation system development. As a result of the long-term progress Finnish S&T policy has evolved from irregular activity to an approach, in which policy makers, funding organisations, producers and users of knowledge and know-how are regarded as one entity – the Finnish national innovation system.

A key task of the Finnish STI policy has been to ensure a balanced development of that national innovation system and promote co-operation within it – both in a societal and geographical sense. In all recent policy papers the need to shift emphasis from a narrowly defined S&T policy to a broad-based innovation policy is addressed. In the visions of the future, development of high technology and its broad application in different sectors has a crucial role. Over time, more horizontal, collaborative relations with other societal sectors, such as economic, industrial, labour, environmental and regional policies and social and health care, have already been growing in importance in connection with policy making. The conditions for knowledge-based development are created in society at large, and within different policy sectors, not just within the science and technology policy sphere[56]. Furthermore, with regard to the geographical dimension the role of the provinces and municipalities has been further strengthened[57].

The main focus of the science policy debate in 2005 was on the development of the Finnish public research system and on the impacts and effectiveness of science. The 2005 Government Resolution on the development of the public research structure sketches the future development of the public research structure[58]. Although the Finnish STI policy making system has remained virtual unchanged over twenty years, the gist of the Resolution is that the current policy direction will (still) be continued[59]. The role of the STPC will be further strengthened, positioning it the principal expert body in all major questions of science, technology and innovation policy. Co-operation between the Ministry of Trade and Industry and the Ministry of Education will be further enhanced by strengthening the role of STI policy within both ministries.

For the position of the universities, the Resolution and its adjoining legal amendments might hold significant structural changes. An 2004 amendment to the University Act f[60] assigns universities a duty to interact with society and promote the impact of their scientific and artistic activities on society (see 4.4). This amendment was backed up by an additional one which makes it possible for universities to start up state-owned companies. In terms of focus (or rather the opposite) the Resolution calls upon universities to identify their own areas of strength and to develop the division of labour among themselves (see hereafter, 4.3 and 4.4). According to the Government, this will partly be achieved by an increase in competitive research funding. The vast majority of these competitive funds are either administered by the Academy of Finland or by Tekes.

The Academy of Finland has a range of different funding instruments for different purposes. The most relevant ones for competitive funding are research projects (personal grants to an individual researcher or research group), research programs (a multidiscipli-nary cluster of research projects focused on a defined subject area or set of problems), and 'centres of excellence in research' (a research or researcher training unit that consists of one or more high-level research teams and that has a clear set of common research objectives and work under the same management)[61]. Research programmes are scheduled to run for a set period of time, usually for three or four years. In general, other funding bodies, both Finnish and foreign, are also involved. In 2003, seven new research programmes were launched at the Academy of Finland. These are Systems Biology and

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[56] The broad perspective on S&T is very well reflected in the new research agenda from the Academy. Upcoming (2006-2010) research programs are: (the inevitable) 'Nanoscience', 'Sustainable production' (process industry), 'Sustainable energy', 'Nutrition, food and health', 'Power in Finland' (politics), 'Work, Well-being and 21st century challenges', 'Finnish public health challenges', 'Substance abuse and addictions', and 'Baltic Sea Research' (see ERA-NETs).

[57] Albeit the Finnish STI policy remains centralised, more room is giving to local initiative and regional collaboration.

[58] The Resolution is built on four recent evaluations: on public research institutes; on universities and polytechnics; on intermediaries; and on VTT.

[59] Tekes was established in 1986, STPC in 1987 (being a revamp of the prior Science Policy Council).

[60] No 715/2004 that came into force on August 2005, thus at the same time as the publication of the Resolution.

[61] In 2005, Research projects (including researcher training) accounted for €119 million (54% of the total budget of €219 million), research programs for €17 million (8%), and Centres of Excellence for €28 million (13%). The remaining items are international cooperation (relatively high on €29 million or 13%) and research posts (€26 million or 12%).

Bioinformatics (SYSBIO), Russia in Flux, Future Electronics (TULE), Health Services Research (TERTTU), Social Capital and Networks of Trust (SOCA), Industrial Design, and Environmental, Societal and Health Effects of Genetically Modified Organisms (ESGEMO). A Centre of Excellence may be a unit operating within a university or research institute, or an assembly of units or research teams and researchers working in several different organisations. It may also be operating in collaboration with a university or research institute in the private sector but this is not a prerequisite for funding. There are currently 39 Centres of Excellence (see further 4.3.1).

In 2005, the mission of Tekes was brought in line with the overall shift towards a broader perspective on S&T. 'Innovation' was incorporated in the mission statement – on equal footing with technology. The broader mission has been translated into another organisation structure. Considerable impetus was for instance provided by the setting up of Technology Development Departments at regional Employment and Economic Development Centres that execute Tekes' activities in the provinces. Thus also Tekes has deepened its activities to the regional level. Furthermore, more weight was put on exploiting R&D results (see section 4.4, valorisation). The strategic priorities that follow from the broader mission are also reflected in the definition of the new Technology Programs[62]. Most of these programs are on business-related topics rather than on RTD[63].

All recent innovation policy measures that have been launched also have a strong focus on business development and entrepreneurship. Sitra, the Ministry of Trade and Industry, and Tekes has started a national program for business incubators. YRKE aims to strengthen the resources of Finland's science parks and technology centres. Its primary vehicles are the regional Employment and Economic Development Centres with which Tekes has close ties (see before). The YRKE development project has three main foci of interest: new services, long-term funding and promoting know-how. The intention is to gradually introduce new uniform models throughout the country. In a similar vein, Syöttörahasto (Feeders Fund) is a new capital fund which targets start-up/early-stage companies. It is included in the budget from the Ministry of Trade and Industry and will be run by Finnvera[64.] The Feeders Fund will be the first phase in the implementation of the strategy of the Ministry aiming to reform seed funding and services for new and start-up companies. Sitra's Innovation Program finally aims at improving the competitiveness of Finnish society. The programme brings together major actors to analyse challenges, set goals and implement the required actions. The innovation programme will also draw on international co-operation. The first initiative carried out within the programme frame was the development programme on the competitive innovation environment.

YRKE is just one of the manifestations of a greater emphasis on the regional dimension of the national system of innovation. The 2003 legislation on regional development requires

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[62] Technology Programs are the most important funding vehicle for Tekes (summing up to about €180 million,

over 40% of all its funding). These programs have already been around for two decades and are used to promote development in specific sectors of technology or industry, and to pass on results of the research work to business in an efficient way. On average, about 2000 firms and 800 research units participate in the technology programs each year. At the end of 2005, 25 programs were on its way.

[63] The technology programs under preparation in 2005 were: 'Creative industry', 'Renewed Business and Management', 'Innovative Services', 'From Biotechnology to Industry', 'Ubiquitous IT', 'Customer Sector Solutions in the Software Business;, and 'Networked Production Control Systems'.

[64] Finnvera plc is a specialised financing company owned 100% by the State of Finland. Finnvera is organised as a limited company and operates under the auspices of the Ministry of Trade and Industry.

that both the Government as a whole and individual Ministries prepare plans for regional development. The new legislation recognises the leading role in regional development of the Regional Councils, which represents municipalities. Regional Councils often take advantage of the expertise of the universities and polytechnics in preparing their strategic development plans (Regional Schemes), which usually emphasise innovation related issues. Main vehicles for regional innovation are the Centres of Expertise which aim at creating highly competitive centres of innovation, each focusing on a few fields and collaborating with other centres[65]. Most of the centres are administered in the regions by science and technology park organisations having close connections with universities. At the national level the programme is co-ordinated by a group of representatives and experts from different Ministries and regional bodies. All in all, there are a staggering number of various types of actors involved at the regional innovation level (see paragraph 4.3.2).

4.2.3 Response to EU policy

The Finnish government has allocated additional resources to the internationalisation of the Finnish science community and has highlighted the need to create new kinds of expertise of clusters. International collaboration is not limited to the EU; the relationship with Japan has deepened and new co-operations were established with India, China, and Russia[66]. Finland also works closely with the other Nordic countries on research, most notably under the umbrella of Nordforsk, an independent institution operation directly under the Nordic Council of Ministers for Education and Research[67]. Central players in Nordforsk are the national research councils, other research-funding agencies and the universities. Its key vehicle are the so-called Nordic centres of excellence[68].

Nonetheless STPC thinks the European collaboration is of particular strategic importance. The general view is that Europe’s success in global competition (see also 4.3.2, Mass tout court) will also improve Finland’s development prospects in the long run. It is therefore in the interest of Finland to try to speed up the development of European knowledge and know-how. The Finnish government (particularly the Academy) is highly (pro)active in policy making processes at the EU level, for instance in the further development of the European Research Area.

Lisbon and Barcelona objectives

Total R&D spending in Finland is levelling off but was already at 3.5% of GDP in 2003 – thus well above the EU 3.0% target for 2010. According to the most recent National Reform Program, by 2010 the share in GDP will be raised to 4,0%. At this moment about 70% of total R&D expenditure comes from the private sector, which is also neatly in line

[65] The Centers of Expertise Programme is administered by the Ministry of the Interior – thus neither the Ministry of Education nor the Ministry of Trade and Industry. Currently there are 22 Centres of Expertise and 3 networking arrangements participating in the programme, covering a total of 45 fields that range from nanotechnology to tourism.

[66] Finland also participates in the ERA-NET on China (CO-REACH). Russia is the subject of one of the ongoing research programs of the Academy (Russia in Flux).

[67] NordForsk was established January 1 2005 and replaces the Nordic Science Policy Council and Nordic Academy for Advanced Study, NorFA.

[68] The programme contains five research themes with 3-4 research programs per theme. Current themes are: Food, Nutrition and Health; Welfare Research; Global Change ; Molecular Medicine; Humanities and Social Sciences, see http://www.nordforsk.org/index.cfm?&lid=3. All research programs involve research teams from at least three Nordic countries.

with the EU targets[69]. However the relatively high expenditure on R&D has not (yet) translated into creating more innovative products and services. Although the current National Reform Program (NRP) still aims at increasing excellence in cutting edge research one of the newly added goals is to broaden the successful high-tech innovation policy to the service sector. One of the bottlenecks is the relative absence of competition in the service sector. In sharp contrast to the manufacturing sector services are not particularly internationally oriented and the domestic market is small and rather isolated from the other European markets.

EU Framework Programme

Finland has been extremely successful in the Sixth Framework for Research (FP6). It has by far the greatest number of participations in FP6-project (826), bypassing much bigger member states such as Germany (604), the United Kingdom (530) and France (462)[70].

FP7 will be launched during the Finnish presidency and Finland has stated its intention to ensure its smooth passage. Improving the EU's competitiveness comes high on Finland's agenda. Particular attention will be given to innovation and energy policies. During its Presidency, Finland intends to focus on initiatives that promote effective use of innovation. The Academy of Finland has been charged with the national responsibility for preparing the FP-7 program. It has been actively involved in preparing sub-programmes for health research, the environment and climate change and socio-economic sciences and humanities, and in research infrastructure components, research potential, science in society and activities of international cooperation.

European Research Area

Finland is also very active in the field of ERA-NETS. All activities are coordinated through Tekes and the Academy of Finland[71]. It participated in 15 ERA-NETS and co-ordinated two of them by itself (BONUS and NORFACE). BONUS has a rather local geographical orientation (Baltic Sea Research) but NORFACE – New Opportunities for Research Funding Co-operation in Europe – is a strategic project in the heartland of the EU STI system development. In this regard, the Finnish government wholeheartedly supports the creation of the European Research Council which is thought to open up completely new prospects for supporting basic research that relies on competition and peer evaluation. Furthermore, the Academy of Finland has actively contributed to the formulation of a new (2005) strategy for the European Science Foundation and is strongly endorses its consistent implementation.

During its EU presidency the Finnish government intends to complete the final steps to launch the Framework Programme for Competitiveness and Innovation (CIP), which will run from 2007 to 2013. The CIP will stimulate greater investment in innovation,

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[69] Comparable to Belgium (70%), Denmark (68%), and Austria (67%). Sweden (74%) and Switzerland (76%) are somewhat higher, Ireland (64%) somewhat lower. The Netherlands (58%) is much lower.

[70] The Netherlands is at 403, fellow leader Sweden at 355. This does not imply that Brussels is a cornucopia for Finnish universities. About 9% of university research funding originates from the EU – which is only slightly above other countries. For the establishments of the polytechnics, the EU structural funds have however been an important factor.

[71] It might come as no surprise then that the selected ERA-NETs seems to be closely related to the current research agenda of the Academy (particularly the Research programmes).

particularly at SME level, and is closely linked to other policy areas (energy, IT, research and the environment). In addition to CIP, the Finnish government is also planning to launch – or further – other Lisbon-related policy action during 2006, such as the Research and Innovation action plan and new aspects of SME policy for growth and jobs. They will be announcing the extension of the Living Labs initiative which aims to stimulate the institutional, structural and financial changes necessary for innovation-based growth and Europe's global competitiveness[72].

Technology Platforms

Finland has already experience with 'technology platforms' (aihealuetyoryhma) at a national scale since 1987. These platforms are run by Tekes. In the field of IT alone there are currently about 20 of such platforms active in Finland.

In its 2004 strategy paper on the internationalisation of Finnish science and technology, STPC stresses the importance for Finnish industry to participate in the creation and activities of all European Technology Platforms that are significant to Finland. More boldly stated, STPC argues that such Platforms should be established in all areas that are important to Finnish businesses. In the fall of 2006, 30 Technology Platforms were established – Finland participated in 25 of those platforms[73].

4.3 Focus and critical mass of research

4.3.1 Focus

Focus at the level of the federal government

The general frames for the national research, technology and innovation policies are set in the Government's Programme document on the one hand and on the other in the triennial reviews of the STCP. At the implementation level, major influence is exercised by the largest public financiers of R&D — Tekes, the National Technology Agency, and the Academy of Finland, which funds basic research. In particular, Tekes, largely through its own active approach, has a powerful position in setting guidelines for the national technology policy. It has been argued that the technological expertise of the Tekes staff is one of the reasons for Tekes' strong position in technology policy making. Also, Sitra has

[72] Living Labs is a framework for implementing the Lisbon goals. Such laboratories exist outside the traditional 'clinical' setting, in real-life settings, which represents a major shift in the whole process of innovation. This is seen as a natural move for ICT and the life sciences: both innovation systems dealing with human and social problems. Living Labs are the creation of Public Private Partnership (PPP). Firms, public authorities and people work together to create, prototype, validate and test new services, businesses, markets and technologies in cities, regions and virtual networks made up of public and private stakeholders. This 'real life' approach – with authorities and citizens fully involved – is meant to stimulate and challenge research and development, as well as contributing to the process of innovation. There are already 12 Living Labs sites in Europe, China, India and Brazil. The projects will identify, prototype, validate and test new ICT services and technologies. In the 5th call of FP-6 DG InfoSoc has allocated €40 million to pilot a European Network of Living Labs.

[73] That is an overall (high) participation rate of 83%. However Finland has a striking absence in alternative technologies (Hydrogen and Fuel Cell Platform, Photovoltaics, Zero Emission Fossil Fuel Power Plants), sustainable chemistry, and agriculture (Plants for the Future). The absence in those areas is almost perpendicular to the policy focus on energy (EU presidency, one of the five international centres of excellence), sustainable development (overall focus, e.g., Tekes) and the strong base in agriculture (e.g., forestry, biotech).

substantial means at its disposal in national terms and, as a fairly autonomous actor under the auspices of the Parliament, has an influence on Finnish innovation policy making. All the three mentioned agencies have their own strategies for funding priorities and conditions. Nonetheless there is a lot of informal coordination since the inner circle of key people that are involved in the STI policy making process is small and there is frequent interaction.

The 2005 Resolution calls upon the Academy of Finland, Tekes and Sitra to join forces with other funding agencies in an attempt to increase the impact of research and innovation funding. The aim is to create larger operating units – so-called 'clusters of expertise'. STPC has appointed a steering group to oversee the drafting of an expertise cluster and an infrastructure strategy. The steering group was chaired by the president of the Academy. Key recommendations of the group are to establish (five) international centres of excellence in the fields of energy and environment (e.g., sustainable energy), metal products and mechanical engineering, forestry (e.g., comprehensive utilisation of timber), health & well-being (e.g., aging, gene diagnostics), and ICT and services (e.g., services for the future information society)[74]. Furthermore, the steering group proposes that the Ministries of Education and of Trade and Industry appoint a committee to chart the existing national research infrastructure (e.g., equipment, collections, databases) and its needs for its reform and development, and to evaluate long-term infrastructure needs in key research areas. Also, the Academy of Finland and Tekes should jointly arrange recurrent application processes for research infrastructure proposals.

In 2005, the Academy and Tekes joined forces to launch the first ever (sic!) foresight project in the field of STI policy. The FinnSight 2015 project examined the change factors that have impact on Finnish business and industry and on Finnish society, identified future challenges of innovation and research activity and analysed such areas of expertise which will foster the well-being in society and the competitiveness of business and industry by means of scientific research and innovation activities. The focus in foresight was on social and global issues[75]. FinnSight will lay the foundation for the Strategic Centres of Excellence in Science, Technology and Innovation. Simultaneously, foresight will reinforce strategy work at the Academy of Finland and Tekes.

Focus at the level of research groups

The national centre of excellence policy is aimed at raising the goals and quality standards of Finnish research and at increasing its international competitiveness and exposure and the esteem of research. Centre of excellence programmes are open to all disciplines. One of the key objectives is to promote interdisciplinary research. Units appointed to the programme are research and researcher training units that consist of one or more high-profile research groups that are either at or very close to the international cutting edge in their own field of expertise. They will also share a clear set of objectives and work under the same management. A centre of excellence may operate within a single university and/or research institute but usually spans multiple organisations[76]. Funding for centres of

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[74] See before: one third (€130 million) of the additional €400 million public research funding in the period 2007-2011 will go to these international Centres of Excellence.

[75] The FinnSight exercise involves more than 120 experts from industry and academia. They work in 10 different panels: learning/learning society; services/service innovation; welfare and health; environment and energy; infrastructures and security; bio-expertise/bio-society; ICT; understanding and human interaction; materials; and the global economy.

[76] The value added and synergy benefits of working as a Centre of Excellence as compared to running separate units without a coordinated management is explicitly mentioned as one of the selection

excellence in research comes not only from the Academy, but also from the host organisations of the units concerned, Tekes and various foundations (such as Sitra). In addition to this regular contractual funding, most units have other sources of national and international funding. Centres of Excellence are not regarded as loose, virtual networks on top of existing collaboration and funding structures. The principal rule is that researchers involved in the Centres of Excellence are not eligible during their term to receive funding through the Academy's call for applications for general research grants.

Centre of excellence programmes are administered and coordinated by the Academy of Finland in close collaboration with the National Technology Agency. The Academy monitors the work and operation of centres of excellence in research, drawing upon experiences gained and upon recent international trends in further developing its international centre of excellence policy (see before). In the second term of the national centre of excellence program (which runs from 2006-20011) 23 centres have been appointed[77]. Only 7 of these centres are new – the others were already funded during the first term (2000-2005). The major chunk of the funding is from the Academy (about €29 million per year), with minor additions from Tekes (€2 million per year) and Nokia (€0.3 million per year).

After the broadening of its mission and the subsequent reorganisation Tekes has also adopted a more focused strategy. The strategy outlines eight thematic areas – three key generic technologies (the usual suspects, with nanotechnology substituted by the more generic material technology), four key application areas, and one overarching area which connects all other areas ('competence in the networked economy').

The more focused strategy has directly been carried through in the latest round for Technology Platforms (2005-2010). Although changing demands have led to increasingly diversified technology programmes (e.g., not only focusing on technology but also on business operations) the number of programmes has been fallen during the past decade. This trend is only further strengthened by the new Technology Strategy (see also 4.3.2).

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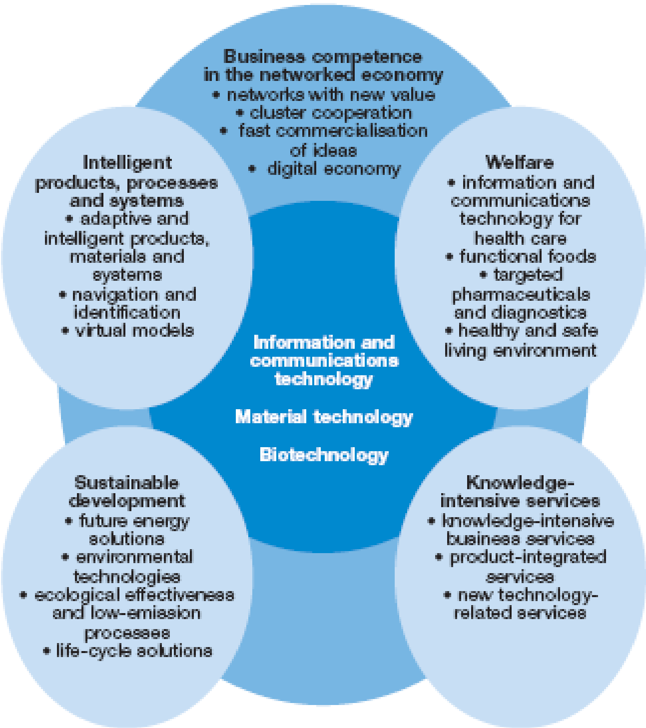
criteria in the application procedure. Furthermore, the closeness of cooperation between researchers in the research teams to attain common objectives is considered, as is the critical mass typical in the field of research.

[77] The Centres are rather evenly spread over all academic fields, with surprisingly few on engineering (2) and ICT (2) and many on medicine (6) and biology (3). The other fields were physics (5), arts (2) and social sciences (3).

Figure 4.2 Thematic Areas of Tekes' new Technology Strategy



Focus at the level of institutions

Focus on the level of institutions is thought to arise bottom-up and is only indirectly steered by priorities set at the national level. The autonomy of the universities has been (and will be) significantly increased over the last couple of years. The 2005 Resolution calls upon universities to identify their own areas of strength and to develop the division of labour among themselves (see 4.3.2.). According to the Government, this will partly be achieved by an increase in competitive research funding, esp. targeted at national development projects (e.g., the five international centres of excellence).

The effect of the stronger emphasis on competitive funding will be limited by the fact that the existing university core funding will remain unchanged. Thus there is no substitution of core funding by competitive funding. Given the current pressure on the research funding of for instance the Academy (see 4.3.2.) the increase of competitive funding could be regarded as a measure to lessen the gap between demand and supply for research funding, rather than an attempt to bring more focus on the university research agendas. That is very much left to the universities themselves.

4.3.2 Mass

Mass tout court

The Finnish government (i.e., the STPC) has a well-rounded view on the position of the Finland as part of the global community. The STI policy (or in essence the overall development strategy as a whole) is embedded in this perspective. According to STPC, what Finland needs above all in order to be able to compete for researchers and research resources, projects and business enterprise research and development with other countries is quality. On the other hand, Finnish players must be equipped to take part in and make use of cooperation openings.

The key lessons learned from the success in the nineties is that success in creating innovations is a key asset for both enterprises and societies. There is an open, constantly growing international competition for innovations and their producers. Speed and flexibility, together with high-standard knowledge and know-how, are a strategic advantage in this competition. Countries which have these assets – such as Finland at the moment – have an edge on others in seizing the opening opportunities. In the case of Finland – as a small welfare society with a rapidly aging population and a strong basis in traditional industries (pulp and paper, machinery) the challenges of globalisation are particular momentous. The capacity for renewal and improved productivity are a precondition for keeping production and jobs in Finland.

The challenge of internationalisation is thought to go both ways. Activity in developing international cooperation also increases opportunities in the domestic setting since dynamic operational environments have international appeal. Thus the overall aim of the Finnish STI policy is to bring about a virtuous circle. Active international opening will yield the best results if one has an equal input in cooperation. On the other hand, the requisite for equality is participation in expanding cooperation. The ever advancing internationalisation of Finnish industrial R&D and the increase of Finnish investment abroad have so far not lead to a decrease in domestic activity. On the contrary, internationally successful companies (such as Nokia) have often increased their domestic activities as well – but it remains of course to be seen whether the co-evolution of international and national private R&D-activities is a permanent or a transitional phenomenon (see the introductory section).

Critical Mass

In spite of the greater resources made available in the 2005 Resolution on the structural development of the public research system, competitive research funding is in an increasingly difficult position because the continuing qualitative and quantitative growth of the Finnish science community means that competition for funding is increasingly fierce. For instance, no more than 10-20% of applications for funding at the Academy can be accepted[78]. A considerable number of research projects has to be turned down although they have excellent scientific ratings. In short, the demand for research funding grows faster than the supply – the Academy and Tekes together simply lack sufficient critical mass to provide for all researchers in Finland[79].

A similar pattern seems to emerge for education. Each year there are over 150,000 applications for scholarships at universities (BA/MA-level) from which less than 30,000 (17%) are eventually admitted. The tough entry selection at the state universities could be a blessing in disguise for the regions. The polytechnics, which are strongly focused on their

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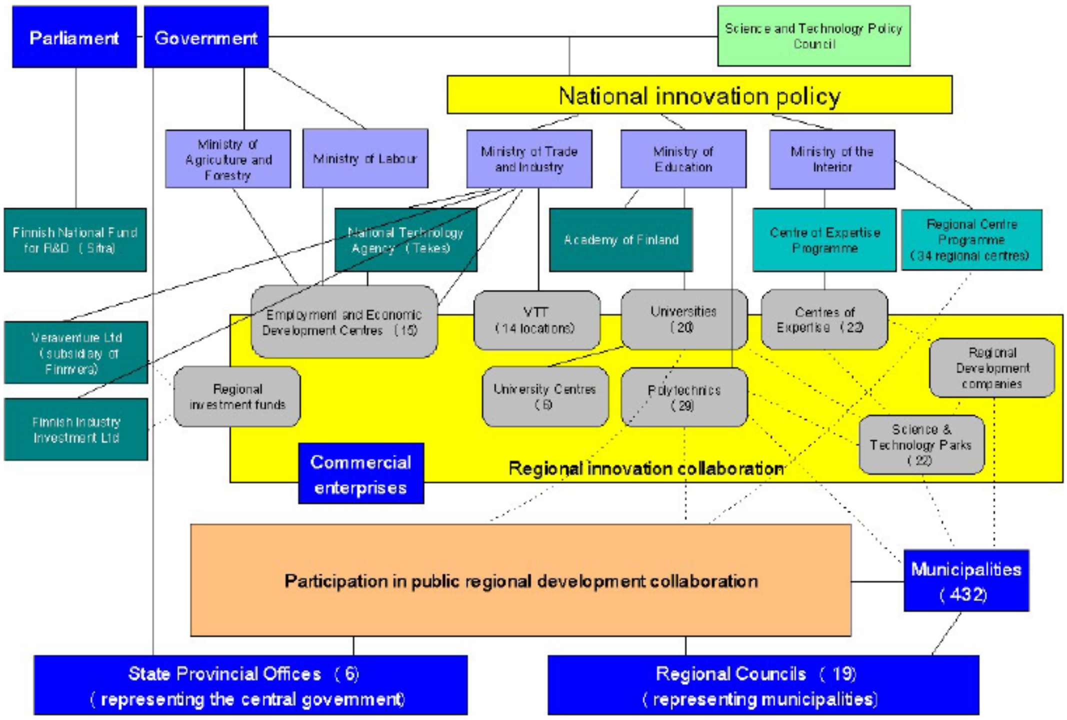
[78] This is despite the fact that the growth of funding for the Academy and Tekes has been almost 30% over the last 15 years.

[79] Finland has been the only EU member state where scientific careers steadily have attracted a growing share of young people. Given the high degree of competition at home one might expect a brain drain to other countries (esp. countries with a higher standard of living for researchers) but this is not the case. Finns are extremely stay-at-home. Brain drain is minimal compared to any other EU country and is not considered as a policy problem.

own regions, are fed by a constant stream of rejected students. Whether the same can be said about research is doubtful.

If the thesis of the rejected students holds, they are at least nicely distributed across the country. There are an incredible number of institutions involved at the regional STI level. On a population of 5 million people, there are 20 universities, 29 polytechnics. Furthermore there are 22 science & technology parks, 22 regional Centres of Expertise (under the Ministry of Interior), 16 Employment and Economic Development Centres, and 14 regional branches of VTT. The Finnish government clearly takes the regional deepening of the national STI-system serious. There is obviously a lack of critical mass at the regional level.

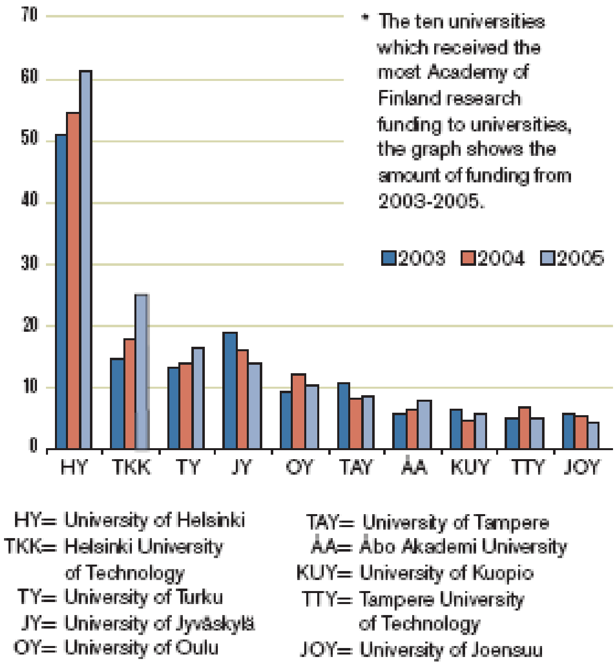
Figure 4.3 The Finnish Regional System of Innovation



Having said this, it should be noted that 8 out of the 20 universities are located in Helsinki (and 3 in nearby Turku), and that within the 8 universities the Technical University of Helsinki (TKK) and especially the University of Helsinki (HY) are by far the biggest. In 2005, the latter university alone received 37% of all research funding from the Academy. HUT received 15% (up from 8% in 2003), Jyväskylä[80] 10%, and Turku 9%, leaving less than 30% to the remaining 16 universities.

[80] Jyväskylä is in central Finland, north of Helsinki and Turku.

Figure 4.4 Distribution of Academy funding over universities (2003-2005)



Source: Academy of Finland (2005)

The policy direction to give more autonomy to the universities and simultaneously to put more focus on competitive funding seems to work in favour of the big universities. But this is a very slow process. Furthermore, although there is a widely-shared opinion in the Finnish academic community that the country needs just one or two top universities (e.g., HY and HUT) where the research talent should be concentrated, this would go against the very egalitarian Finnish culture. But at least, in the 2005 Resolution on the structural development of the public research system, it has been explicitly recorded that the higher education system will not be expanded anymore. Also, it is mentioned that measures will be taken (by the Ministry of Education) to ensure and promote the impact, quality, content and efficiency of units by means of larger, focused resource entities, stronger networking and more effective management and performance evaluation. University management, strategic planning and research administration will be stepped up and research will be assembled into larger entities with a view to more synergy and a larger number of critical masses and multidisciplinary research entities.

Although the overall size of the core university funding will remain unchanged (see 4.3.1) a larger share of that funding will be allocated on the basis of educational and research quality. The general increase of the quality levels might, in combination with the stronger emphasis on multidisciplinary (and thus bigger) research groups, eventually lead to the situation that the smaller regional universities are no longer viable and will either be merged with neighbouring polytechnics are disappear altogether.

With regard to the (shared) national research infrastructure, the STPC steering group has recommended the Academy of Finland and Tekes to join forces when funding infrastructure proposals (see also 4.3.1). Furthermore, the steering group argues that the share of the overhead expenditure of the Academy of Finland should be raised, so that it can better used to cover maintenance and development costs of the university and research institute infrastructures. Obviously this requires more public funding.

The more focused strategy of Tekes has also led to a significant increase in the mass of the Technology Programs. Whereas the number of Programs has continued to decline, the overall size of the Programs has sharply risen[81]. Since the absolute share of Tekes has remained more or less constant the leverage of Tekes has greatly improved[82].

4.4 Valorisation of research results

The lack of an entrepreneurial culture remains one of the weak spots of the Finnish STI policy. The relatively high expenditure on R&D has not (yet) translated into creating more innovative products and services. The exclusive focus on technological innovation has been a sounding success and was instrumental in tackling the severe depression in the early nineties. More recently though it is explicitly been recognised (e.g., by STPC) that technological innovation needs to be supported by effective social innovation in all sectors of society. In reverse, without social innovation the benefit of technological innovation will remain at least to some extent untapped. There is a key role for the Finnish government here, it is regarded as a central task for the public sector in a knowledge society to develop and maintain basic prerequisites for innovation in the broader sense, that is, creative innovation environments.

In the Finnish policy, universities, polytechnics and public research institutions play a central role in the establishment (and operation) of such creative innovation environment. From a companies' standpoint, the profound knowledge found in the public research institutes are a critical factor for cooperation. The importance of strategic basic research has therefore been reinforced in the official STI policy ever since 2001. However, the role of public research institutions in the knowledge society is widely regarded to be more active and dynamic than merely providing training people and providing knowledge . An 2004 amendment to the University Act assigns universities a duty to interact with society and promote the impact of their scientific and artistic activities on society[83]. This so-called 'third mission' forces universities to actively reach out and to actively promote the utilization of the knowledge that they generate.

The third mission of public research institutes is directly linked to the issue of regional development, which is regarded as the top priority in the overall development plan for Finland. Thus, at the regional level, tight clusters of universities, polytechnics, (regional branches of) GTI's and regional development centres (see figure 4.3) are positioned as the engine of technological and social innovation and economic growth. The third mission now also makes public research institutes responsible for developing regional knowledge potential and for making knowledge and know-how available to users through collaborative

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[81] The average total costs of the projects almost doubled from €63 million (2002-2007) to €118 million (2005-2010). The average duration of the programs also increased (from 4,3 to 4,8 years) but the average share of Tekes in the programs declined (from 60% to 40%). One explanation is that the absolute shares of Tekes did not grow as fast as the absolute increase of the total costs. Thus in the two biggest projects in the 2005-2010 period (€237 and €202 million) Tekes' shares were respectively a meagre 7% and 5%.

[82] In absolute terms, funding for Tekes has remained constant during the period 1999-2003 but has increased since then with an average annual growth rate of about 5%. This is probably in line with the development of the overall state funding for R&D (alas no recent figures available yet).

[83] No 715/2004 that came into force on August 2005, thus at the same time as the publication of the Resolution.

effort (e.g., through intensified co-operation with local business and industries and by facilitating the transfer of expertise to working life)[84]. Owing to a longer tradition, universities have more extensive and more effective contacts with business enterprises than polytechnics. On the other hand, lack of business activity in a region may have the consequence that a university remains less embedded in the region than a polytechnic. The policy challenge is to match the development of dynamic innovative, and attractive research environments with regional development. This is directly linked to the issue of critical mass and focus. Higher education units must be sufficiently large and versatile to achieve their broader aims. The Ministry of Education has proposed to further structural development of the national higher education network. Within that national structure, universities must carry on defining their profiles (see 4.3.1), and smaller polytechnic units must be compiled into larger multi-field entities. Universities and polytechnics have been summoned to draw up joint regional strategies. Furthermore the Ministry of Education has also decided to enhance the regional impact of polytechnics by designating more centres of excellence in regional development.

The 2004 amendment of the University Law was backed up by a long-awaited overhaul of the 1967 (sic!) IPR regime. Two important changes were made. First, the new legislation makes it possible for universities to hold company shares – yet prior formal permission from the Ministry of Education is still required. The new rules provide universities with a number of possibilities to diversify their activities as well as strengthen their relationship with the private sector[85]. A key question remains the role of university personnel in the commercial firms. This issue is at least partly addressed in the second change, which concerns the ownership of university-inventions. So far, in the absence of a legal framework, such inventions remained with the inventors[86]. The new legislation will not only cover university researchers and teachers – who had been exempted from the existing Employee Inventions Act – but also all other persons employed by or in the service of all institutions of higher education – including polytechnics[87].

If the regional clusters of public research institutes are to be functioning as dynamic innovative research environments – and thus as hotspots for regional activity – they need to be attractive as a work and study place for promising young researchers since without these young researchers the institutes cannot maintain their dynamism and capacity for

[84] The Academy of Finland for instance aims to encourage researchers at universities, research institutes and business companies to "work together in flexible international communities that carry out high-level research and development projects and provide researcher training to benefit all the parties concerned." The Academy has two funding instruments that are intended for promoting cooperation between research organisations and business companies: grants for the doctoral studies of employed persons and grants for researcher mobility in working life.

[85] For instance, universities could establish separate technology transfer units and spin-off companies that would be responsible for non-academic functions, so that they can focus on their core activities (education and basic research). So far, five proposals for the setting up of companies have been submitted to the Ministry of Education. As yet no favourable decision has been made. Some universities invested their funds in research-driven companies, while others boosted their science and enterprise park cooperation. All in all, the new legal possibilities have not yet lead to major commercial initiatives.

[86] This is not a unique legal set-up. In all other Nordic countries and Germany the same exemption for university staff members applies.

[87] The new legislation does not change the principle that the invention right belong by default to the inventor (in case the university or polytechnic staff member) but does state that institutions should always be notified of an invention. This at least ensures that new inventions are effectively monitored and administered, and that the institutions would be granted a right to take up such inventions in certain cases by virtue of law.

contact renewal. Ultimately, this concerns the question how an institute promotes the education of good teachers and researchers, their career prospects within the institutes, and their recruitment outside the university. The current Centres of Excellence of the Academy are the exemplar here.

The proposed operational model for the earlier mentioned international centres of excellence are also in line with the new university legislation. STPC has recommended to set up the centres as non-profit limited companies. This offers the opportunity to flexibly implement various kinds of co-operation with the same structures. According to STPC, operation under the limited company model clearly prescribed the roles and responsibilities of the various parties involved (e.g, shareholders, strategic partners etc.) and the limits of liability.

It is important to note that the turn towards a more commercial structure for public research institutes and a deepening and extension of the links with the private sector is not detrimental for public funding of basic research – rather the opposite. STPC states explicitly that the best results in competitive funding are achieved when long-term core funding is in order (cf. 4.3.1). A large-scale knowledge reserve, a capacity for exploiting the scientific opportunities available and the capacity needed for renewing education in response to even weak signals require vision, courage and initiative, as well as material resources for rapid response. The implementation of the national strategy entails that university core funding is increased as part of the development of a humane information society. Core funding should for instance be used for post-doctoral education and for the placement of young PhDs (e.g., in networks of excellence). Whereas in most countries the increased ratio between private and public research funding would be hailed (certainly considering the high absolute volumes), in Finland the decline of the share of public funding is considered detrimental in many ways (for instance, because it raises concerns about the internationally small proportion of public research and development in the whole of business enterprise research and development)[88].

4.5 Conclusions

The success of the Finnish model has been impressive. Within a decade it brought the country from a deep recession to the top of the world league. The success of the Finnish model has been driven by an extreme focus on scientific excellence and high-tech development. There is still unconditional support for the model, and despite its obvious disadvantages (most notably the high structural unemployment and uneven regional economic development) the National Reform Program (NRP) refused to compromise on the basic line of increasing excellence in cutting edge research. This is also backed up by the unchallenged investment in basic research and core university funding, and by a genuine worry about the decline of the relative share of public expenditure on R&D (although relatively big in absolute terms).

The policy makers in Finland – groupthink or not and despite the presence of foresight exercises – are very aware of the drawbacks of the high-tech model. Regional development has now top priority and is explicitly linked with a broader perspective on the STI strategy (for instance, establishing regional knowledge clusters and making universities responsible for regional development). At the same time, the Finnish national STI strategy is clearly placed in a global perspective. So far the ever increasing rate of internationalisation has

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[88] Share of public funding in total research funding has been fallen from 21% to 10% in 2005, against 57% and 70% for the private sector (rest is funding for higher education, RtV). However, the 70/10 split has remained more or less constant since 2000.

only lead to more rather than less domestic activity. The challenge is to spread this domestic activity (more) evenly across the country, and for instance to use it to upgrade and/or revitalise the traditional industrial clusters (pulp and paper, heavy machinery) in which Finland has a strong basis. So far much of the success of the Finnish model has accumulated in a limited number of regions, notably the Helsinki, Oulu, Tampere and Turku and has especially been linked to electronics and to a lesser extend biotechnology.

The Finnish model has not been characterized by a focused effort on specific scientific and/or industrial areas. It was rather based on increasing scientific excellence across the board. There is fierce competition for education and research funding but this is not because there has been a shift from basic funding to competitive funding but because the total number of students and scientists has significantly increased over the years. The shift towards a broader perspective on STI (witnessed for instance by the introduction of the third mission for universities, and innovation as second pillar for Tekes) has not diluted the constant striving for scientific excellence and quality. So far the general increase of the level of education and research seems to have successfully trickled down from academia (for instance, because polytechnics functioned as buffers) but it remains very much the question whether or when the strong egalitarian Finnish culture will be a hindrance rather than a stimulus for further development.

In discussion of regional development in Finland, the basic unit most often used is the traditional province. But if the subject is the development of high-level knowledge and know-how this causes problems: dividing a small population of five million into 20 still smaller sets (provinces) does not necessarily offer a good basis for national or region-based development. In the regional development strategy the nexus for regional clusters of excellence therefore comprises several provinces. Meanwhile the traditional division based on provinces could still apply to polytechnics. A further hierarchical division of labour could thus be envisaged in which half a dozen universities operate at the supra-regional level (focusing on scientific excellence), and 20 polytechnics at the province level (focusing on the valorisation of research). The crucial question then becomes how to optimize the vertical links within the overall innovation system, and especially the links between the universities and the polytechnics. One important contributing factor to the establishment of regional polytechnics, the Structural Funds from the EU, will largely fall away with the entrance of the new member states.

The scientific basis for the supra-regional knowledge centers could be provided by the five proposed international centres of excellence. The areas chosen for these centres (energy & environment; metal products & mechanical engineering; forestry; health & well-being; ICT & services) are strategically positioned at the crossroads of the existing industrial structure, acknowledge scientific strengths, and relevant societal areas. The new technology policy of Tekes is also more or less aligned to these strategic areas but the national centres of excellence are clearly not. The latter are predominantly selected on their scientific merits[89]. They are however presented as exemplars for regional knowledge clusters and they might, in the longer run, lay the foundation for the establishment of new regional industrial clusters.

Much of the additional funding from the Academy and Tekes will go to the international centres of excellence. The operational models of the centres will be shaped along the lines

[89] Nevertheless, in the selection criteria for Centres of Excellence, both societal relevance and effectiveness of the research (e.g., patents) and the effects of the research unit on the advancement of research potential in its immediate vicinity and transfer of know-how outside the unit are explicitly mentioned.

of the new legislative framework for universities (i.e., non profit limited companies). So far the greater autonomy and the commercial space that has been given to universities has not resulted in much new activities but the measures have just recently been implemented. The litmus test would be to see whether universities will venture into commercial activities at all, and if so, whether they will adhere to a strict separation between basic research and commercial activities.

5. Flanders

5.1 Introduction

Belgium is a Federal State composed of communities and regions[90]. In practice, this means that each of the federalised entities exercises the powers granted to it by the constitution in their territory. Each entity is autonomous and there is no hierarchy giving the Federal government the right to intervene in matters devolved to the communities or regions. With regard to the topics of this case study, the three regions (Brussels-Capital, Flanders and Wallonia) have competence over almost all policy levers influencing innovation activity in enterprises (with the exception of fiscal powers and some aspects of intellectual property rights policy which are retained by the Federal State); the three communities (Dutch speaking, French speaking and German speaking) have competence over a.o. education matters, including university research. There are therefore at least two (separate) innovation systems in Belgium.

For this case study we will focus on Flanders (approximately 6 million inhabitants), where the governing bodies for the Flemish Community and the Flemish region have merged into one government. Some basic R&D figures are included in table 5.1 below.

Table 5.1 Some basis R&D figures for Flanders 2001-2003

	2001		2002		2003	
	%	M€	%	M€	%	M€
GNP (running prices)		145.068.800		148.852.100		160.097.305
GERD (constant prices)	2,47	3.292	2,28	3.062	2,18	2.972
BERD(constant prices)	1,87	2.493	1,66	2.237	1,55	2.116
GOVERD (constant prices)	} 0,6	227	} 0,62	254	} 0,63	232
HERD (constant prices)	}	539	}	549	}	591

Source: Vlaams indicatorenboek 2005

[90] As defined in Article 1 of the Belgian constitution.

5.2 Institutional setting

5.2.1 The key players in STI policy

The Flemish Science and Innovation Governance System is quite logically constructed. Coordinating Minister for innovation is the Minister of Economy, Enterprise, Science, Innovation and Foreign Trade (who is also Vice-minister-president). The other important minister in the innovation area is the Minister of Education, responsible for the universities. Almost all the other ministers have some science, technology innovation expenses in their budgets, but these are relatively small amounts (in total less then 10% of government expenses).

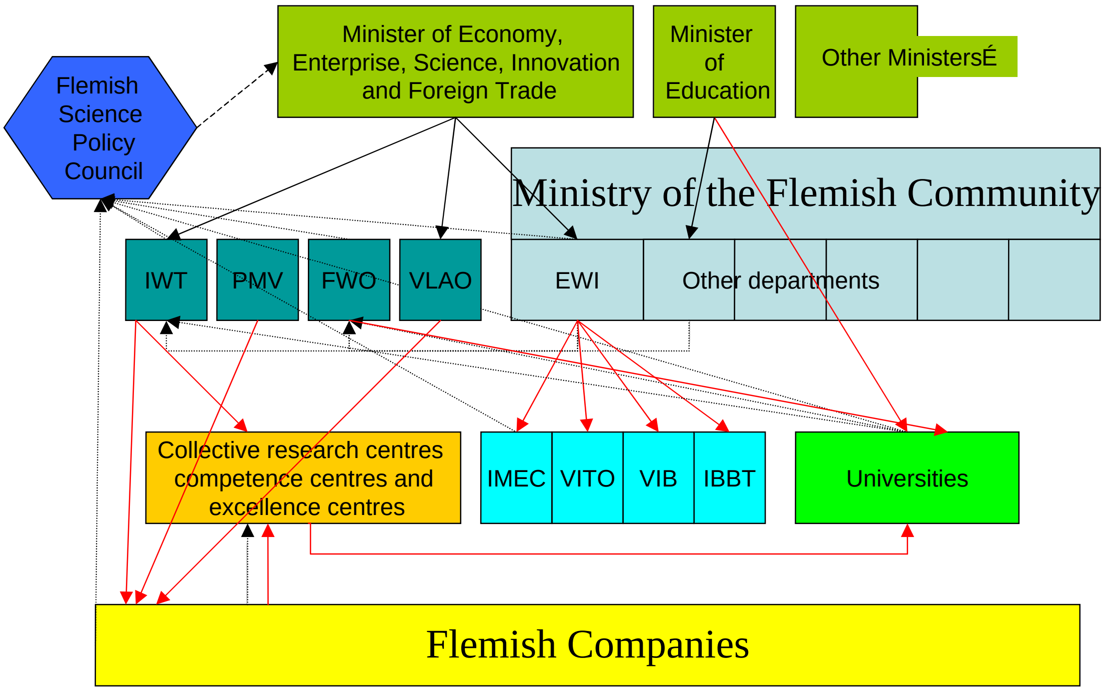
At administrative level there is one ministry in Flanders with several departments. From 2006 onwards the administrations responsible for Economic Policy and Science and Innovation Policy have merged into EWI, the administration for Economy, Science and Innovation. Its task is mainly in policy design and policy evaluation. The focus of EWI is on the research side of innovation, including the international programmes. It is also responsible for the management contracts with the large research institutes (IMEC (microelectronics); VITO (environment and materials); VIB (biotechnology); IBBT (broad band technology)).

The universities have a rather autonomous position: they receive approximately 2/3ds of all government funding for ST&I, and have full autonomy over almost 90% of their budget from the government (M€900/yr). The tradition of university involvement in governance boards (of research institutes and government organisations), and other representative forums (like 'expert' committees for subsidy programmes) is also very strong, so the university rectors and research coordinators have a very influential position in the area of science and innovation.

IWT is the agency for innovation and has more of a focus on the industry and valorisation side of innovation. It is directly responsible to the Minister. EWI is represented in the board of IWT, as are representatives from the universities. IWT has a budget of approximately €220 million (2003, including €11 million operating costs). IWT is also an important source for policy ideas and policy initiatives. Apart from the innovation support activities of IWT, more general support measures or grants for companies located in Flanders are monitored by the economy administration of Flanders (see http://www.vlaanderen.be/subsidiewegwijzer) or the Flanders Holding Company (www.pmvlaanderen.be). Other sources of aid to companies include the long-term equity investments managed by the Flanders' Investment Company, GIMV, the Flanders Business Angels Network (BAN Vlaanderen), or the Flanders Foreign Investment Office (FFIO, http://www.ffio.com). FWO-Vlaanderen is the agency for fundamental research. The universities and the ministries are represented in the board. VLAO is the Flemish Agency for Enterprise.

On the research performing side the universities are the largest players, followed by the four research institutes already mentioned. In the science area there are also 7 scientific institutes that are performing research for policy needs. Their budget is now €60 million/year. Furthermore several collective research centres and competence centres have been set up. These will be discussed in the chapter on focus and mass.

Figure 5.1 The Flemish Innovation System



5.2.2 Main developments in STI policy

Since the early the 1990s Flanders region began to make serious efforts in setting up and implementing the responsibilities in the area of STI policy they had acquired since the federalisation of Belgium. Although there was a science and technology policy at Belgian level before 1989, the Flemish Government started more or less from scratch in order to be able to organise STI governance in the most effective and efficient manner. The universities (who were the element of continuity in the change to a regional innovation system) seized the opportunity to strengthen their already strong position further, while especially in the innovation area a completely new governance system was set up.

Innovation policy in Flanders has, as in most regions, three strands: science policy, technology policy and economic policy. These policy areas are becoming more and more geared to one another. Science and innovation policy were already the responsibility of one administration (AWI: Administration for Science and Innovation), and since the merger of this administration with Economic Support division of the Economy administration in 2006 these domains are becoming more and more integrated. Since 2004 these domains are falling under the same Minister.

At present the Flemish Government spends €1486 million (2005, Indicatorenboek 2005) on science, technology and innovation policy. From this amount approximately €1050 million, is spent in universities and university related research institutes.

Direct university funding (‘universitaire werkingsmiddelen’) is the largest part of the government funding for universities. (€592 million of which 75% is used for education, and 25% for research and development activities (i.e. salaries for staff who are allowed to do research on their own initiative).

Indirect university funding consists of the BOF (Special Research Fund), FWO Vlaanderen (Organisation for Fundamental Scientific Research) and IWT's scholarships programme.

The BOF (at present M€98, a joint responsibility of the Minister of Science and the Minister of Education) is funding directly given to the universities (distribution based on input parameters and scientific output parameters) and then spend on research priorities of the universities themselves (so based on strategic considerations, not on the initiative of individual researchers). Financed by BOF is the Methuselah programme which was started in 2006 in order to provide top level researcher with long term (7 years) financing, in order to give them the opportunity to focus all their attention on research and not on the yearly search for financing. Each university can nominate a researcher (with a research project). International scientists evaluate the proposals based on scientific excellence.

The FWO budget is at present €129 million (2005, mainly coming from the government). The only criterion for assessment of subsidy applications is scientific excellence. In 2007 a new, structural, budget for investments in large research infrastructure will become available (Hercules Fund, size not yet known).

IWT scholarships for PhD students account to €20 million.

The core of the innovation governance system is IWT Vlaanderen. IWT (based on a federal predecessor) was set up in 1991 and started out (as was then in fashion all over Europe) with a number of fairly broad, but technology specific programmes in the areas of materials technology, information technology, biotechnology and environmental technology in the so-called 'Impulse-programmes'. Furthermore there were more generic programmes for scholarships for PhD students and other programmes for the Higher Education Sector. Funds for research in the universities became partly transferred by FWO Vlaanderen. The largest part of government expenditure on R&D remained, as was the tradition in Belgium, the direct transferral of government funds to the universities.

In the mid 1990s when the funds of the impulse-programmes had run out, a change was made from more or less specific programmes to generic programmes with no restrictions with regard to sectors or technologies. By this change the Flemish government wanted to give excellent researchers and entrepreneurs more space for operation and more room to differentiate themselves from other countries in the world that were also focussing on life sciences, information technology, environmental technology and materials technology.

The scholarship and other Higher education sector oriented programmes remained horizontal.

This does not mean these areas were forgotten, however a more structural and focused approach was chosen instead of the bottom up approach from the 'impulse programmes': the set up of large focused research institutes. In the area of microelectronics the research centre IMEC had already been set up in 1984. IMEC was supplemented with initiatives in the areas energy, environment & materials (were the non-nuclear research activities from the former federal Belgian institute for energy research were transferred to the new Flemish Institute for Technological Research (VITO) in 1991, and an initiative in the area of Life Sciences (the virtual research institute VIB, Flemish Interuniversity Institute for Biotechnology, which started in 1996).

Since then the Flemish policy with regard to innovation has not fundamentally changed, although a last research institute IBBT (on broadband technologies) was added in 2004.

On policy level innovation is becoming more and more important as a driver for economic development, while application of R&D-results (in other words: valorisation) becomes more and more important in the technology policy area.

The overall innovation policy in Flanders is set in the Policy Note 2004-2009 Economy, Enterprise, Science, Innovation and Foreign Trade from Minister Moerman that was published at the start of the present Flemish Government in 2004. This policy note is in line with the policy note on Science and Technology Policy 2000-2004 from the former Government. Top priority of the Policy note (and of the Flemish Government in general, as stated in the Flemish coalition agreement) is 'More enterprise, more employment'. Flanders wants to be in the top five of European regions in terms of growth of the number of enterprises by 2009, and create an administrative environment that is in line with that aim. Innovation is, stated as being a horizontal policy issue that will be embedded in all policy domains.

The note is greatly inspired by the Lisbon and Barcelona objectives that placed innovation more central in the national debate as will be stated in the next chapter.

Recently (July 2006) the Flemish government published an evaluation of their first two years in office, and reconfirmed the importance of innovation in the policy note 'Flanders in Action'. Flanders in action does not announce new policy measures in the area of innovation policy: it sums up recently introduced programmes and programmes under construction. It however raises awareness and reconfirms the important position they see for innovation in all policy areas and the way the government itself works, and it also starts a specific political discussion on the range of policy instruments for innovation.

5.2.3 Response to EU Policy

Lisbon and Barcelona objectives

The Lisbon and Barcelona agreements led to a broad discussion in Flanders between government and social actors on the necessity of action and the possible ways to act. The resulting outcome of the discussion was the so-called 'Pact of Vilvoorde' of 2001, an agreement of the Flemish government and the social partners (employers and employee federations) in order to meet the Lisbon goals.

In the science and innovation area the following goals are mentioned:

- To further the development of Flanders in becoming an entrepreneurial society. The number of companies and the number of start-ups should increase continuously. The performance of Flanders should, in this respect in 2010, be comparable to the performance of the best performing neighbouring country.
- The continuous dynamism of the Flemish economy is in 2010 characterised by an increasing growth of small and medium sized enterprises. The percentage of gazelles (fast growing medium sized enterprises) should increase systematically (original target was doubling of number of gazelles in 2010).
- To be among the most competitive locations for foreign companies (investment quote should be increasing again, and in 2010 at least at the level of 2000)
- Doubling of the number of start up companies from the Flemish knowledge institutes (including universities) and realise 25% of turnover by Flemish companies from new products and services by 2010.

These goals are further elaborated in the Innovation Pact between the Flemish Government, companies, and representatives from Flemish universities and knowledge institutes of 29 March 2003. This pact states that, among others, the government expenditure on R&D will be increased further (the increase was started in 1996) in order to be at the Lisbon level of 1% government expenditure. It foresaw a yearly increase in the budget for science and innovation with at least EUR 60 million until 2010. The increase of the budget between 1995 and 2004 was 175%. In total all Flemish Ministers will spend

€1418 million on science policy of which €848 million on R&D. In 2005 €55 million was added to the science and innovation budget (structurally) while also €75 million will be made available for financing of innovation by means of risk capital. However, the increase in government expenditure was by far not enough to match the decrease in business expenditure on R&D.

Education is an important topic in all these documents, in order to secure adequately trained employees, both in the short as well in the long term. Sustainability is also more or less integrated.

Lisbon and Barcelona targets do, in this way, provide the base for Flemish innovation policy (as well as for many other policy domains).

EU Framework Programme[91]

The Flemish participation in the EU framework programmes is shown in table 5.2.

Table 5.2 Flemish participation in EU Framework programmes

	Flemish participation (M€)	Flemish participation (%)	Just retour (%)	Univer-sities (%)	Research Institutes (%)	Com-panies (%)	Other (%)
FP3		2.58	2.0-2.4				
FP4	273.4	2.38	2.1-2.3	41	24	29	5
FP5	282.9	2.20	2.1-2.2	42	27	27	3
FP6 (2006, 32% of budget)	122.4	2.16	2.1-2.2	31	42	23	4

Although Flemish participation in the EU Framework Programmes increased in absolute terms since FP3, relative participation (the percentage of funds that is spent in Flanders) decreased gradually from 2.58% to 2.16% in FP6 (first 32% of budget). The participation of companies is stable in absolute terms, but decreases in relative terms. The participation of universities decreases very strongly (in absolute and relative terms in FP4, compared to FP5). Research institutes have become the backbone of Flemish participation in FP 6. This is caused by the leading position of IMEC in the field of microelectronics, the nuclear research within SCK and the growth of participation of VIB in the field of biotechnology.

Together with 'Policy Research' and 'Science and Society' these three areas are also the strong areas of Flanders in EU research.

The relation between regional research priorities and FP participation is clear. Especially in the area of biotechnology it can be shown that a decrease in FP participation (from FP2 towards FP4) was turned around after the start of VIB in 1996.

[91] Participation in FP4, FP5 and FP6, based on analyses by EWI.

Technology Platforms

Technology platforms do not play a role in policy documents in Flanders.

EUREKA

Belgium is the third largest investor in Eureka as when the budget for Eureka projects is compared to GDP with 0.05%. In absolute terms Belgium is the fifth investor in Eureka, taking into account 6% of the Eureka budget of ongoing projects (data from The Impact of Eureka, 2005). Since in Belgium Flanders is a relatively large participant in the 'standard' type of Eureka projects and a dominant participant in the Cluster projects it can be said that Flanders' presence in Eureka is prominent[92]. This prominence is for a large part caused by the participation of IMEC (and related companies) in micro electronics clusters like ITEA and MEDEA.

5.3 Critical mass and focus of research

As has been stated above the universities have a very strong position in Flanders. Some 2/3 of government budget for STI (M€1050 of M€1500) is spent in universities. Universities or individual researchers within universities determine the destination for most of these funds (estimate 60%). The distribution of 30% is almost completely based on scientific excellence (and in the case of SBO valorisation potential see below) as evaluated by external organisations like FWO and IWT.

Only 10% (the funds spend by way of VIB and IBBT and the research for policy support) has a thematic approach.

The scientific policy in Flanders (with regard to universities) can therefore be characterised as almost completely horizontal, and focus and mass do not play a prominent role in policy making at government level (apart from the already mentioned BOF and Methuselah programmes which are aiming at realising critical mass and focus based on scientific excellence, and which are programmes where the universities play an important role in the appropriation of the funds).

The main instruments of innovation policy in Flanders are also of generic nature: there are no specific R&D programmes for certain technologies and sectors. In the policy documents focus and mass are not mentioned explicitly until recently when a report from the Flemish Science Policy Council proposed a list of 30 priorities for technological research in Flanders, and a frame of reference for using these priorities in government innovation initiatives[93]. This report may play a role in the recently announced integral evaluation of the Flemish innovation policy[94].

Implicitly however the funds for the 4 research institutes (of which 2 are virtual (VIB and IBBT), and involve research in universities) can be seen as a way to create focus as well as mass on specified topics.

Table 5.3 shows the budgets for the research institutes, and the resulting additional budgets that are generated by the institutes.

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[92] Vlaams Indicatorenboek 2005, Steunpunt O&O statistieken, 2005

[93] Expertgevalideerde prioriteitsstelling inzake technologie en innovatie in Vlaanderen, Aanbeveling 29, VRWB, 22 juni 2006.

[94] Flanders in Action, 2006.

Table 5.3 Budgets of research institutes in Flanders

	Government Budget (2005, k€)	Total research (2005, k€)
IMEC	35.033	196.624
VITO	33.022	60.634
VIB	30.366	59.875
IBBT	17.000	Approx. 34.000
Total	115.421	361.000

Sources: Speurgids 2006; Annual reports 2005 IBBT, IMEC, VIB, VITO

In total the government budget for the four research institutes of €115 million has generated research within these organisations of €361 million, and concentrates therefore more than 10% of Flemish research in only four research institutes.

Since VIB and IBBT are virtual institutes where all, respectively 50%, of research is carried out in universities this has also an effect on focussing university research.

A relevant programme is the Odysseus programme. In this programme top-level scientists with Flemish roots, but at present doing research outside Flanders, and excellent foreign researchers, are offered a grant to return/come to Flanders and set up a top-level research group in a Flemish university. The grant is 400-1500k€/y for five years. The budgets are rather small (M€11 in 2006), so that only a very limited number of researchers is supported (1-2 each year), but the return of a researcher may have a large mass effect on the specific research topic in Flanders (e.g. the return of professor Catherine Verfaillie within this programme gave a large impetus to stem cell research in Flanders).

Another programme whose primary effect is creating mass in certain areas in university research (that are defined in a bottom-up way) is the IWT programme for Strategic Basic Research (SBO) from IWT. In this programme (M€37.5 /year) large cooperative projects with a high scientific quality and a relevant valorisation potential (and valorisation approach) are supported. Each project has an average size of €2.5-3 million.

Overall focus and mass do not play an important role in Flemish science policy: the autonomy of the universities is not always cherished, but not really challenged either.

With regard to research of universities with companies and research in companies the Flemish Government has instructed IWT to play a coordinating role in the Flemish Cooperative Innovation Networks (VIS). Although these networks are for a large part oriented towards valorisation (see below) they also play a role in focussing research on topics that are relevant for industry. Competence poles and collective research centres are part of these networks and are sometimes able to increase mass of research in topics that are relevant for industry.

Collective research centres have a long tradition in Belgium that dates from the post-second world war era: in order to provide a sound knowledge base for whole sectors that needed to rebuild a number of centres (11) was set up. These collective centres are in traditional sectors like textiles and equipment industry, and are financed by the industry themselves.

In the late nineties and early this century, the collective research centres were supplemented with ‘competence poles’ or ‘excellence poles’: new knowledge actors in the

Flemish innovation system that facilitate the interaction between the actors in the innovation system (companies and knowledge infrastructure) in order to create a more open innovation system. To overcome the increasing complexity of the research (which prevents parties to innovate all by themselves) and to prevent the retreat of companies from strategic basic research (to minimise risks of research driven innovation) cooperation between companies and knowledge infrastructure may lead to obtaining critical mass and adequate knowledge transfer.

There are three types of competence poles[95]:

- knowledge centres for cooperative research and knowledge diffusion (I);
- knowledge centres that can be interpreted as one large cooperative industry research project (II);
- initiatives for starting up a large test centre or research facility (III).

Some competence poles have activities in more than 1 group (see table 5.4).

Table 5.4 Competence poles in Flanders (2006)

Competence pole	Sector/area	Group		
		I	II	III
Flanders' Drive	Automotive	X		X
VIL	Logistics	X		
IncGeo	Geo-information	X		
FMTC	Mechatronics	X		
Flamac	Materials		X	
MIP	Environmental technology	X		
STAAL	Steel		X	
Flanders' Food	Food	X		
Productontwikkeling en Design	Design & Product development	X		
Flanders' DC	Creativity en innovation	X		

All centres are, like most innovation institutes with government involvement) set up as a foundation ('vzw' in Flemish, comparable to a 'stichting' in the Netherlands). A Board of Directors of which the composition is dependent on the function of the foundation governs these foundations. In the boards of the research institutes e.g. the universities are represented, together with representatives from the government (quite often not the government officials themselves, but experts from the field, or region) and business representatives. In the boards of competence poles university representation is less strong.

The financial contribution for the research centres has been stated above, while the basic funding for the collective research centres is provided by the companies or their sector organisations (but project subsidies from the government are quite common). The competence poles have very different financial models, depending on aim and sector in which they operate. Industry contributions vary from very limited (e.g. €2000 for a small company participating in a larger cooperative project in one sector), to contributions of 50% or more. There are also competence centres that do not use their basic contribution for research, but for stimulation and knowledge transfer only, and that provide support to their members in applying for grants at IWT.

[95] Beleidskader competentiepolen (2005), Ministerie van de Vlaamse Gemeenschap, Brussel.

5.4 Valorisation of research results

In the last five years the attention in innovation policy for valorisation of research results has increased sharply, inspired by the Lisbon and Barcelona objectives and the motto of the Flemish government: ‘More enterprise, more jobs’. This has lead to the increase in attention (and of budget) for valorisation within existing policy measures in the field of innovation, as well as to a number of new policy measures.

Very important is the introduction of ‘valorisation potential and valorisation approach’ as an evaluation criterion within the R&D projects programme of IWT (supporting R&D in companies, budget M€ 80/year) and within the SBO programme for strategic basic research (budget M€37.5/year), where the research is predominantly performed at the universities. Research excellence and valorisation now both account for 50% of the score at the ex-ante evaluation of projects.

With respect to increasing the attention for valorisation in university research the IOF (Industrial Research Fund) was set up. This small fund (at present M€10/yr, but intended to grow) is distributed over the universities, based on their performance as measured by a number of quantitative parameters. Apart from input parameters and scientific output parameters (like number of publications in peer reviewed articles, participation in Framework programmes) the IOF is also taking into account valorisation output parameters like number of patents, number of industrial research contracts and number of spin-off companies. The universities must spend their IOF means on research projects within the university that contribute to a portfolio of potentially application oriented knowledge with a potential economic valorisation. IOF is managed by AWI.

Apart from these changes in evaluation mechanism the measures can be divided into 5 groups: measures aiming at universities and research institutes, measures aiming at researchers, measures aiming at entrepreneurs/start-ups, measures aiming at increasing financing for start-ups and measures aiming at existing industry.

To increase valorisation of university research the universities are stimulated to make their research more oriented to the needs of industry by means of the already mentioned SBO (which stimulates interuniversity and university-industry cooperation, and which has an open competition) and by means of the IOF (Industry Oriented Research Fund) where intra-university cooperation projects with a focus on industry are supported. The budget (at present approximately M€10/year) is divided over the universities based on performance parameters including some parameters related to overall valorisation performance of the university.

A second way to increase valorisation in universities and research institutes is to stimulate their tech transfer activities. KU Leuven has a European reputation in this area: with a combination of professional management, a dedicated IPR approach, and start-up support services (including incubators and venture capital funds) they have increased both contract research and number of spin-off companies.

Based on this success there is a specific programme for universities (and polytechnics (university interface services programme, budget €2 million in 2005, an increase of 50% compared to 2004 and earlier) for building professional tech transfer units. The Leuven approach however, is not easily copied to other universities. Since Ghent University seems the most successful, it may also be a question of ‘size matters’.

The research institutes are required in their management agreements with the Flemish Government to make their research available to industry. IMEC and VIB use part of their budget for tech transfer offices and have very professional patenting, licensing and start up policies, as well as professional policies towards contract research for industrial parties. IBBT has a policy to fund only projects in which at least 2 industrial parties participate that perform at least 50% of the research. Tech transfer is therefore organised in the projects themselves.

Researchers that want to evaluate the commercial potential of their findings are stimulated by way of research mandates (budget 2005: €3 million). These mandates can be used for development of research results into a product, for making a business plan, etc. Valorisation can be done by way of a start up, but also in an already existing company.

Apart from the research mandates, which are aiming at researchers at universities or research institutes, there are also a number of measures aiming at start-ups and entrepreneurs in general. The Flemish Entrepreneurship Action Plan offers al kinds of possibilities, from support for coaching to education, etc.

In 2005/6 these measures aimed at entrepreneurs were further supported by a group of measures to increase the availability of (venture) capital for start-ups. The 'Win-win-loan' is a fiscal incentive for friends and family to support start-ups with a loan of maximum €50.000 (inspired by the Dutch Tante Agaath regeling). The VINNOF is a fund providing loans to starting companies (a contribution of €75 million was made by the Flemish government into this fund in 2005 and 2006). ARKimedes is a measure were the general public receives a fiscal advantage to buy bonds or shares into a fund which is investing in specific VC funds (financed for 50% by private VC funds and for 50% by ARKimedes) that are again investing their money in young companies (with a maximum investment of €1 million per company, so in the pre-seed or seed phase). The ARKimedes fund was able to rise €110 million in bonds and shares with the general public (within 2 weeks after its start!), and has now, together with the private VC funds, € 220 million available for investments in Flemish companies.

The last group of measures is aiming at increasing the valorisation performance of the existing industry, by creation of industry-industry and industry-research networks in the VIS programme. Within this programme (€15 million in 2005) all kinds of activities are supported that increase cooperation in order to increase the effective transfer of knowledge between universities and companies and between various companies.

Activities may have a permanent form (like the so called competence poles where systematic user oriented programming of research and transfer of technology from research to esp. SMEs, is promoted; see above) or a more project like form. The various initiatives are linked with each other in order to exchange experience.

A, from international perspective, rather unique feature with regard to research valorisation, is the specific budget of €12.5 million every year (since 2003) within the SBO programme for Strategic Basic Research for projects with an non-economic valorisation. In these projects research is supported that is of great importance to society in Flanders, but which has no commercial value. Many of the projects are of non technological nature (e.g. projects on End-of-Life care, Education, Social effects of nanotechnology, etc.). Projects are evaluated on their scientific excellence and on their valorisation approach and impact. Both criteria account for 50% of the evaluation.

Furthermore a programme was introduced recently to support applied biomedical research aiming at developing new forms of therapy or diagnosis, close to clinical application, with a clear societal application and no interest by industrial parties (yet).

5.5 Conclusions

Focus and mass and valorisation are important topics in the Flanders innovation policy.

Universities are very autonomous and can decide on their research topics themselves, and the division of funds over the universities is preset, inflexible and almost independent of research topics in the universities, so debate on focus and mass in the university system is mainly within the universities and not at policy level.

In the discussion with regard to focus and mass of government support for industry oriented research Flanders has rather explicitly chosen for a horizontal approach of companies: all innovation support instruments focussing on industry are open for all sectors and technologies. Rationale for this is that the Flemish government is of the opinion that industries themselves are better aware of the specific needs and opportunities of industry than the government. This horizontal strategy with regard to innovation is however supplemented by a more specific approach of research in four large research centres in the areas microelectronics, ‘energy, environment and materials’, biotechnology and broad band technology. These programmes are aiming at creating critical mass at scientific level, but have also valorisation aims.

The discussion about a more thematic approach has however recently started with a report from the Flemish Science Policy Council where a list of 30 priorities for technological research in Flanders, and a frame of reference for using these priorities in government innovation initiatives were proposed.

The approach towards valorisation in Flanders has become rather comprehensive in the last few years, and is going from stimuli for valorisation in (a small part of) university funding, interventions in research programming and changing ex-ante criteria in subsidy programmes to specific measures supporting start-ups and increasing the availability of (early stage) venture capital.

6. Ireland

6.1 Introduction

The Irish economy has grown dramatically in the nineties of the previous century. In the period 1997-1999 economic growth in Ireland was among the highest in Europe and far above the EU-15 average. GDP per capita has risen from 92% of the EU-15 average in 1995 to 111% in 1999 and is now still among the highest in Europe with 132.5% of EU-25 average (2003). This period of strong economic growth was accompanied with falling unemployment and a low inflation rate. An important driver for this period of economic growth was Ireland's ability to attract foreign multinational (high-tech) manufacturing and production companies to Ireland by providing a comfortable environment for investors in terms of workforce skills (up to first degree level), low wages, subsidised factory space, low corporate tax rates, and so on. Even now Ireland is still one of the most successful Member States at attracting foreign investment, with direct inward investment flows representing 17% of GDP in 2003[96].

It is generally accepted in Ireland nowadays that in order to sustain economic growth Ireland has to transform to a knowledge economy and invest substantially in science, technology and innovation (STI). This is reflected in the National Development Plan (NDP) 2000-2006 which allocated €2.5 billion to Research, Technology Development and Innovation (RTDI) for 6 years. The new NDP 2006-2013 envisages that €2.7 billion will be spent on research before the end of 2008. This is substantially higher than earlier expenditure levels of just €0.5 billion from 1994-1999[97].

Ireland spends about €1.39 billion on R&D in 2003, which corresponds to 1,20% of GDP. This is below the EU average. Unlike many other European countries the amount of public spending on R&D is very limited in Ireland. The business sector accounts for more than 2/3 of total R&D spending in Ireland[98].

6.2 Institutional setting

6.2.1 The key players in STI policy

Unlike in many countries, there is not a 'clean' distinction in Ireland between the research funding roles of the industry and education ministries. The two main ministries are the Department of Education and Science and the Department of Enterprise, Trade and Employment. Several other Departments also have a (much more limited) responsibility of funding research. An overview of the Irish research and innovation system is presented in Figure 6.1. A more detailed description of all the actors involved is available in the Trend Chart Country Report Ireland[96].

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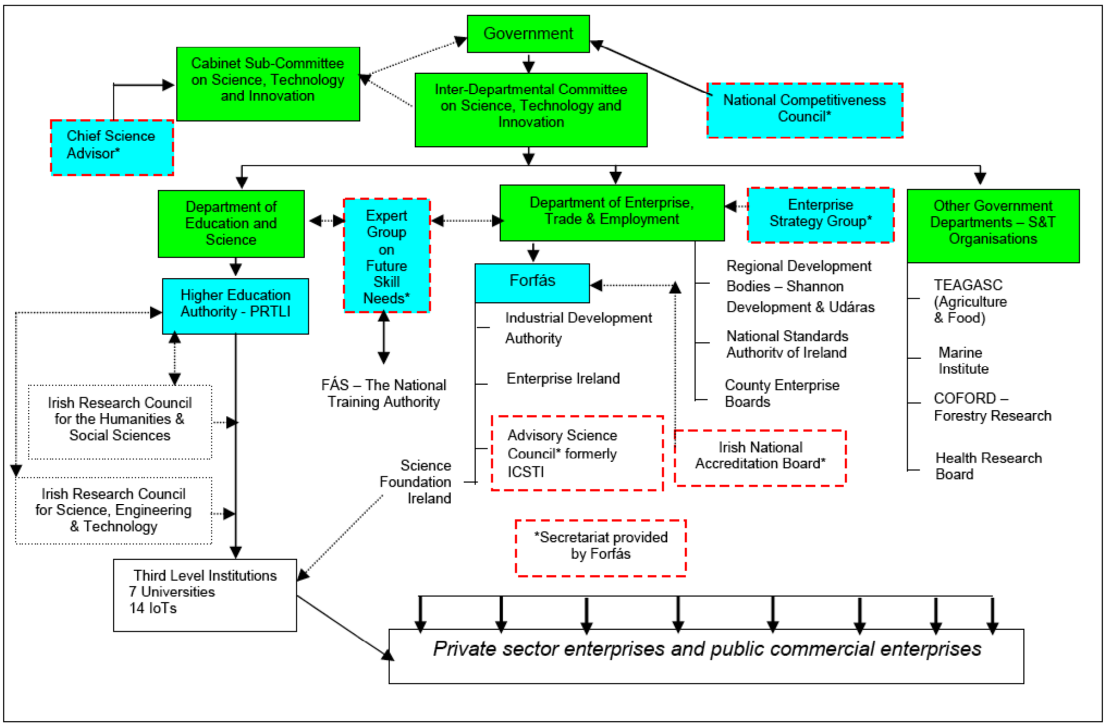
[96] TrendChart Country Report Ireland. 2005. http://trendchart.cordis.lu/tc_country_list.cfm?ID=9

[97] ERA-Watch and Ireland's Competitiveness report 2003.

[98] OECD

Figure 6.1 Overview Irish National Innovation System



Source: Trend Chart Country Report Ireland 2005

The most powerful influence on policy within the civil service in recent years has been the Department of Enterprise, Trade and Employment's Office of Science and Technology (OST). This Office is responsible for the development, promotion and co-ordination of Ireland's STI policy, as well as Ireland's policy in international research activities, including the EU Research Framework Programmes and activities related to the development of a European Research Area. The work of the Office covers all aspects of the national system of innovation, including basic research, applied research, industry RTDI, technology transfer, funding for innovation and public awareness of science and technology. It advises the Government on the strategy for the prioritisation, preparation and implementation of national and international programmes in STI. It formulates policy in STI, inter alia, by reviewing the experience of existing schemes and by researching the trends and indicators, both physical and financial, of the developments in science and technology in Ireland and internationally. OST has a series of schemes which are managed by its agencies Enterprise Ireland, IDA Ireland or Forfás. Most of these activities are funded through the Productive Sector Operational Programme 2000-2006 (which is part of the overarching National Development Plan 2000-2006).

Forfás, the National Policy and Advisory Board for Enterprise, Trade, Science, Technology and Innovation in Ireland, is an agency of the Department of Enterprise, Trade and Employment (DETE). It is responsible for industrial promotion and technology development. Forfás advises the Minister on matters relating to industrial developments and policies for the agencies Enterprise Ireland and IDA Ireland (see below). It also encourages the development of industry, technology, marketing and human resources as well as the establishment and development of industrial undertakings (including R&D) from abroad. Forfás fulfils these functions directly and also through a number of bodies which operate under the aegis of Forfás. These include:

- Enterprise Ireland. This is the key innovation-funding agency in Ireland with a range of measures to support innovation in indigenous firms and companies based in Ireland. Enterprise Ireland also administers national and EU supports for building technological innovation capability and co-operation between industry and higher educational institutions. It provides a range of services to help international business access and evaluate appropriate and competitive sources of supply in Ireland. Enterprise Ireland also supports international collaborations in R&D. Funding from Enterprise Ireland towards HEI is mainly to stimulate public-private research collaboration

- IDA Ireland is a state sponsored agency funded through Government grant under the National Development Plan (NDP). This is the agency primarily responsible for encouraging FDI in Ireland, offering a wide range of grants and incentives. Among these is a budget of over €100 million per year for large R&D investment, a scheme run jointly with Enterprise Ireland. IDA Ireland not only tries to attract inward investment (from multinational enterprises) but also focuses on developing strategic business areas, clusters of excellence in which groups of companies, corporate and academic research facilities, venture capitalists and others congregate together to create an environment conducive to innovation and entrepreneurship. This will contribute to the attractiveness of Ireland as a location for R&D. IDA Ireland aims to actively build links between international business and third level educational and other research-based centres.

- The Irish Council for Science, Technology and Innovation (ICSTI) is an independent body appointed by the Minister for Science and Technology and Forfás, which provides expert, independent advice to Government within a legal mandate and foundation under the powers delegated to it by Forfás. ICSTI's Technology Foresight exercise, carried out between 1998 and 1999, was an important step towards developing an autonomous national policy.

- Science Foundation Ireland (SFI) is an agency that promotes investment in basic research. The SFI has been set up to administer the Technology Foresight Fund, which was established in 2000 to address the immediate and urgent need to develop a critical mass of researchers in Ireland trained to world-class standards. The Fund (approximately €635 million in 2000–2006) is intended to make Ireland an internationally recognised centre of research excellence in strategic areas relevant to economic development, particularly in niche areas of information and communication technologies and biotechnology. SFI also tries to attract world-class overseas researchers to strengthen the national research system.

The Higher Education Authority is the principal agency of the Department of Education and Science dealing with higher education. It regulates the higher education sector, channelling both the university block grants (whose size have tended to be driven by student numbers, rather than any research considerations) and the money to the research councils. On behalf of the Department the HEA operates the Programme for Research in Third Level Institutions (PRTLI) to enable a strategic approach by those institutes, to enhance the quality and relevance of graduate outputs and to support outstandingly qualified individual researchers and teams. In addition two research councils operate under the HEA:

- The Irish Research Council for Humanities and Social Sciences (IRCHSS) was established in 1999 and provided an important new means to fund individual researchers and research projects in the humanities and social sciences.

- In 2001, the Irish Research Council for Science, Engineering and Technology (IRCSET) was established to support individual researchers in science, engineering and technology.

Approximately 90% of fundamental research is performed within the higher education sector. Given the size of the population (approximately €3.5 million), the number of universities, institutes, centres, etc. in Ireland is comparatively high. In Ireland the higher education system consists of 7 universities, 14 Institute of Technology and a small number of private colleges. There are no prestigious, long established technological universities as many European countries and the US have.

Furthermore, Ireland has very few public or private research bodies. Public R&D is generally focused on natural resources (food, agriculture, forestry and marine) and on the environment, health and energy. Most of the public research bodies are small and the awarding of grants to the universities and the hospitals are important functions of these bodies. The largest is TEAGASC, the agricultural research and development body.

Neither indigenous industry nor foreign-owned industry (in their Irish operations) performs basic research.

6.2.2 Main developments in STI policy

By the end of the nineties it became clear to Irish policymakers that it would be impossible to sustain the momentum built up by the inward investment policy. Without the research capability to support the technology-based industries, Ireland would gradually lose its comparative attractiveness for manufacturing industry and the basis of its export led growth in the 1990s.

Therefore the Irish Council for Science, Technology and Innovation (ICSTI) carried out a Technology Foresight exercise between 1998 and 1999. It was an important step towards developing an autonomous national STI policy. It looked at many sectors of the Irish economy like agriculture, transport, health, etc and the private sector was involved as well in this exercise. One of the main conclusions was that information and communication technologies (ICT) and biotechnology are two pervasive and strategic technology areas underpinning many existing sectors in the Irish economy.

The Technology Foresight exercise led directly to a major policy decision by the Irish Government to invest substantially in a new research initiative to establish a strong research capability in Ireland in the areas of biotechnology and ICT. The report also highlighted the fact that Ireland must constantly seek to improve the capability and performance of its industrial base to cope with increasing global and knowledge-based competition. To do this, it would be necessary to create a durable science and technology infrastructure which would stimulate the creation of new, technology-based, indigenous firms, establish an internationally competitive research base in universities and research institutes, attract the R&D activities of multinational firms to locate in Ireland and provide the physical infrastructure and environment to promote innovation.

The ICSTI recommendations were accepted by Forfás and the Department of Enterprise, Trade and Employment (DETE) and under National Development Plan (NDP) 2000-2006 around □2.5 billion was allocated towards Research, Technological Development and Innovation (RTDI).

Since the new Nation Development Plan was established in 2000 Ireland's ambitions towards creating a knowledge economy has become a political priority and is stressed in several policy documents (see TC country report Ireland – Appendix 1). In 2004 a report from the Department of Enterprise (DETE) "Building Ireland's Knowledge Economy[99] stressed the need to:

[99] IDC, (2004), The Research Agenda: Making Knowledge Work for Ireland, DETE.

- Increase R&D performance in the public and private sectors,
- Strengthen research excellence in the higher education and public research sectors in a sustainable and planned manner,
- Promote innovation and entrepreneurship amongst researchers,
- Grow deep and lasting partnerships between academia and enterprise to ensure that the knowledge generated is successfully translated into new products, processes and services (valorisation or commercialisation of research results),
- Attract the necessary extra researchers to perform the increased levels of R&D required in enterprises and in the science base.

Based on this report and adopting its targets, the Minister for Enterprise, Trade and Employment elaborated the objectives of a national research and innovation policy as part of the Irish R&D Action Plan Building Ireland's Knowledge Economy. The overall objective is that: "Ireland by 2010 will be internationally renowned for the excellence of its research and be at the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture."

Recently, the government launched the “Strategy for Science, Technology and Innovation 2006-2013” which outlines in some detail how the Government proposes to achieve the 3% R&D target. The document has very close parallels with the document "Building Ireland's Knowledge Economy," and it uses the same vision. The core elements of the strategy are to develop a world class research infrastructure and to double Ireland's throughput of researchers. The document recognises that science, technology and innovation is largely underdeveloped in Ireland and that a significant effort will be needed to achieve the national goal of placing Ireland as a leading knowledge-based economy.

6.2.3 Response to EU policy

Lisbon and Barcelona objectives

The overall objective of the Irish R&D Action Plan, "Building Ireland's Knowledge Economy," is that: "Ireland by 2010 will be internationally renowned for the excellence of its research and be at the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture."

The action plan goes on to set targets by which the objective can be realised. The most important of these are:

- Gross Expenditure on Research and Development should increase from 1.4% of GNP in 2001 to 2.5% by 2010;
- Business expenditure on R&D should increase from €917 million in 2001 to €2.5 billion by 2010;
- R&D investment in the higher education and government sectors should increase from €422 million in 2001 to €1.1 billion by 2010;
- The number of researchers should increase from 5.1 per thousand of total.

These objectives clearly underline the Government's commitment to achieving the targets set down in the Lisbon Strategy and the 3% Barcelona objective.

The publication of the National Reform Programme Ireland report in October 2005 outlined how Ireland was performing in relation to the key Lisbon indicators. On the positive side, the document noted that Ireland has the lowest level of unemployment within the European Union, the second lowest national debt and the highest level of investment in infrastructure. The need to develop mechanisms by which the delivery of public support for public and private R&D was stressed as was the need to seek a higher level of coherence, efficiency and effectiveness of investment.

EU Framework Programme[100]

The European Framework Programme continues to be relevant and important for Ireland. For the great majority of FP5 participants, international collaboration in research and technological development (RTD) remains relevant and/or has become even more relevant. Thus FP5 has offered a platform to organise this collaboration in a structured way:

- It provides companies and research organisations with access to networks and partners in other parts of Europe
- It has strengthened the international profile and reputation of Irish organisations
- It has allowed a large group of companies to develop new products and processes that have reinforced their competitive position

The analysis participation in FP 5 shows that overall the performance of Ireland was on a level that can be expected given the Irish position in Europe. Ireland was very successful in FP5's predecessor FP4 (1994-1998) and it was expected that this success would be continued. However, by comparison with FP4, the participation in FP5 decreased both in terms of the number of participations and in terms of the funding received. The Irish business sector in particular is the main reason for this downfall in participation and funding.

Participation of the Irish business The Irish Higher Education sector retained its position in Europe with respect to FP5. Although the sector had fewer projects in FP5 compared to FP4, the average size of their research projects has increased in FP5. Despite the increasing opportunities for national funding for the HEI sector, most organisations have kept their involvement in FP5 at a high level and, despite fewer participations, the most active universities and research centres have increased their funding from FP5. One can conclude that the HEI sector has become more selective in the projects it takes part in and is successful in entering projects with more critical mass. However the strong position is particularly concentrated in a small number of universities.

Irish participation was concentrated in three specific FP5 programmes that collectively accounted for 68% of Irish participation and 71% of Irish funding. These programmes are: Quality of Life (QOL), Information Society (IST), and Sustainable Growth (GROWTH). This reflects also the Irish national research priorities.

In general, Ireland is committed to Europe and stimulates researchers to participate to European research projects. For a small country, with a limited research infrastructure, it becomes however more difficult to participate in big European research projects.

[100] Technopolis (2005), Evaluation of the Impacts and Operations in Ireland of the European Union's Fifth Framework Programme for Research Technological Development and Demonstration. A study commissioned by Forfas, Ireland.

6.3 Critical mass and focus of research

6.3.1 Policy development

Since 2000 science, technology and innovation (STI) became more of a political priority and is now regarded as an important element for continued economic growth and success. Consequently, the National Development Plan significantly increased the amount of national R&D funding available to the HE sector.

Until that time there has been a significant under-funding of the Irish research base. There were no national funding programmes and there was a lack of central or overhead funding for research departments. As a result research managers did not have the opportunity to develop a research strategy and had little alternative but to behave opportunistically in their search for funding (this means that university departments did not have a strategic research focus; all reasonable good ideas got funding).

Due to the lack of national funding resources the research community was largely dependent on foreign sources of funding, in particular the European Commission. Until FP5 Irish researchers from HEI were very successful in capturing European research funds, especially in the area of ICT. This enabled Irish researchers to build up expertise in certain areas (see Technopolis/Forfas, 2002).

Given these conditions, a study commissioned by Forfas[101] found that the overall standard of Irish research performance is surprisingly high. A bibliometric study, which considered research outputs from 1991-2000, revealed a small number of strong areas spread around different research departments. The study confirmed the relative strength Irish researchers have in biotechnology (strong subfields are biochemistry and molecular biology, microbiology and analytical chemistry, food science and general medicine) and ICT (strong sub fields are engineering, physics, computer science). There are 3 world-class research departments (two in biotechnology and 1 in ICT) and a number of departments have the potential to become so in the next 5 years. Despite strong expertise is certain sub research areas in biotechnology and ICT, the study concludes that by the end of the nineties Irish research is too fragmented and lacks critical mass in order to become truly world-class and compete internationally. More specifically, the report concluded that:

- Irish research shows a high degree of fragmentation and there is limited collaboration between the different universities and institutes.
- Many research areas in which Ireland has a relative strength, like computer science and modern and developing areas of biotechnology appears to be sub-critical. The average size of research groups appears to be too small and have too few post-doctoral researchers to build up some critical mass in a research area and compete at an international level with leading groups.

Several changes in the Irish research environment occurred recently to address the issues described above. The PRTLI programme which was introduced in 1998, meant a major change in the Irish research environment since it provided a new source of research funding to support strategic institutional research programmes and joint research programmes. Other changes in the Irish research environment included the creation in 1999 of the Irish Research Council for Humanities and Social Sciences (IRCHSS) provided an important new means to fund individual researchers and research projects in the

[101] Technopolis (2002), Baseline Assessment of the Public Research System in Ireland in the areas of Biotechnology and Information and Communication Technologies. A Study commissioned by Forfas – Science Foundation Ireland.

humanities and social sciences. In 2001, the Irish Research Council for Science, Engineering and Technology (IRCSET) was established to support individual researchers in science, engineering and technology. The establishment of Science Foundation Ireland (SFI) in 2000 to support strategically oriented basic research in the areas of information and communication technology and biotechnology, contributed to the development of a comprehensive national research capacity[102].

Moreover a significant part of the new budget for RTDI is allocated to address the issues described above (i.e. funding of research in key areas that are of economic value to Ireland (biotech and ICT), stimulate strategic priority setting of research departments, stimulate collaboration between research departments, etc). Both the Higher Education Authority (HEA), via the PRTL programme, and Science Foundation Ireland (SFI), were allocated over €600 million each to fund their respective activities and stimulate research at Irish HEI.

Besides these two funding programmes research and innovation policy in Ireland is pretty non-specific. But Ireland's historical focus on computer sciences (and biotechnology) means that there is automatically a strong research focus in these areas. As these two initiatives (PRTL and SFI) are the most important elements in Irish research policy to address the issue of critical mass and focus, they will be described in more detail below.

6.3.2 Programme for Research in Third Level Institutions (PRTLI)[103]

PRTLI was the first attempt to address the research infrastructure deficit. The programme was launched in 1998 and is administered by the HEA. The fundamental purpose of PRTLI is "to build internationally competitive and collaborative research centres in third level institutions" and is to accelerate the development of critical mass. Funding is available to support all sectors and disciplines, at the discretion (institutes decide which areas) of applicant institutions. The PRTLI's investment of €605 million in the three funding cycles to date has been allocated on a competitive basis to third-level institutions.

The projects and centres funded by the PRTLI address some of the most fundamental research challenges. The funding awards support the national sectoral priorities in biosciences and biomedicine and ICT as well as providing opportunities for development of basic sciences, of new platform technologies such as nanotechnology and addressing issues related to the physical environment. Research excellence in the humanities and social sciences is an important dimension of the PRTLI awards, as are the two substantial investments in research libraries at TCD and UCC that is part of the support infrastructure for the research community in Ireland.

A key prerequisite for consideration for PRTLI funding was the development of an institutional research strategy based on the strengths of the institution. This set out to address the deficit in institutional research strategy in Ireland. At this stage, strategic planning processes for research are now in place in all institutions that have successfully competed for PRTLI funding. This has ensured effective prioritisation and selection of research areas, the formation of trans-disciplinary research teams and programmes, as well as very significant levels of inter-institutional co-operation.

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[102] HEA and Forfás (2003), *Creating Ireland's Innovation Society: The Next Strategic Step*, p. 2.

[103] This section is partly based on: Higher Education Authority (2006), The programme for Research in Third Level Institutions (PRTLI) – Transforming the Irish Research Landscape. And Higher Education Authority. 2004. *The programme for Research in Third Level Institutions (PRTLI) – Impact Assessment Vol 1. Report by the International Assessment Committee.*

PRTLI has generally been beneficial in developing scale and critical mass in the institutions. The forty new inter-institutional programmes or initiatives, established as part of the PRTLI, allow the research to achieve critical mass well beyond the capacity of individual institutions. Its emphasis on inter-institutional collaboration appears to have greatly assisted this objective and there are several remarkable examples of institutions together offering a scale of inter-institutional operations that heretofore would have been inconceivable. The Dublin Molecular Medicine project, involving three of the Dublin universities, is an outstanding example.

To conclude, there is clear evidence that PRTLI has changed institutional thinking and has brought about an extraordinary transformation in the way third level institutions undertake research. Collaboration has helped to improve the scale of operations of many institutions and it has assisted institutions in accessing other funding sources.

6.3.3 Science Foundation Ireland (SFI)[104]

Science Foundation Ireland (SFI) was established in early 2000, under the aegis of Forfás, to create a critical mass of world-class research in strategic areas relevant to Ireland's economic development, particularly in niche areas within biotechnology and Information and Communications Technologies (ICT). Until April 2005 €464 million has been committed.

It was envisaged from the outset that the SFI budget, while large relative to historical levels of research funding in Ireland, could not sustain a strong research effort across all fields of ICT and biotechnology. Therefore it was decided to focus on specific niche areas is these fields, based on the expert opinion of the researchers involved in the funding programme. Now the SFI appears to be moving towards a higher degree of concentration on specific themes within biotechnology and ICT and even toward the support of preferred individuals and teams within these specific themes.

The main contribution of SFI to date has been to establish an array of research groups, where the basis for selection has been the criterion of research excellence in the broadly identified – and economically relevant – sectors of biotechnology and of ICT. Leading foreign research scientists have been attracted to Ireland and six Centres for Science, Engineering and Technology (CSETs) have been established in the core thematic fields and with considerable industry involvement. Industry covers about 20% of total operation costs of the centre. It is expected that these centres will have a strong influence on the research system and the higher education institutions in Ireland in coming years.

To conclude, the establishment of Science Foundation Ireland (SFI) in 2000 has supported strategically oriented basic research in the areas of information and communication technology and biotechnology, and SFI contributed to the development of a comprehensive national research capacity[105].

6.4 Valorisation of research results

Since 2000 the Irish government has invested substantial amounts of money in the higher education system, but a majority of the research funding is oriented towards basic research and not specifically oriented towards the needs of the Irish industry. Moreover, the indigenous Irish industry is not very research intensive and despite efforts from the

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[104] This section is partly based on: Forfas. Report of International Evaluation Panel. 2005. Science Foundation Ireland – The first years 2001-2005.

[105] HEA and Forfás, 2003, *Creating Ireland's Innovation Society: The Next Strategic Step*, p. 2.

Irish government to stimulate R&D expenditure by the business sector, the level of private R&D is still very low in Ireland (see table 1.1 in chapter 1 for some figures).

As a result the Irish industry has not been able to benefit from the public investments in research. Therefore various policy measures are established to stimulate private R&D investments (tax credits, etc), to stimulate public-private R&D collaboration with a view to joint innovation activities, and to foster the use of research results (IPR) in the generation of new products and process.

The following sections provide an overview of the most important policy instruments that address the issue of "valorisation of research results" in Ireland. These policy instruments are categorised using the following categories:

- research-industry co-operation;
- commercialisation of research results (i.e. IPR);
- technology transfer by spin-offs;
- other technology transfer measures.

6.4.1 Research-industry co-operation

As mentioned before, most of the indigenous Irish companies are SMEs with limited technical capability and R&D absorption capacity. These companies often have often not enough people and/or recourses to undertake new product development. To improve the situation several measures have been launched to bridge the gap between (basic) research performed at the higher education sector and the needs of the Irish indigenous industry and to improve transfer of technology and knowledge from research to companies.

The Advanced Technologies Research Programme 2001 is a new programme that has evolved from the successful Programmes in Advance Technology (PATs) and aims to fund research that is relevant for Irish industry. It made a significant contribution to university research for industry. The objective of the programme is to generate technologies, products or processes that can provide the basis of new start-up companies in Ireland or can improve the competitiveness of industry in Ireland. The PATs are based in the universities. Research proposals will be evaluated through a two- stage process. The first stage will be to determine their technical merit (originality and novelty of approach, feasibility, likely outputs, credibility of the project work plan etc.). Those reaching an acceptably high standard of technical merit will then be evaluated and ranked on the basis of commercial potential (i.e. potential for start-ups, for transfer to existing industry or to address sectoral threats or opportunities)

The Technology Centres are mainly based in the Regional Colleges/Institutes of Technology. These centres were established to make access easier for industry and to provide a focal point within the technical institution for specific industry contact and services. The measure has been successful in bridging this gap and it has assisted many companies to update their technology and product range.

The purpose of the Innovation Partnership scheme (formerly known as the Applied Research Grants Scheme for Universities and the Institutes of Technology) is to support the undertaking of collaborative applied research with direct industrial and commercial application, between industry and colleges/universities. The scheme is open to academic staff of the colleges in collaboration with an Irish-based company. Successful project proposals must demonstrate a clear benefit to the participating company(ies) for whom the college carries out the research. This measure ensures that the technical resources in the higher education sector are available to Irish based companies and it stimulates increased cooperation and R&D joint ventures.

6.4.2 Commercialisation of research results

In 2001 a Dept of Enterprise, Trade and Employment (DETE) study, undertaken by the CIRCA Group, indicated that the level of patent registration from the Higher Education sector and the Public Research Institutions (PRI) was low. There were no funds to assist the commercialisation of IP and the systems within the PRI were generally over stretched and needed both staff and funding to be more effective. The low level of patent registration is also stressed in the European Innovation Scoreboard.

The Commercialisation Fund is launched to encourage researchers to commercialise their research and make IP more accessible to industry. According to the IDC 2005[99] it is a great challenge for the Irish government to create a strong pro commercialisation culture in the third level institutions with an appropriate balance between the protection of IP and its exploitation.

The Commercialisation Fund contains a range of support measures designed to further the commercial exploitation of knowledge. It puts a greater emphasis on commercialising state funded IP. After its restructuring in 2003 researchers can now gain support through:

- a proof of Concept Phase to test out the feasibility of their idea;
- a Technology Development Phase to put significant resources behind applied research to bring their idea to a marketable stage.

Over €16.9 million was committed in 2003 to 116 high quality applied research initiatives in areas of emerging technologies of relevance to companies[106]. The projects supported reflected Irish priority areas: ICT, biotechnology, advanced manufacturing and photonics.

In addition there are many other measures encouraging companies to increase their R&D expenditures, which will in turns stimulate the commercialisation of research results. The most important measures are aimed at:

- funding research infrastructure and equipment (R&D Capability Initiative);
- funding Applied industrial research, development or prototype creation, (Research Technology & Innovation (RTI) Competitive Grants Scheme);
- providing a tax deduction to R&D expenditures of manufacturing companies that are eligible for a reduced corporate tax of 10% (Tax deduction for companies investing in R&D).

6.4.3 Technology transfer by spin-offs

Part of Ireland's ambition to build a knowledge economy is to promote innovation and entrepreneurships amongst researchers by supporting the development of high tech companies. Besides increasing the level of collaboration between research and industry, an important aspect is to encourage spin-offs from Third Level educational institutes. Several measures are launched in this area.

The Campus Companies Programme has been designed to assist individuals interested in commercialising R&D on the college campus. An element of the programme is the provision of CORD (Commercialisation of Research & Development) grants. The assistance can vary

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[106] http://www.trendchart.org/tc_policy_measures_overview.cfm

from premises to business advisory services. It is tailored to suit the individual academic. All Irish universities now have incubator space and new enterprise services so they are ideally situated to assist such new enterprises.

The Graduate Enterprise Programme has been designed to assist graduates interested in establishing their own businesses, including through the commercialising of R&D, particularly on-campus.

The Business Incubation Centre programme aims at expanding the base of high tech companies operating on college campuses through developing and expanding incubation space facilities. In addition, a new initiative has been launched to support Regional Business Incubation and R&D space in Institutes of Technology. It will be operated by Enterprise Ireland. Support is available to all higher education institutes. Institutes can apply for assistance towards the development of new industrial incubation and R&D facilities or the expansion of existing operations. Ideally, the incubation and R&D space should be combined in Centres located on the campus of the Institute.

In addition, a set of initiatives is put in place to address shortages of venture capital - particularly early stage/seed capital for innovative high-tech start-up companies. The approach has been for the state to act as catalyst and/or co-funder with private sector sources of finance.

6.4.4 Other technology transfer measures

The Technology Transfer & Business Partnership Programme aims to stimulate development of new products and processes by identifying opportunities for technology acquisition (i.e. technology transfer via joint ventures or licensing opportunities, etc). It was aimed at boosting the very modest level of assistance for technology transfer activities provided at the time of its initiation. This initiative provides suitable technology transfer, partnership, and joint venture opportunities for Irish firms.

6.5 Conclusions

Irish innovation policy is clearly focused on stimulating the knowledge economy by increasing the level of public and private R&D expenditures. The primary goal is building up critical mass and excellence in higher education research.

Initiatives like the Programme for Research in Third-Level Institutions (PRTLI) and Science Foundation Ireland (SFI) have a tremendous impact on the strategic orientation of higher education research efforts and have focused research funding on key areas that are of economic value to Ireland (mainly biotech and ICT).

An independent evaluation team, chaired by prof Banda, concludes that the leverage impacts of PRTLI on SFI have been very positive[107]. This confirms that both PRTLI and SFI had a strong impact on the Irish research community. The PRTLI programme address the issue of sub-critical mass and fragmentation of research, while the SFI enables institutes to focus their research efforts on a selection of key research themes in the area of biotechnology and ICT.

Together with the focus on increasing the level of public and private R&D investments, growing emphasis is given to the translation of research results into new products, processes and services (commercialisation or valorisation of research results). Several

[107] Higher Education Authority (2004), *The programme for Research in Third Level Institutions (PRTLI) – Impact Assessment Vol 1. Report by the International Assessment Committee.*

policy initiatives are launched in this area to make Irish firms (and start-up companies) benefit more from the results of (public funded) research activities in Ireland. Special attention is given to promote structural R&D partnerships between research and industry and to promote innovation and entrepreneurship amongst researchers.

Annex A: Irish research policy priorities

The main goals of current Irish research policy are to assist in the achievement of national objectives of positioning Ireland as a leading knowledge economy. The primary objective of the Irish 3% Action Plan, "Building Ireland's Knowledge Economy," is that: "Ireland by 2010 will be internationally renowned for the excellence of its research and be at the forefront in generating and using new knowledge for economic and social progress, within an innovation driven culture."

To realise this step change the Action Plan proposes the following targets for Ireland to be achieved by 2010:

- Business investment in R&D should increase from €917 million in 2001 (0.9% GNP) to €2.5 billion in 2010 or 1.7% GNP;
- The number of indigenous companies with minimum scale R&D activity (in excess of €100,000) should double, from 525 in 2001 to 1,050 in 2010;
- The number of indigenous enterprises performing significant R&D (in excess of €2 million) should increase from 26, currently, to 100 by 2010;
- The number of foreign affiliates companies with minimum scale R&D activity (in excess of €100,000) should double, from 239 in 2001 to at least 520;
- The number of foreign affiliates performing significant levels of R&D (in excess of €2 million) should increase from 47 in 2001 to 150 by 2010;
- R&D performance in the higher education and public sectors should increase from €422 million in 2001 (0.4% GNP) to €1.1 billion in 2010 or 0.8% GNP.

The Action Plan recommends a range of actions to support achievement of the targets as follows:

- Develop a national pro-innovation culture supportive of invention, risk-taking and entrepreneurship;
- Re-orient the enterprise support budget to R&D and develop a new and less bureaucratic approach to R&D support that encourages a systematic and continuous approach to R&D within enterprises;
- Strongly support the development of strategic research competencies (technology platforms) based on enterprise needs;
- Develop the seed capital markets for early stage ventures;
- Develop a national plan to increase the performance, productivity and efficiency of research in the higher education and the public sectors;
- Sustain Ireland's commitment to building it international reputation for research excellence;
- Make Ireland a highly attractive environment for high quality researchers and research careers;
- Develop the research commercialisation expertise necessary to ensure effective and rapid exploitation of research in higher education and public research sectors by enterprise.

7. Sweden

7.1 Introduction

Sweden is investing about 3.95% of GDP in R&D and the business sector finance two-third of that. Swedish enterprises are among the world leaders in terms of R&D intensity. In relation to GDP, companies in Sweden invested nearly 3 percent in R&D, nearly 160 percent above the average for the EU-25. Public R&D financing is around 1% of GDP. This makes Sweden one of the leaders in terms of R&D expenditures and one of the few Member States meeting the Barcelona objective.

Although the 3% target is reached Swedish policy makers are still committed to stimulate investments in research and development. Sweden has strong belief in the knowledge society and wants to remain a leading county in high quality research.

7.2 Institutional setting

Research policy plays a central role in Sweden's innovation system and many objectives are established to maintain Sweden has a position as a leading knowledge and research nation where research of high scientific quality is conducted.

The governance of the Swedish research system is characterised by:

- A high level of commitment to science and research and a high degree of autonomy for the actors of the science system.
- Relatively small ministries resulting in a high degree of autonomy for government agencies to formulate and implement policies.
- Horizontal coordination mainly taking place through informal mechanisms at ministry and agency levels.
- Decentralisation of responsibilities, including innovation policy measures, to regional authorities (counties).
- An obligation for each university and college to formulate its own research stra-tegy.
- Internationally unique research doctrine dictating that the universities should be the main providers of both curiosity-driven (i.e. fundamental research) and mission-oriented research (i.e. applied research) and the fact that the universities have notable difficulties in fulfilling their intended function of intermediary between academic research and industrial exploitation.
- A research institute sector that by international standards is small and fragmented and which receives considerably less base funding than research institutes in comparable countries.

7.2.1 Main developments in STI policy

About every fourth year the Government presents a new research policy bill, which will constitute a guide for research policy for the years to come. These bills give an overview of the goals of the Swedish research policy and initiatives of how to reach these goals.

The newest government bill “Research for a better life” was presented in March 2005 and sets the direction of Swedish research policy for the years 2005-2008. The main focus is on how the additional resources for research are to be distributed in order to meet strategic needs. Therefore special initiatives were proposed for research in life sciences, technology and sustainable development. At the same time, priority would be given to internationally competitive research environments, i.e. centres of excellence. The transfer of knowledge from academia to industry would be boosted by R&D programmes involving the business sector and by providing more resources to industrial research institutes. To meet the growing need for trained researchers, the Government proposed a committing of new resources to postgraduate education and to positions for young researchers at universities and university colleges.

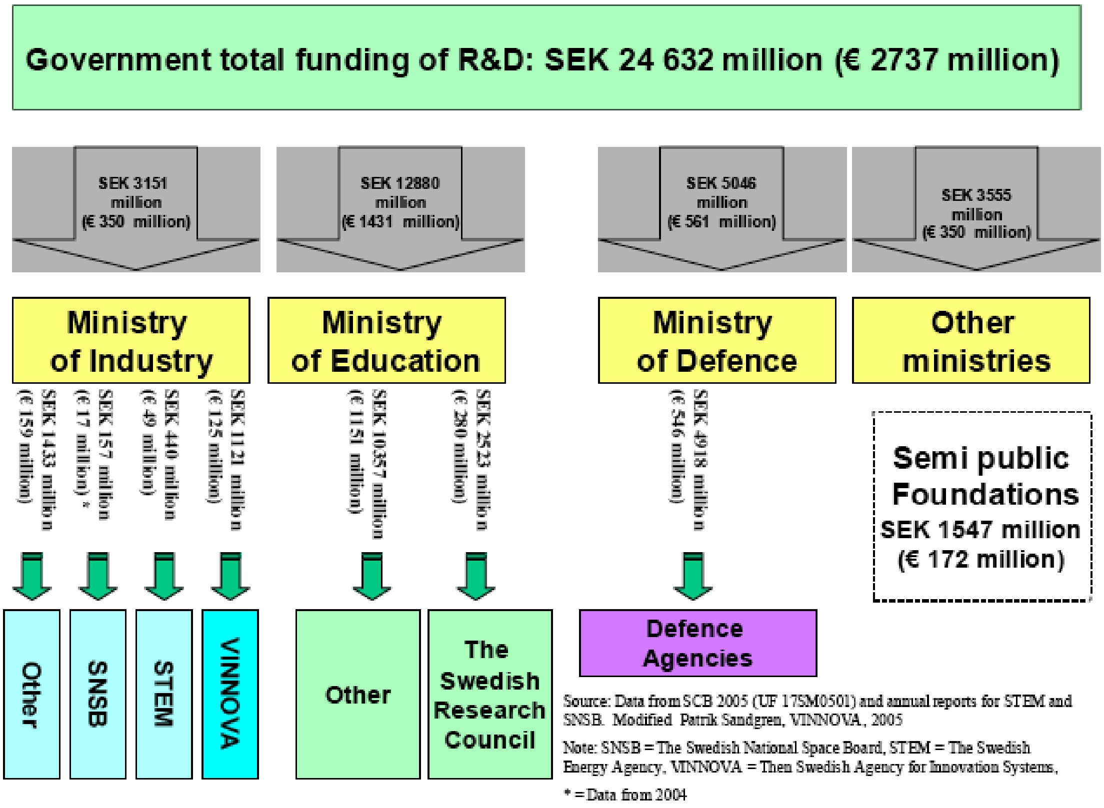
In more detail, the priority areas of the bill are:

- Research areas: Additional resources of €109 million will be devoted to research in the following sectors: medicine SEK 400 million (€44.4 million), technology (€38.9million), environment and sustainable development (€23.3 million), and some other smaller areas.
- Graduate schools. Additional funding of €85.7 million will be geared towards securing a good supply of researchers. The overall ambition is to make it more attractive to become a researcher.
- International competitive research environments (centres of excellence) - An additional amount of €33.3 million is earmarked for the creation and improvement of centres of excellence – i.e. environments characterised by a high level of specialisation in a certain research field. The idea is to concentrate available resources in such a way as to create a critical mass.
- Improved transfer of knowledge –Additional resources are allocated to measures that will improve the current knowledge transfer between universities, business and the rest of society. Four measures are used for the purpose. The biggest budget €13.3 million is allocated to the creation of new public private partnerships (PPPs) in sectors of special importance (automotive, environment technology, air and space). Public funding for PPPs must be matched by at least the same level of investment from the private business sector. The industrial institutes are allocated an extra €12.2 million in order to improve publicly financed research in the field of engineering. Some □1.08 million is earmarked for measures to improve access to research for SMEs. Closely related to this are forward-looking plans to establish a national organisation for research cooperation within the European Union, which will provide information, education, consultancy and legal guidance to business companies, especially SMEs.
- Improved possibilities of commercialisation for universities - Another important measure in terms of knowledge transfer is that universities are to establish action plans for commercialisation. The aim is to establish reliable and professional structures, characterised by a well-functioning cooperation between researchers and external actors (such as financers of research, holding companies and the knowledge intensive parts of the business community).

7.2.2 The key players in STI policy

The Swedish NIS has a two-legged structure. On the one hand, there is the business sector that conducts mission-oriented research and product development, financing close to 80% of all R&D in Sweden. On the other hand, there is the publicly financed R&D sector, which allocates a majority of the funds to the universities and the defence sector.

Figure 7.1 Overview Swedish National Innovation System



Source: TrendChart country report Sweden 2004-2005

Ministries

All ministries support research activities in their sectors of responsibility and influence Swedish research and innovation policy. The most important ministries are described below. It is important to note that the Swedish Ministries are relatively small, meaning that functions assumed by ministries in other countries to some extent fall under the responsibility of government agencies in Sweden. In addition, the local authorities and the country councils are also important actors in policymaking and financing of R&D.

The mains Ministries are:

- The Ministry of Education, Research and Culture is responsible for research policy and universities. The ministry allocates more than 50% of the public R&D and has an overall responsibility for the coordination of research.
- The Ministry of Defence deals with government business in the field of the military defence and controls some 20% of the public R&D budget.
- The Ministry of Industry, Employment and Communications is responsible for issues of crucial importance to growth and distributes nearly 15% of the public R&D budget. The ministry deals, for example, with matters relating to the labour market, working life, business, energy, space, IT, infrastructure as well as regional development.
- The Ministry of Finance has no substantial own R&D activities but is responsible for the overall budget allocation and consequently exercises significant influence on the framework of the innovation system.

Agencies

The are various bodies funding research activities in Sweden. A distinction can be made between research councils, sector agencies, foundations and bodies for policy support.

Research councils

The research councils base their activities on an approach where scientists decide the direction of research. There are currently three major public research councils in Sweden. The Swedish Research Council (VR), which acts in three separate areas: humanities and social sciences, natural sciences, engineering and medicine. VR distributes some 10% of the total public R&D budget (2005). The Swedish council for working life and social research (FAS) has the mission to promote the accumulation of knowledge in matters relating to the working life and the understanding of social conditions and processes. FAS distributes about 10% of the total public R&D financing (2005). The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (Formas) encourages and supports scientifically significant research related to sustainable development. Formas distributes about two percent of the total public R&D expenditure (2005).

Sector agencies

Sector agencies base their innovation activities on the sector model. The model means that activities are based on collaboration between societal needs and scientific interest. VINNOVA, which is the most influential financing body of mission oriented R&D, covers the areas of technology, transport and working life in order to promote sustainable growth and develop effective innovation systems. VINNOVA allocates some 5% of the total public R&D expenditure (2005).

Other important actors using similar models with a clear mission-oriented approach are the Swedish National Space Board, responsible for national and international activities relating to space and remote sensing, primarily R&D, the Swedish Energy

Agency (STEM), responsible for transforming the Swedish energy system into an ecological and economically sustainable system and the Swedish Defense Materiel Administration (FMV), responsible for the development of advanced military technology. Furthermore, the Institute for Growth Policy Studies (ITPS), a government agency that works like a think-tank, is in charge of providing analysis, policy intelligence and policy evaluation. It mainly covers the areas of economic growth, innovation systems and entrepreneurship.

Foundations

The Semi-public research foundations were created as a way to generate additional resources for strategic R&D. A board appointed by the government manages the foundations, but once a board has been constituted, public control is strictly limited and the boards are free to choose the direction of R&D. There are currently six national semi-public foundations allocating some SEK 1500 million (€166.7 million) to R&D (2005). Among these the Knowledge Foundation (KKS) and the Swedish Foundation for Strategic Research (SSF) are of particular importance for innovation policy. The two foundations allocate nearly 70 percent of all R&D investments made by the foundations (2005). The KKS promotes a broad use of IT in society and supports research at Swedish universities. The foundation also promotes exchanges of knowledge between universities, institutes and the business community, while the SSF supports strategic research in natural science, engineering and medicine.

In addition there are agencies focusing on commercialisation and entrepreneurship. The most important public actors are the Innovation Bridge, the National Agency for Business

Development (NUTEK), ALMI Business Partner (ALMI), Industrifonden and the Invest in Sweden Agency (ISA).

Research Performers

Universities

There are 14 state owned universities and 22 state colleges for higher education, as well as three private universities (Chalmers University of Technology, Stockholm School of Economics and Jönköping University).

Swedish universities and university colleges have three missions: to educate, to perform research and to interact with society. The higher education institutions enjoy a great deal of freedom within the framework of the regulations and parameters laid down by parliament and government. The institutions themselves decide how to plan their operations, utilise their resources and organise their programmes.

Most of the public financed R&D is performed at the universities. The Swedish universities receive SEK 10606 million (€1.178 million) directly from the Ministry of Education to perform research. Additional R&D funding is secured in open calls from research councils, sector agencies, research foundation (semi-public and private) and the EU as well as from industry.

The unique Swedish research doctrine has dictated that the universities should be the main providers of both “curiosity-driven” and “mission-oriented” research services (i.e. fundamental and applied research). The institute sector is very small in Sweden, and universities are supposed to take a greater responsibility for mission oriented R&D, as well as an active transfer of knowledge to the Swedish society. The universities have however not been able to develop the intended function of intermediary between academic research and industrial application and do not live up the needs of industry in terms of contract R&D. Moreover, public support of research is favouring curiosity-driven research over mission-oriented research.

Research Institutes

Because of the strong research position given to universities, the institute sector in Sweden is fragmented and small. It represents only 3% of the available public R&D resources, although there are some 30 industrial and research institutes.

Despite their modest collective size, the research institutes are on the other hand quite successful intermediaries between research and industrial application, particularly for SMEs, thus playing a vital role in the innovation system.

Industrial research institutes with a strong focus on manufacturing industries constitute some 50% of the Swedish R&D institute sector. The other half consists of government-owned institutes specialised in areas of general (national) importance such as defence, working life, infectious disease control and infrastructure.

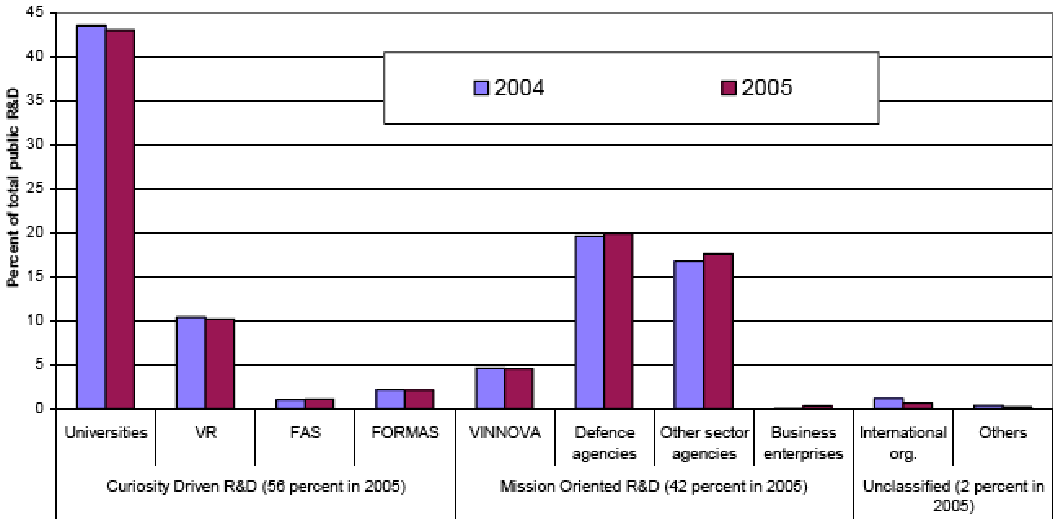
Industry sector

About 2/3 of total R&D in Sweden is financed by the business sector. Companies within telecommunication, pharmaceuticals and automotive industries represented nearly 70% of the total Swedish business R&D investments in 2003. Some 95%of business R&D is geared towards development, while the research part is marginal.

7.2.3 Funding

The actors of curiosity driven research (fundamental research) control some 56% of the public R&D resources, while the corresponding figure for the mission oriented agencies (more applied research) is 42%, 20% of which was dedicated to defence. So of the civilian public R&D expenditures a very large share, over 70%, is allocated to so-called curiosity driven basic research. This research is controlled by academic quality criteria.

Figure 7.2 Public R&D funding 2004-2005



Source: Trendchart country report Sweden, 2004-2005

7.2.4 Regional policy

Overall research policy is decided at national level. Within that framework, several sector agencies and semi-public research foundations implement programmes, including support of research, designed to facilitate development of clusters and centres of excellence, as well as university-based postgraduate schools in regions throughout Sweden.

7.2.5 Response to EU policy

Lisbon agenda and 3% action plan

Sweden already meets the aim of spending 3% of GDP on R&D (Sweden´s R&D investments correspond to 4% of GDP, whereof 1% is of public origin). Nevertheless, the government has chosen to increase the amount of public money spent on research in order to remain competitive.

Another aspect of the 3% action plans addressed in the Swedish research policy is the strengthening of the public research base and its links to industry. This is exemplified by the emphasis placed on relevance for industry in several of these new centre of excellences launched by VINNOVA and some of the semi-public research foundations. Emphasis is also placed on how SMEs can access financing and engage in R&D activities, e.g. through VINNOVA so-called VinnVäxt (Vinngrowth) programme. The issue of intellectual property rights has been investigated and debated, however, no profound changes has been introduced. Another aspect of the 3% action plan addressed is the strengthening of human resources in science and technology with specific focus on how to encourage young people to study science.

Swedish participation in EU Framework Programme (FP)

So far, no specific Framework Programme impact studies have been conducted in Sweden. The FP studies that have been conducted focus on level of Swedish participation and financial returns on national level only. These reports show that the degree to which the Swedish researchers have taken part in the programmes has exceeded expectations. After the first round of calls in the sixth Framework Programme Sweden had received €433 millions, which accounts to 4.5% of the money granted from the programme. Sweden's share has increased with each Framework Programme. Hence, Sweden received 4% from the fifth Framework Programme and 3.9% from the fourth Framework Programme. Swedish researchers are also increasingly engaged as coordinators of projects.

Response to other European initiatives

A European research council (ERC) governed by researchers and with a budget from the EU is a prioritised issue for Sweden.

The most recent research policy bill provides ample references to the ERA and introduced a reorganised national support system for participation in EU programmes to better respond to the challenges and opportunities brought on by the emerging ERA.

At present, Sweden is actively preparing its input for the seventh Framework Programme and the building up of Technology Platforms through the establishment of national branch dialogues (see section 7.4.4). This branch dialogues involves actors from industry, government and research institutes who together develop a common R&D strategy. In these dialogues the industry has taken a leading role.

7.3 Critical mass and focus of research

The recent government bill "Research for a better life" shows clearly Sweden's commitment towards research as an enabler of economic growth and prosperity. A couple of issues are raised in the bill that are of interest in relation to "focus and mass" in research.

Firstly, the bill presents additional investments in research in three key areas of strategic importance to Sweden (medicine, technology, and environment and sustainable development). Together with the funding of the Berzelii excellence Centres and the Linneaus Grant this meant a de facto focus of research efforts on a number of specific fields. The Berzelii excellence centres in particular are in line with the focus on centres of excellence in FP6 and FP7.

Secondly, the bill acknowledged the need to build and maintain critical mass in research despite tendencies of fragmentation, both in order to generate knowledge and in order to generate sufficient absorptive capacity. An other issue raised and debated is the contradiction between the need to reach critical R&D mass at the national level and the desire for knowledge-based regional development and the creation of regional clusters.

Thirdly, the bill addressed the inability to exploit public funded research. Although the level of R&D investments are at a high level in Sweden, and business R&D accounts for over 70%, it is perceived that the public funded research base remains relatively unexploited. One of the critical issues in Sweden is that universities are unable to fulfil their "third mission", while at the same time the research institutes are to small and fragmented to take over this role.

Berzelii Centres are funded by the Swedish Research Council and VINNOVA and focus on excellent basic research. The grant is awarded to universities for environments that cater for basic research in the international frontline. The purpose is to encourage the formation of research environments characterised by scientific excellence with innovation potential, i.e. with strong links to the production of knowledge that can result in new processes and products. Berzelii Centres must have a clear ambition in the long term to collaborate actively with stakeholders from the private and public centres and to put research results to concrete use in the form of commercial applications.

Support will be provided for up to 10 years. A total of four Berzelii Centres have been founded in the area of forest biotechnology, materials, bio-nanotech, and medicine.

They will be gradually developed to a maximum level of SEK 5 million each in grants per year. In addition to this, there will be co-funding from universities and colleges and from stakeholders in the private and public sectors.

To overcome this problem in the Swedish Innovation System a lot of policy measures aim at increasing the level of cooperation between industry and the knowledge infrastructure (see section 7.4.1). Good examples are the VINN Centres of Excellence, Berzelii Centres, etc. Also many research funding programmes of VINNOVA, the Knowledge Foundation, etc require some form of cooperation with the industry to ensure commercial exploitation of research results. This makes the “third mission” of the universities more tacit.

An other way to facilitate public-private interaction is to strengthen the research institutes who could act as intermediaries between research performed at universities and industrial implementation.

The **Linnaeus Grant** is awarded to universities with strong research environments where basic research in all scientific fields is carried out. Altogether, at least 14 research environments will be supported. The Linneaus Grant is a new type of long-term support for strong basic-research environments. It may be applied for only by HEIs, not by individual researchers or research groups.

The objective of the programme is to raise Sweden´s international competitiveness by granting strong research environments from all scientific fields 5-10 million SEK/year for 10 years. A first call was made in 2005, and a second will be made in 2007. The call is a co-operation between the Swedish Research Council (VR) and Formas.

Instead of distributing the faculty money directly to the HEIs, with the Linneaus Grant it is for the first time distributed in a nation-wide competition where the HEIs have nominated strong research environments within those research fields they themselves give priority in their strategies.

To summarize, achieving critical mass in a number of key research areas is high on the policy agenda in Sweden and this is clearly reflected in policy documents and different policy measures. In the Swedish tradition, this goes together with an intensive dialogue between the government, the universities and the private sector. This will be elaborated in section 7.4.4 but public-private collaboration is a key issue in Swedish research policy, also in relation to creating critical mass and focus. The main priorities in Swedish research policy are:

- focus on a limited number of high-priority research fields are life science, engineering and sustainable development;
- inter- and multidisciplinary research;
- establishment of internationally competitive centres of excellence;
- higher education institutions for research and postgraduate education, including post-doctoral positions for young researchers;
- development and implementation of a more effective holding-company structure at higher education institutions;
- cooperative programmes between government and industry;
- long-term base funding of industrial research institutes;
- measures to support access of research to SMEs.

7.4 Valorisation of research results

Despite high level of R&D investments in Sweden, it is perceived that the Swedish industry has not been able to benefit from the public investments in research. Therefore various policy measures are established to stimulate public-private R&D collaboration with a view to joint innovation activities, and to foster the use of research results (IPR) in the generation of new products and process.

The following sections provide an overview of the most important policy instruments that address the issue of "valorisation of research results" in Sweden. These policy instruments are categorised using the following categories:

- research-industry co-operation;
- commercialisation of research results (i.e. IPR);
- technology transfer by spin-offs.

7.4.1 Research-industry co-operation

The most important initiative in this area is the VINN Excellence (VINN Centres of Excellence), a development of The Swedish Competence Centres Programme. VINN Excellence provides a brand new generation of Competence Centres. The effort is to build bridges between science and industry in Sweden by creating excellent academic research environments in which industrial companies participate actively and persistently in order to derive long-term benefits. The mission is to strengthen the crucial link in the Swedish National Innovation System between academic research groups and industrial R&D. It is central to the idea of competence centres that they aim to do more fundamental types of research than is normally possible in industry, or even in conventional academic/industrial collaboration. A Centre of Excellence has two main goals:

- to become a productive, academic Centre of Excellence by actively involving a number of companies and research groups in joint research;
- to promote the introduction and implementation of new technology and to strengthen the technical competence in Swedish industry.

An evaluation of the competence programme by Technopolis in 2004[108] showed that the competence centres have proved to be a massively successful instrument. The design has been imitated in Austria and has influenced competence centre programme designs elsewhere. A strong and positive signal about the programme is the enthusiasm of the academic and industrial communities for it, and their willingness to commit to and invest in the centres over very long periods of time. Important outcomes of the programme include:

- substantial research productivity, with large numbers of academic outputs (papers, PhDs and so on) in addition to industrial outcomes;
- inspiration of research by industrial problems, generation of new knowledge and its transfer and use in industry – both established and new – to raise the rate of innovation;
- increased research specifically on fundamental questions of industrial relevance, in a way that is difficult to co-ordinate and exploit using other steering mechanisms;
- development and strengthening of the R&D networks that are core to innovation systems;
- movement towards critical mass in R&D in some areas;
- contribution to the retention of R&D and manufacturing in Sweden by large Swedish-based firms.

7.4.2 Commercialisation of research results

Since the 1940s, there has been a discussion in Sweden about the importance of making university research useful for society (“third mission”). During the last decades, a number of different organisations were established with the aim to facilitate the commercialisation of the research results. Due to the economic crisis in the 1990s, further emphasis was placed on how the research results could be exploited commercially and how they thereby could contribute to increasing the employment through the development of new firms. An example of a policy measure implemented in the beginning of the 1990s was the establishment of eleven holding-companies which were closely connected to the universities. It is against this background that the Swedish universities today have strong measures to support and strengthen the incitements for the commercialisation of research results (e.g. through the holding-companies), but that these measures could be developed further.

A proposal by VINNOVA to improve commercialisation and to increase returns of research investments at universities[109] presented a number of suggestions concerning how the support structures within the universities could be developed. For example, it is suggested that the universities should own the right to use the profit made in the holding-companies. It is also important that the universities develop a clear and positive approach to the commercialisation of research. In addition, the report also highlights the necessity to develop legal structures which to a greater extent than it is the case today form a protection towards trespassing of patents. The policy document also concludes that the so-called “lärarundantaget” (i.e. the teachers/researchers’ right to own their findings (i.e. research results) and exploit them, instead of the universities) should be kept, at least for

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[108] Arnold, et al. (2004),.Impacts of the Swedish Competence Centres: Report to VINNOVA and the Swedish Energy Agency.

[109] VINNFORSK - VINNOVA's proposal to improved commercialisation and increased returns in growth of research investments at universities – Discussion and strategy document. Vinnova.

the moment. However, a possibility for the researcher to report formally his or her findings to hosting university should be introduced. Finally, it is proposed that VINNOVA should take on the assignment to develop indicators of the progress and publish them every second year.

7.4.3 Technology transfer by spin-offs

To overcome the financial barriers for new and small research intensive businesses (lack of (venture) capital in early phase of growth, valley of death, etc) VINNOVA has set up a so-called "technology bridge, which should provide a supporting infrastructure for these (start-up) companies. Within this programme fourteen regional incubators were established, which were closely located to the universities. The evaluation of this pilot programme was very positive. Some figures:

- The rate of return on the public investments is about 4-6 times the money invested.
- The flow of new ideas, has increased with 69% totalling 934.
- The number of companies within the 14 incubators has increased with 43% totalling 255.

In 2005 these local incubators are put under a newly established national foundation called Innovationsbron[110], which aims to contribute to the commercialization of research-based and knowledge-intense business ideas. It is a national organisation with seven subsidiaries. This enables them to provide regional support with local knowledge, networks, and proximity to existing competence and expertise at universities and other institutes of higher education and links to the business community.

Innovationsbron is financed by Swedish government, Teknikbrostifterserna (group of investment foundations), VINNOVA and Industrifonden and manages a budget of approximately. €200 million (2 billion SEK) over a 10-year period.

7.4.4 Public-private partnership

Sweden has a long tradition in public-private partnership and according to ERA-Watch the importance of PPP is increasingly recognised in Sweden. Some recent development include:

- Branche dialogue. This a recent but very important development in Sweden. In June 2004, the Government published a report outlining its innovation strategy "Innovative Sweden: A Strategy for Growth Through Innovation". This strategy serves as a platform for enhancing Sweden's position as a knowledge society. As part of this strategy the government and the business have organised different "branch specific dialogues" to develop a common strategy. In general, these strategy plans outline a common vision and puts forward an action plan for achieving this vision on the basis of a collaborative endeavour by enterprises, government agencies and other stake-holders. Often common research strategies or even research programmes are developed together. Some sectors prepare for active participation in FP7 or the European Technology Platforms. The six industry sectors that have developed a common strategy are (with links to the strategy plans):
  - Automotive (http://www.regeringen.se/content/1/c6/05/65/80/fac12156.pdf)
  - Pharmaceutical, biotechnology and medical technology (http://www.regeringen.se/content/1/c6/06/12/60/ea55a20e.pdf)

[110] www.innovationsbron.se

- Aerospace (http://www.regeringen.se/content/1/c6/06/73/31/a3fbaeba.pdf)
- Forest-products (http://www.regeringen.se/content/1/c6/06/73/21/7de3aceb.pdf)
- IT- and telecommunication: (exists only in Swedish)
- Metallurgi (http://www.regeringen.se/content/1/c6/05/94/41/0d16aa22.pdf)

- The research institutes, most of which are partly owned by industry, have received somewhat higher funding through the most recent research bill "Research for a Better Life" and their role and funding is receiving renewed attention.
- Co-funding between government agencies and semi-public research foundations on the one hand, and industry on the other, on both project and program levels is used in a number of areas to foster development of industrially relevant knowledge in universities, colleges and institutes and absorption capacity in industry.
- Both academically based and research-institute based competence centres featuring notable industry involvement (funded by research councils, VINNOVA and semi-public research foundations). One example is VINNOVA's Vinn Excellence Centres.
- The so-called "third mission". Apart from educating (first mission) and performing research (second mission) universities and university colleges in Sweden are obliged to engage activities that will contribute to communicate research results to actors outside the academy, especially industry.
- A range of programmes funded by VINNOVA to support mission-oriented, pre-competitive R&D in collaboration between R&D providers and industry. Typically, private enterprises make in-kind contributions amounting to 50% of the project budget, while R&D providers receive equally much in public funding.
- Ad-hoc groups with representatives from both public and private stakeholders formulating policy recommendations, e.g. to improve the business environment in general or in a specific industry sector, or to foster growth.

7.5 Conclusions

Sweden´s R&D investments correspond to 4% of GDP, whereof 1% is of public origin). Nevertheless, the government has chosen to increase the amount of public money spent on research in order to remain competitive. Therefore research policy plays a central role in Sweden's innovation system and many objectives are established to maintain Sweden has a position as a leading knowledge and research nation where research of high scientific quality is conducted.

The newest government bill “Research for a better life” presents additional investments in research in three key areas of strategic importance to Sweden (medicine, technology, and environment and sustainable development). Together with the funding of the Berzelii excellence Centres and the Linneaus Grant this meant a de facto focus of research efforts on a number of specific fields. The Berzelii excellence centres in particular are in line with the focus on centres of excellence introduced in FP6 and FP7.

Achieving critical mass in a number of key research areas is high on the policy agenda in Sweden and this is stressed in the government bill and the initiatives like the centres of excellence. In the Swedish tradition, this goes together with an intensive dialogue between the government, the universities and the private sector. This is illustrated by the national branch dialogues. These branch dialogues involve actors from industry, government and research institutes who together develop a common R&D strategy, define programmes, prepare for FP7 or the European Technology Platforms, etc. In these dialogues the industry has taken a leading role.

Despite high levels of R&D investments in Sweden, it is perceived that the Swedish industry has not been able to benefit from the public investments in research and that the commercial exploitation of public funded is limited. One of the critical issues in Sweden is that universities are unable to fulfil their "third mission" (i.e. transfer of knowledge to industry and society), while at the same time the research institutes are to small and fragmented to take over this role. Therefore various policy measures are established to stimulate public-private R&D collaboration. The most important and successful initiative in this area is the VINN Excellence (VINN Centres of Excellence), a development of The Swedish Competence Centres Programme.

8. Switzerland

8.1 Introduction

Switzerland has been stuck in a low-growth trap during the last couple of years. Economic activity seems to be partly affected to some extent by unfavourable conditions in Europe – lately the conditions have improved significantly and also in Switzerland economic growth has picked up again. Nevertheless the low trend growth in the past few years might have more structural roots. Growth of production and per capita income has been among the lowest in the OECD for many years, largely reflecting weak productivity gains. In the absence of a significant pick-up in productivity, trend output growth will decline further due to population ageing, inducing growing fiscal pressures.

The unfavourable situation is directly linked to the nation's STI-policy. The major challenges of Swiss are to raise growth performance – and STI is a major factor in productivity gains – while simultaneously restoring better control of public spending – which implies that public spending on S&T is also under pressure.

Switzrland has a very strong track record in R&D and even ranks number 1 in the most recent Innovation Trend Chart. There seems to be little room for further improvement – so much for the first challenge. However in comparison to other OECD countries public R&D is concentrated on basic research, and the (indirect) funding of private sector R&D is very low[111]. The leading position of Swiss is largely due to the strong performance of the private sector[112]. Most gains can thus be made in public strategic research – hence the valorisation of public research is a core element in meeting the first challenge.

Improving the performance of the public strategic research would usually imply an increase in public R&D expenditure. Indeed in the national R&D plan 2004-2007 (ERT-Message, see hereafter) an overall annual increase of 6% was foreseen[113]. Due to the increased overall budget deficits already in the first year budget cuts have occurred. However in relative terms the impact of these cuts is limited and they are most likely not to reoccur in the face of the more favourable economic conditions right now[114]. Nonetheless for the policy aim of increasing valorisation of public research this means that substantial emphasis will be placed on conducting research in a more efficient way (e.g., by carrying through increases in scale).

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[111] This can be partly explained by the complete absence of military research.

[112] For instance, although public funding of private research is low, private funding of public research is exceptionally high.

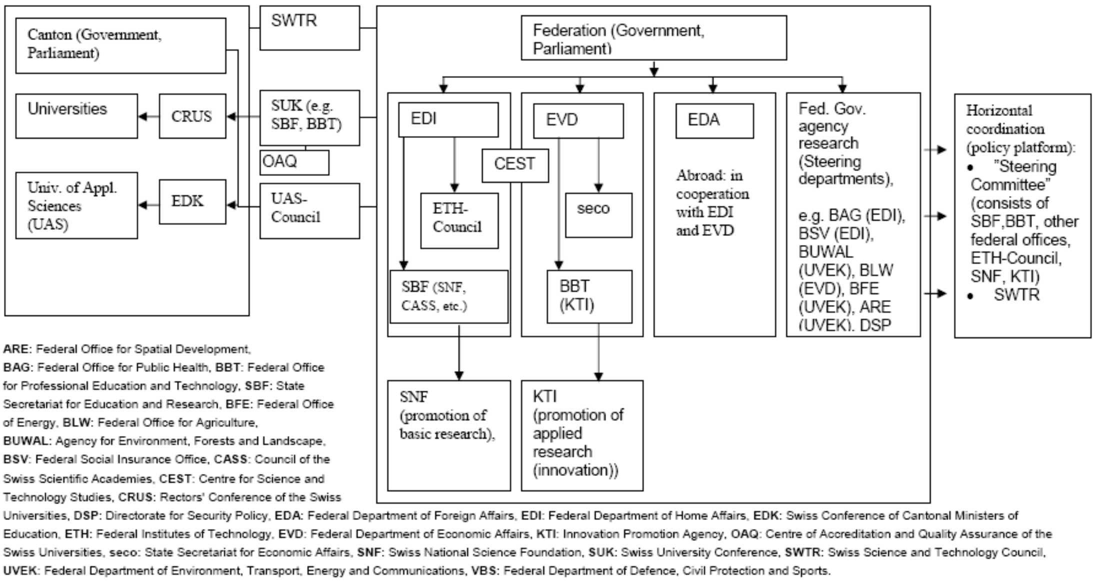
[113] In absolute terms this amounts to an increase of €2.1 billion compared to the previous period (2000-2003), bringing the total budget available for the entire four-year period at €11,7 billion which is very near to 1% of GDP at an annual base.

[114] In relative terms the impact of these cuts is limited (about 1% across the board) but some recipients are more effected than others. CTI for instance (see hereafter) had to hand in 15% of the planned budget. For the next four-year plan (see hereafter) which covers the period 2008-2011, a minimum increase of 4% has already been laid down and might be raised by another 2-4%.

8.2 Institutional setting

In Switzerland the federal authorities share responsibilities with cantons with regard to STI. The cantons have a lot of autonomy, especially in the field of education but somewhat less in the field of tertiary education and research[115]. Over the years, there is a gradual but steady shift in power from the cantons to the federal government. A recent indication in the field of STI is the revision of the Education Chapter which redefines the division of authority in favour of the Confederation (*Bund*). Innovation policy was already predominantly centralised at the federal level and as such has always been one of the few areas where the contribution of the cantons was – and is – limited.

Figure 8.1 Overview Swiss National Innovation System



Source: Trend Chart Country Report Swiss 2005

8.2.1 The key players in STI policy

The responsibility for STI policy is divided between the Ministry of Economic Affairs (EVD) and the Ministry of Interior Affairs (EDI). Switzerland does not have a separate ministry for science and/or education. There is a clear division in labour between the Ministry of Interior Affairs (dealing with science policy and fundamental research) and the Ministry of Economic Affairs (dealing with innovation policy, applied research and vocational training). No formal body for the co-ordination of STI at the ministerial level (along the lines of the Finnish Innovation Council) exists. The present 'steering committee' has only limited interministerial power and mainly deals with departmental research.

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[115] Overall the autonomy of the cantons is really high, also in the field of STI. For instance, over 50% of S&T expenditure comes from the cantons, against 30% from the municipalities and less than 20% from the Confederation. At the university level, the share of the Confederation is much higher: about 65%.

The particular setup of the Swiss STI-structure should be interpreted against the light of the rather unique overall institutional design. The Swiss federal government has only seven Ministries and no primus inter paribus (no prime minister or so). Consequently each Ministry covers a broad policy area. This explains for instance why there is no separate Ministry for Education and/or Science. Due to the limited number of actors co-ordination costs are relatively low. Also, the Ministry of Economic Affairs and Interior Affairs usually have already come to a common agreement before they bring an issue to the table in the interministerial consultation. Thus without a clear institutional presence effectively there is a lot of co-ordination.

The ETH-Council, which is responsible for the two federal (technical) universities (ETH Zürich and ETH Lausanne) and the four federal research agencies[116], is under the Ministry of Interior Affairs and so is the recently established State Secretariat for Science and Technology (SBF)[117]. SBF administers the most important funding agency, the Swiss National Science Foundation (SNSF), and the Council of the Swiss Scientific Academies (CASS). SNSF is a foundation and operates independent from the government[118]. It aims at promoting research excellence carried out at Swiss universities and the ETHs through a series of funding programs such as the National Research Programmes (NRP) and National Centres of Competence in Research (NCCR).

The Federal Office for Professional Education and Technology, BBT, is under the Ministry of Economic Affairs. The Office coordinates three different areas: vocational training, the federal oversight on the cantonal Universities of Applied Sciences (UAS), and innovation policy. The actual implementation of the latter is delegated to a separate unit, the Innovation Promotion Agency (KTI a.k.a. CTI). CTI focuses on knowledge and technology transfer and fosters the innovation abilities of Swiss firms (with a particular focus on SMEs) and the entrepreneurial abilities of the Universities of Applied Sciences. CTI is the main funding institution in the Swiss STI system, next to the Swiss National Science Foundation [119].

Two important bridging institutions between the federal and cantonal level are the Swiss Science and Technology Council (SWTR), the umbrella S&T advisory council, and SUK, the Swiss University Conference. SUK is a joint institution from the Bund and the cantons and responsible for the quality control of the (cantonal) universities. Is also makes periodical assessments of how the Science Foundation allocated tasks among universities throughout Switzerland by means of its National Centres of Competence in Research programme. The University Conference also issues directives on knowledge transfer in research and makes recommendations on cooperation between universities (e.g., balanced distribution of tasks). SWTR is a politically independent advisory body of the government. It is involved in high-level co-ordination, both horizontally (with other federal political bodies outside the Ministries of Interior and of Economic Affairs) and vertically (with cantonal political bodies).

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[116] ETH Zürich and ETH Lausanne, and the Paul Scherrer Institute (Physics), Swiss Federal Institute for Forest, Snow and Landscape Research, Swiss Federal Laboratories for Materials Testing and Research, and the Swiss Federal Institute for Environmental Science and Technology.

[117] SBF is a merger of the former Federal Office for Education and Science (BBW) and the Swiss Science Agency (GWF).

[118] It is not financially independent but partly directly funded by the government (EDI).

[119] CTI's planned budget for the period 2004-2007 – before the cuts – is about €315 million (or €68 million on an annual base). SNSF's budget is more than four times higher: €1450 million (or €363 million on an annual base).

Together with SBF and BBT, SWTR draws up the important four-year STI-plan, the so-called 'ERT-message' (see 8.2.2)[120].

The major research units within the public sector research system are the (2) Federal Institutes of Technology (ETH), (4) federal research institutes, (12) cantonal universities, and (7) Universities of Applied Research. The UAS were launched in 1998 and focus on immediate applications rather than long-term projects[121]. That is the realm of the ETHs and the cantonal universities.

8.2.2 Main developments in STI policy

The ERT-Message 2004-2007 contains the STI policy objectives for that period and also gives a description of the proposed measures to achieve these objectives. The overall budget is about €11.7 billion, a 18% increase from the previous period. Within the overall budget, there are considerable differences in growth rates between the various main items. (see table 8.1).

Table 8.1 Overview of the ERT 2004-2007 budget (€ million)

	2000-2003	*2004-2007*	*change*
Research, innovation and valorisation of knowledge (SNF & CTI)	1.414	2.022	30%
of which allocated to SNF	*991*	*1451*	*32%*
of wich allocated to CTI	*208*	*316*	*34%*
International cooperation (esp. EU)	82	122	33%
of which European Research Area (FP & COST)	*59*	*70*	*16%*
Educational assistance	259	268	3%
Vocational education	1.161	1.443	20%
Universities of Applied Sciences (UAS)	577	770	25%
Cantonal universities	1.425	1.804	21%
ETHs	4.706	5.291	11%
totals	9.625	11.720	18%

Main priorities, with the most relevant measures, in the current policy are:

1. Updating the teaching structure of the ETHs and Universities of Applied Sciences.
   - Promotion of research priority areas in the fields of life sciences, nanotechnology, ICT, material sciences, the environment and risk management at the ETHs.
   - Focus on UAS study courses which do not have sufficient critical mass (see 8.3.2).
2. Increasing research activities by the National Science Foundation (SNSF).
   - Greater emphasis on and financing of independent basic research projects.
   - Greater financing of research in the humanities, social sciences, and research infrastructures.
   - Establishment of three to six additional National Centres of Competence in Research (NCCRs).
3. Promoting innovation by the Innovation Promotion Agency (CTI)

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[120] 'Message concerning the promotion of Education, Research and Technology'. The current ERT-message covers the period from 2004-2007.

[121] The label 'UAS' is somewhat misleading. They should be rather regarded as polytechnics.

4. Development of the CTI start-up initiative
   - setting priorities in the areas of life sciences, nanotechnology, and ICT.
   - expansion of activities in the framework of ESA, EUREKA, and the Intelligent Manufacturing Systems program[122].
   - development of competencies in applied R&D in the Universities of Applied Sciences.
   - promotion of 'Discovery Projects' (higher risk, with high potential market value).
5. Intensifying national and international cooperation
   - participation in FP-6 (see 8.2.3).
   - creation of 'Swiss houses for S&T exchange' abroad.
   - development of a scholarship programme for foreign students in Switzerland.

The main vehicles for the implementation of the measures are the National Research Programs (NRPs) and National Centres of Competence in Research (NCCRs) from SNSF and the initiatives from CTI. There is a logical order assumed between these vehicles. The EU FP-programmes are positioned between the NCCRs and the activities of CTI.

The National Science Foundation (SNSF) allocated about 15-20% of its annual research funds for targeted research (NRP and NCCR). The rest of the funding goes to basic research projects. The main part these projects are scientist-driven projects. About 20% are so-called Swiss Priority Programs (SPP) of which the topics are decided upon by Parliament.

These Priority Programmes should ensure that Swiss research keeps up with international developments and support the establishment of Centres and Networks of Competence at Swiss universities. They are designed to cover research areas of strategic importance. SPPs run 8 to 10 years and are receive between €40 to €75 million. There are currently four SPPs: social sciences, biotechnology, ICT, and environment.

National Centres of Competence in Research (NCCRs) are directed towards forward-looking areas that strengthen structures of the Swiss research scene. The Centres should conduct excellent research (from international standards) and actively foster the transfer of knowledge and technology. Each Centre receives between €3 to €7 million which is supplemented by funding from the universities involved and third parties. They run for 4 years. There are currently 20 Centres. Research used to be heavily biased towards natural sciences but recently 6 Centres within the social sciences were added to the total of 14.

National Research Programs (NRPs) deal with "immediately pressing problems of national importance". The topics are chosen by the Swiss federal government. The programs generally require an interdisciplinary approach to research and a combination of theoretical research and practical application. NRPs typically also last 4-5 years and receive funding

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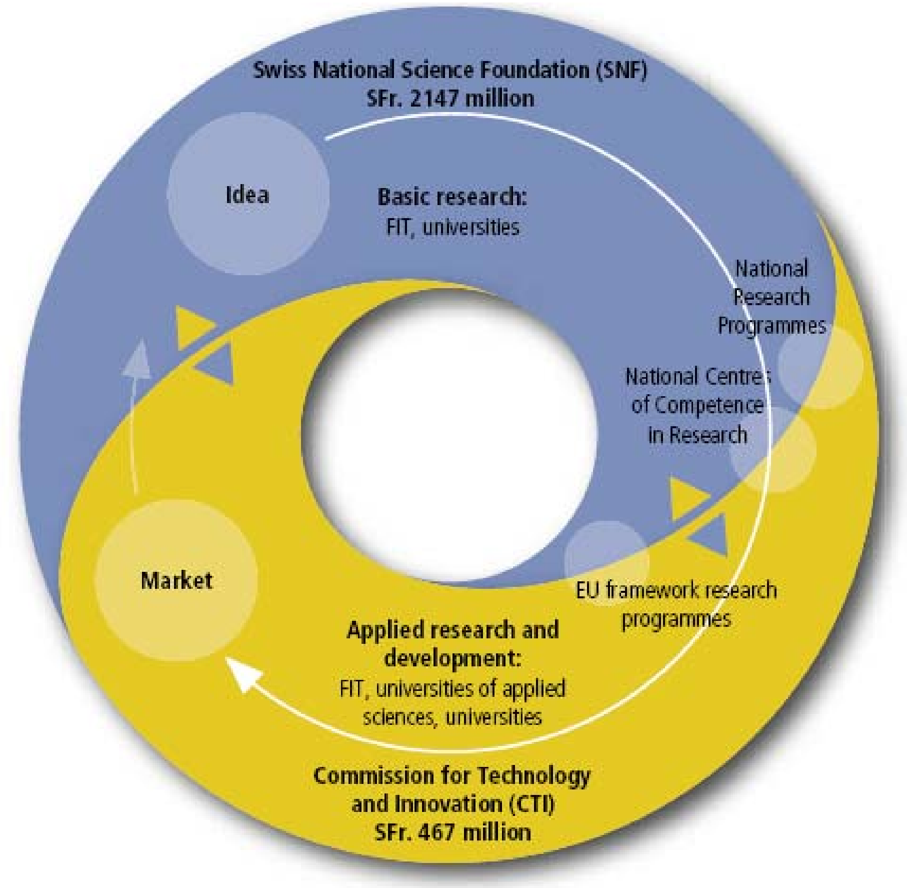
[122] The Intelligent Manufacturing Systems (IMS) initiative is an international research and development collaboration scheme. It provides a framework within which industrial and academic players can identify RTD issues and potential research partners worldwide so that they can carry out collaborative projects, conduct broad-based technology trials and set up networks. IMS was founded in 1995 by Switzerland, together with Australia, Canada, Japan and the US. Two years later the EU (together with Norway) joined the program and it became part of the broader FP-6 framework. In 2000, South Korea also linked up with IMS. Since its inception, a total of 40 active projects have been launched, representing an international commitment of around €500 million and an involvement of 850 companies and research organisations.

from €4 to €14 million. There are currently 14 NRPs running. The focus on temporary policy-driven problems appears from the relatively large share of social science (5) and medicine (4) and a modest share of natural sciences programs (4)[123].

Figure 8.2 The Swiss valorisation chain



Source: ERT Message 2004-2007

The Innovation Promotion Agency (CTI) is the only institution within the Swiss STI system which is – already over 60 years – dedicated to the transfer of knowledge and technology between businesses and universities[124]. It has three major lines of action. It supports project R&D (almost 1,500 projects between 2001 and 2005 alone), it facilities international and national research networks (e.g., centres of excellence at the Universities of Applied Research), and it promotes innovative start-ups (e.g., via its Start-up Campaign)

[123] Compare the changing focus of the National Centres of Competence in Research.

[124] CTI will be treated at length in paragraph 4 ('valorisation').

8.2.3 Response to EU policy

Lisbon and Barcelona objectives

Switzerland has a very strong tradition of neutrality. It is not a member of the EU neither to become one in the foreseeable future. As such it is not formally bound to the Barcelona objectives in any way. However it is likely that the Swiss government does not want to step out of pace too much with its neighbours and OECD peers.

EU Framework Programme

Since 1 January 2004 Switzerland has taken part as an associated nation in the 6th Framework Research Programme (FRP); i.e. the same conditions for participation apply to Swiss researchers as to their colleagues from EU member states. It contributes €140 million per year to FP6[125]. In turn Swiss researchers (and SMEs) get funding directly from the European Commission. One of the explicit aims of participation in the EU initiatives is to return as much of the financial contributions to Switzerland once again.

CTI evaluates projects for EUREKA and Intelligent Manufacturing Systems and funds Swiss partners in the projects. It also funds projects generated by ERA-NET calls, and plans to do so for activities of FP-7. Currently it takes part in the ERA-NETs MNT (nanotechnology), MATERA (material technologies) en e-TRanet (ICT in manufacturing). With regard to the latter, CTI wants to establish a national technology platform on manufacturing which should then be integrated in the existing EU Technology Platform (Manu*future*).

Whether and to what extent CTI will continue co-funding EU projects depends on the outcome of the coming (2007) discussions in the Swiss parliament on the future participation of Switzerland in EU programmes[126]. In FP-7, for the first time, basic research will also be funded. This is a favourable change for Switzerland, given its strong focus on and particular strength in basic research. On the other hand, given the tight federal budget funding of foreign research might be one of the obvious items to economize. In the ERT 2004-2007, expenditure on international research cooperation saw only a relatively modest rise (16%) whereas expenditure on bilateral and multilateral activities (see 2.2, last two items under 5) grew with 55%.

In its official reaction to the EC's draft STI policy[127], the Swiss government fully supports the 3%-Lisban target but adds that this input-oriented objective has to be supplemented by systematic monitoring of the effect and output of European public research funding with a special reference to the leverage on private R&D spending. With regard to the collaborative instruments of the Framework Programs (e.g., Integrated Projects and Networks of Excellence) the Swiss government explicitly mentions the notion of critical mass and says that is must be adapted to the research area as well as to the objectives of each instrument. In other words, the *instruments in FP-7 should not promote projects with more partners than necessary or desirable.* It is rather sceptical about the new instrument

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[125] More precisely, €124 million to EU research programs, €74 million to ESA (European Space Agency), €44 million to transnational research institutes (such as CERN), and only €9 million to Eureka and IMS together.

[126] For instance, in the new type of Competitiveness and Innovation Programme [CIP] which will run from 2007 to 2013. The choice for the Parliament is to enter into considerable long-term financial commitments (FP-7) or to return to the much more limited project-based arrangement which existed prior to FP-6.

[127] European Commission's Communication 'Science and technology, the key to Europe's Future' (16 June 2004).

of 'Technology Platforms'. The success of such platforms depends on a strict (sic!) bottom-up approach and should be only driven by the industrial and academic sector. Technology Platforms should be co-financed by private partners from an early stage on and in a significant way. Management structures of the Platforms should remain lean, transparent and efficient, with the lowest possible overhead possible. The existing EUREKA-clusters might serve as an example here. In a similar vein, the project of the European Research Council should be abandoned altogether if it cannot be guaranteed that the funding mechanism will be implemented independently of the existing administrative structures within the Framework Programme, and that it can operate in complete autonomy.

8.3 Focus and critical mass of research

8.3.1 Focus

Focus at the level of the federal government

It has been mentioned before that the Swiss STI system has no formal co-ordination body at the federal level. Whether the government will be able to bring focus to the system as a whole depends to a large extent on the way the two core actors in the system – SBF/SNSF for basic research and BBF/CTI for applied research – adjust their research agendas internally and externally. Although the Swiss STI structure is quite well-organized there is considerable pressure to unite SNSF and CTI. Partly in response to the pressure there is already a lot of consultation between the heads of the two institutions.

Nevertheless the current research agendas do not (yet?) seem to reflect fervent cooperation. There is an overall focus on life sciences, nanotechnology, ICT, material sciences, and biotechnology. However this covers such a wide range of topics – of which many fields are usual suspects – that one could hardly speak of focus. Furthermore there is already little overlap between the three lines within SNF, let alone between SNF and CTI[128]. When these would have been complementary lines of action this could have been taken as an indication of proper co-ordination. However assumingly there is a certain order of rank between the programs, starting from the National Science Foundation's Priority Programs (SPPs) via its the National Centres of Competence in Research (NCCRs) and National Research Programs (NRPs) to CTI's EU participations and R&D support projects (see exhibit 3). One could expect a follow-up downstream on research themes there were selected upstream. This does not seem to be the case. Thus there is no clear focus on a limited number of strategic research areas.

Within the specific line of action of the National Research Programs (NRPs) there is a clear concerted action to link ongoing research to certain specific themes. Periodically SBF invites proposals for new Programs. Both individuals, organisations, and academies can submit suggestions. The Ministry of Interior Affairs then review the proposals to ensure that they address a problem that is socially, politically and/or economically relevant. Thus there is focus, but not geared towards industry needs but to concrete policy problems.

Next, the National Science Foundation looks in detail at the scope of the proposed National Research Programs and checks whether they can be realized from a scientific point of view – that is, what practical benefit can be expected and whether there are enough qualified researchers available in Switzerland within the particular area at hand (see 8.3.1.).

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[128] An obvious exception being NSF's recently added NCCR on aging and CTI's ISA program. However ISA seems to be somewhat of a stranger within the portfolio of CTI.

The overall lack of focus might generally not be regarded as a problem. In the particular setting of the Swiss STI-system the public pole functions as an infrastructure to the industry rather than a service provider. The (big) private R&D-sector needs a steady supply of high quality research and researchers. It can cater for most of the short and medium term industry needs itself. Strategic alliances are very frequently being sought but they will be on the level of individual research groups and rather be triggered by the scientific excellence of the work than the direct usability of it (that is, the connection with the current industry needs). Industry will eventually find the hotspots of scientific excellence – either abroad or in Switzerland – it would even be rather suspicious to see a public research institute actively looking for private clients.

Such an industry pull is facilitated by a clear profile of the individual public research institutes. The National Centres of Competence in Research program plays an important role here since it always places a particular competence in one particular university and/or team and from there links to other teams in the same field throughout the country.

In short, there is no overall focus in the sense of a jointly defined national research agenda by the public research bodies and private industry. There is nevertheless a lot of public private collaboration, but this is usually initiated by the private sector (see 8.4).

Focus at the level of research groups

The bulk of the funding of the National Science Foundation goes to conventional scientist-driven basic research projects. Funds are allocated independently to individual researchers and research groups. In the case of National Research Programs on the other hand, the Foundation actively leads and coordinates research and promotes interaction between researchers, practitioners, and the steering committee. For this purpose, it organizes on-site visits and workshops.

Focus at the level of institutions

There have been various initiatives in establishing research networks between the ETHs and/or cantonal universities (see also 8.3.2). Most of these networks are local in nature (e.g., between ETH Zurich and the cantonal University of Zurich[129]) but some are sizeable networks which span the entire country. Most notable examples are the Neuroscience Center Zurich – which compasses over 100 research groups in 34 institutes, SystemsX – a €20 million research enterprise for system biology, and the recently established Swiss Finance Institute – a public private partnerships between banks and universities.

8.3.2 Mass

Mass tout court

The ERT-Message 2004-2007 identifies life sciences, nanotechnology, and ICT as priority fields. These are not spectacularly original choices as the rest of the world also seems to have targeted these areas as strategic ones. Thus the overall focus (insofar as one could speak of a focus – see before) is to follow the global research crowd rather than to take a distinctive direction. The basic thought of course being that public research in Switzerland should at least be on the fields that seem to matter, so as to support the absorption capacity of the Swiss private sector.

[129] Amongst other the Functional Genomics Center Zurich, Life Science Zurich, and the Interuniversity Partnership for Earth Observation and Geocomputation.

Critical Mass

The Master Plan reform tertiary education explicitly mentions the reallocation of tasks between different universities in very cost-intensive areas. Due to financial restrictions universities seek collaborations with other universities in certain science fields to overcome these financial restrictions and to reach a critical mass: e.g. the schools of pharmacy (only two schools left) and faculty of veterinary medicine (only one left). Moreover, there has been a portfolio reorganisation in natural sciences between several universities (e.g. the University of Lausanne and the Federal Institute of Technology Lausanne; the University of Berne and the University of Fribourg).

At the same time, a bottom-up concentrations seems to a occur within the university landscape, with a shift from the cantonal universities to the ETHs. Whereas there has been an overall (modest) drop in S&E graduates the number of students are the ETHs has steadily risen. The two federal institutes attract the bulk of students in science and engineering.

8.4 Valorisation of research results

In contrast to many other countries, direct funding of business R&D has no tradition in Switzerland. R&D subsidies of the business sector are not even a subject of discussion in parliament. Innovation and technology policy focuses on knowledge and technology transfer and valorisation of knowledge through network building and co-operations between public research institutions and business firms in a so called public-private partnership (the key actor being CTI). Thus the Swiss promotion of business R&D and technological innovation emphasises strongly a supportive infrastructure for business R&D. This includes an attractive regulatory and administrative environment for business firms (including a highly effective IPR regime), well-educated graduates of schools of higher education (especially in high-tech fields) and excellence in basic research. The very high proportion of basic funding by the federal government of the ETHs (85%), cantonal universities (81%) and the Universities of Applied Research (96%[130]) illustrates the focus on basic research.

Although some initiatives could be labelled as public-private partnership (e.g., the industry-sponsored professorships at the University of Basle and the earlier mentioned Swiss Finance Institute) there has been no deliberate national strategy for such partnerships. In general, the government follows a restrictive policy of funding for public private partnerships in form of knowledge platforms in certain business branches because of the weak financial commitment of the industry. However framework conditions for PPPs differ from one industry to another because of the size of firms (favourable in the finance sector and unfavourable in for instance the machine industry sector). The general model is that in public-private partnerships the government only covers the costs of the public partner (cf. the setup of CTI R&D projects). This means that in (financial) statistics the (frequent) collaborations between public research institutions and private firms do not show up.

There are hardly any large-scale public-private partnerships on R&D. At the micro level, though, CTI is actively supporting the transfer of knowledge and technology between businesses (esp. SMEs) and universities (esp. Universities of Applied Research). It especially aims at innovative R&D projects with serious market potential. Although project managers are free to choose the subject matter, after a recent restructuring CTI especially

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[130] This figure includes investments (e.g., in facilities) and is thus slightly exaggerated. Based on the available split for cantonal universities, the corrected figure for basic funding would be around 80%.

focuses on life sciences (biotech and medical technology), microsystems/nanotechnology, engineering, and enabling sciences (management, ICT, production, logistics, and design). In addition a special initiative on aging has been established131. Projects always require a 50/50 participation between industry and non-profit research institutes (with the private firm usually in the lead). Funding is exclusively done in natura – CTI pays the salaries of the university researchers involved in the joint projects132. For the so-called 'Discovery projects' which aims at researchers who are planning to develop a highly innovative projects from their existing basic research but who lack patents and feasibility studies to do so the 50/50 rule does not apply – the participation of private industry is not a pre-requisite. However there will be an ex ante screening to see whether the potential 'Discovery project' cannot be funded by CTI's conventional R&D project scheme or by basic funding from the National Science Foundation.

Next to R&D project funding, CTI also facilitates international and national R&D networking. CTI seeks a balanced commitment to key international programmes and organisations with an explicit reference to valorisation. It is argued that participation in international R&D programmes will shorten the time to market for excellent innovative ideas, as there will be no national boundaries to stand in the way of research and development (see 8.2.3). At the national level, CTI supports and coaches the set-up and further development of the R&D consortia of the UAS and the establishment of service centers for knowledge transfer and IPR ('Knowledge & Technology Transfer, or KTT)[133].

Finally, CTI promotes innovative start-ups, either by training students and young entrepreneurs ('Venturelab'), by making it easier for potential start-ups to attract seed capital ('Start-up label), and eventually by directly investing in these start-ups by means of its own VC, ('CTI-Invest'). 'Start-up label' is an audit process for technology business proposals. About 10% of the reviewed proposals (over 1,000 in the period 1996-2005) received the CTI Start-up quality label which makes it significantly easier to acquire external (seed) funding[134]. Due to the success of CTI Start-up label the federal government has significantly increased the funding of the programme[135].

8.5 Conclusions

The Swiss STI system has a rather peculiar set-up, with a relatively large share (75%) of the private sector in overall S&T expenditure which concentrates less on large firms than in other countries. Usually the dominance of smaller firms results in a bias towards applied research but in the exceptional case of Switzerland there is a rather strong focus in basic research – both in the private and especially in the public sector.

The responsibility for STI policy is neatly divided between the ministries of interior affairs (science) and economic affairs (technology and innovation). There is no separate ministry

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[131] 'Innovation for Succesful Aging' (ISA) aims at targeting research and development projects that take the specific needs of elderly people into account and leads to innovative solutions in the market.

[132] This involves around 1,000 researchers a year. These salary costs make up about 40% of total costs, the remaining 60% covered by the private partners (80% being SMEs). In the period 2001-2005, almost 1,500 projects were supported (375 on a yearly base), with a total revenue of €630 million (or €400K per project).

[133] Up until 2007, five KTTs (consortia of UASs and private consultants) will be supported.

[134] In absolute numbers: 122 business proposals were rewarded with the CTI Start-up label. In 2005, 107 of these start-ups were still in business, having created about 4,000 new jobs.

[135] In the ERT-2004-2007, €25 million was allocated to the programme – a 370% rise with regard to the previous ERT.

for education and/or science, neither a formal body for the co-ordination of STI at the ministerial level. In the absence of a clear nexus for the formulation of an overall national STI policy such an overarching strategy is missing. Partly as a result there is a general lack of focus with regard to strategic research fields – besides the adoption of the broad areas biotechnology, nanotechnology and ICT. Although from a conceptual point of view there is a certain order of rank between the key programmes of the two core actors (respectively SBF/SNSF under Interior affairs and BBF/CTI under Economic affairs) in practice the links between the programmes are rather weak with regard to content.

However this does not seem to be much of a problem – stated differently Swiss can do very well without an overall STI strategy and large-scale programs for the matching of public research and private industry needs[136]. Direct funding of private R&D is absent altogether and the government follows a restrictive policy of funding massive public-private knowledge platforms because of the weak commitment of the industry. This does not mean that the industry does not fund collaboration with public research – on the contrary – but that there generally is a neat split between the two types of funding and research: public research is funded from public and private funding from private sources (see before, section 8.4).

The only actor that is dedicated to the transfer of knowledge between businesses and universities – that is, at the micro level – is CTI. The institute implements a rather successful 'diffusion-oriented' technology policy (e.g., the R&D project funding, the strategic use of international research collaboration, and the Start-up label) but due to the small volume of the promotion activities the impact on the Swiss economic remains small. Also here, there is no direct public funding of private research (e.g., CTI compensates for the in natura participation of public research institutes in joint research projects).

There is no evidence so far that the private sector actually needs a stronger promotion. It can cater for most of its industry research needs itself. Strategic collaboration with public research is very frequently sought but is seems to be triggered by the scientific excellence of the work rather than the direct applicability to industry needs. The Swiss federal government seems to have adapted rather well to this situation by strongly emphasising a supportive infrastructure for business R&D. This includes an attractive regulatory and administrative environment for business firms (including a highly effective IPR regime), well-educated graduates of schools of higher education (especially in high-tech fields) and excellence in basic research. The latter is reflected by a very high proportion of basic funding by the federal government of the universities.

Critical mass is partly an issue in Switzerland, especially for the relatively young Universities of Applied Sciences at the cantonal level. In the present ERT policy (2004-2007) explicit focus is given on study courses which do not have sufficient critical mass. However due to tight budgetary constraints from the last couple of years various Universities of Applied Sciences, especially those in cost-intensive areas, have sought structural collaboration with other universities to overcome the financial restrictions and reach a critical mass. Meanwhile, a bottom-up concentration occurs at the two federal technical institutes (ETHs) which are slowly but surely attracting S&E students from the cantonal universities and the Universities of Applied Sciences.

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[136] In 'The Swiss innovation performance and the technology policy puzzle' (2006), Dominque Foray states even more boldly that STI policy just does not seem to matter in Switzerland – the country performs well with very little government invention. Market incentives seem to be enough to generate private R&D investments close to optimality. More heavy-handed policy invention would only generate (substantial) deadweight losses.

9. The Netherlands

9.1 Introduction

The relatively small economy of the Netherlands shows its strength on indicators such as GDP/Capita, which has been, already for quite some years, amongst the highest in the EU, and for most of the period starting from the end of the 1980s until the end of the 1990s, GDP-growth has outpaced the EU and OECD average. Growth in the Netherlands is influenced however strongly by cyclical developments in the world economy. This is caused by its specific structure and openness, which is illustrated by figures on trade and investments.

There are however also structural problems and developments, which threaten the strong position of the Netherlands. If we consider for example the competitiveness of the Netherlands based on international rankings such as the one of the Institute for Management Development, World Economic Forum or the Economist intelligence Unit, the position of the Netherlands indicates an average performance compared to its competitors, with a decreasing position in recent years.

The main driver for economic growth in the Netherlands in the past decade has been the growth of employment (deployment of labour) resulting from the so-called 'Dutch model' characterised by low costs and wage restraint. The limits of this factor driven economic growth however will be reached in the near future, because of for example the aging population in the Netherlands. Future economic growth will therefore have to be realised more and more through increasing the labour productivity level by strengthening the innovation system and improving its performance: innovation driven growth. The absolute level of labour productivity in the Netherlands (in GDP per hour worked) is amongst the highest in Europe. The structural problems of the Dutch economy however are reflected in the performance on labour productivity growth. Figures indicate very limited development already for quit some years, which is worse than that of the main competitors of the Netherlands.

The innovative performance of the Netherlands can be regarded as good, based on different indicators: high quality of output of scientific research, high level of patenting, high share of financing of public research by industry and high use of ICT and access to its applications.

The innovation system however, is also characterised by specific features and (structural) problems that weaken the strong innovative performance of the Netherlands, while countries with a less favourable innovation performance seem to be catching up:

- The total financial efforts in R&D expenditure are stagnating; business expenditure on R&D lags behind compared to main competitors. R&D expenditure in the public sector has decreased in the last years.
- Despite a generally favourable investment climate, few foreign companies decide to locate RTDI activities in the Netherlands
- There is an increasing shortage of highly educated people, especially in science and technology; and inadequate match between outflow from education and demand by industry.
- Innovative entrepreneurial activity is limited.

- There are problems concerning financing (early stages) of innovation.
- The history of funding mechanisms for the public research sector has led to fragmentation of research efforts across many universities, research institutions and networks. Finding the appropriate balance between creating sufficient focus and critical mass, while also supporting excellence in a number of priority areas is a major policy challenge.
- The interaction between the actors of the National Innovation System (NIS) is not yet intensive, resulting in inadequate exploitation of research results. Stronger incentives have to be put in place to valorise the research results in the public knowledge institutes
- Although improvements have recently been made relating to the immigration procedures for knowledge workers, the Netherlands still has problems attracting non-EU researchers and engineers and keeping them for the longer term.

9.2 Institutional setting

9.2.1 Main developments in STI policy

The Dutch government realised at the end of the 90s, when the economy was hit relatively hard by the global cyclical downtrend that the national strategy for further economic growth had to be changed. In a changing global economy, the Dutch industry would lose its competitive position by focussing on a strategy aimed at limiting labour costs. Further economic growth had to be realised by increasing labour productivity by strengthening the innovation system and improving its output.

In order to realise innovation driven economic growth, the Cabinet Balkenende II launched in 2003 an Innovation White paper called the Innovation Letter: Action for Innovation: Raising the Dutch knowledge economy to a leading position in Europe.

The Innovation Letter introduced the philosophy of creating “focus and mass” in all policies addressing the innovation system. The idea behind this philosophy is that a relatively small country like the Netherlands does not have the potential and resources to address all fields of research and innovation. It should therefore focus research and innovation on areas in which the Netherlands can be leading in an international perspective, and which may contribute to sustainable growth of the Dutch economy.

The Innovation Letter is part of an integral strategy “for the build-up of a sustainable knowledge-driven economy”. Different pillars support this strategy: innovation, education and research. Industry-oriented R&D and innovation policy are specifically addressed in the Innovation Letter of the Ministry of Economic Affairs. Education and research are specifically addressed in the policy documents HOOP 2004 (Higher Education and Research Plan) and the Science Budget 2004 of the Ministry of Education, Culture and Science[137].

Other recent relevant documents in which innovation plays an important role are the policy memorandums Action for Entrepreneurs! (enterprise policy), Peaks in the Delta (regional economic policy) and Industry Memorandum: Heart for Industry (industry policy). These memorandums (all from the Ministry of Economic Affairs) have a strong emphasis on creating focus and mass in areas where the Netherlands have (or can achieve) a strong international position. They illustrate a recent trend in which generic innovation policy (as

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[137] Both policy documents have been updated (yearly) since their publication, but no new documents have been published.

formulated in the Innovation Letter) is complemented with a more specific innovation policy.

The Innovation Letter, as well as the other policies addressing the pillars for a sustainable knowledge-driven economy, have been discussed and agreed upon by all other ministries involved in research and innovation. The Innovation Letter is therefore the overall policy for (industry-oriented) innovation.

The policy defined in the Innovation Letter is based on a thorough analysis of the Dutch innovation system. On the basis of the analysis, the Innovation Letter identified a series of bottlenecks, which hamper the innovative potential of the Netherlands. Having defined these problems, the Innovation Letter identified thereupon a series of 'focus areas' for the innovation policy and its instruments supporting it, which address the bottlenecks as mentioned above[138]:

- Strengthening the climate for innovation. The Netherlands has to become an attractive business location from the point of view of innovation. The government also has to provide a favourable business environment (good macro-economic policy, fewer restrictive laws and regulations, etc.)
- Creating the right dynamics: encouraging more companies to be innovative.
- Dutch companies should produce more new products and provide innovative services. In order to achieve this, the government has to guarantee a more dynamic climate, for instance by enhancing competition.
- Taking advantage of opportunities for innovation by opting for strategic areas. It is impossible for the Netherlands to excel in all fields. With limited resources and increasing competition, it is essential to invest in those areas of innovation that provide the best opportunities for strengthening the country's competitiveness and generating the greatest social benefits. The government should therefore stimulate Dutch research institutes and companies to carry out more joint research projects in these strategic areas to create focus and critical mass.

The policy documents HOOP 2004 (Higher Education and Research Plan) and the Science Budget 2004 of the Ministry of Education, Culture and Science form the basis for the science policy in the Netherlands. The main issues of this science policy are:

- Creating focus and mass. In order to maintain and improve the Dutch position in science, it is necessary to concentrate research efforts and funds on national priorities.
- Rewarding excellent research. Additional funding should be allocated based on excellent research and excellent forms of cooperation.
- Improving utilisation of research results. The European paradox is the starting point for a number of activities that aim at valorisation of research results. For example by strengthening the societal role of the universities, adapting their funding model, and stimulating a university patent policy.

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[138] Besides these 'areas of focus', two horizontal themes run through the policy. First of all, the policy will contribute to the drive towards sustainability. This requires further exploration and management of the ambivalent relationship between the environment and the economy and between the economy and social ambitions. Innovation can offer solutions to alleviate pressure points. Secondly, the policy anticipates international (i.e. European) developments. International knowledge will have to be utilised more effectively and the Netherlands will have to put its national knowledge more on display.

- Improving quality and quantity of Human Resources. Human Capital is the cornerstone for developing a knowledge economy. It is therefore important that the Netherlands have a well-educated labour force, especially in science and engineering. However, the Netherlands faces an impending shortage of so-called knowledge workers and researchers in these areas; a shortage that starts in educational choices.
- Raising awareness. Realising the Dutch ambition within Europe requires not only investments in research and innovation, but also calls for changes in the education system and an adequate strategy in terms of communicating science and technology. Public communication policy on science and technology is intended to motivate the general public, and especially young persons, and to raise their interest in science and technology.

In July 2004 the Ministry of Economic Affairs published the policy paper Peaks in the Delta with the government's economic agenda for six Dutch regions. Until recently, the Dutch regional economic policy mainly focused on a catch-up drive for deprived regions. This new regional policy however indicates a clear shift in the core philosophy: the focus has shifted to capitalising on existing strengths. In effect, The Ministry of Economic Affairs proposes not to automatically transfer funds to the less favoured regions, but instead challenges all regions to come with promising innovation strategies. This new policy is in line with the important premise in the national innovation policy: increased focus and (critical) mass instead of small-scale initiatives and fragmentation.

In Peaks in the Delta four innovation regions ("hot spots") are identified[139]. Only those innovative regions with the capacity to develop into internationally competitive innovation "hot spots" are supported through a combination of customised regional measures and more general national incentives.

Also in July 2004, the Ministry of Economic Affairs published in the policy paper entitled Action for Entrepreneurs. This policy paper identifies the following objectives / actions:

- More entrepreneurs. Enterprise and risk-taking are not sufficiently embedded in the Dutch culture. There are still too few people opting to run their own businesses. Yet start-ups are crucial for our economy since it is these entrepreneurs who often develop new products and services. In doing so, they also encourage established entrepreneurs to innovate. The government is therefore committed to creating more entrepreneurs. Removing obstacles to starting enterprises is a key part of this strategy.
- Better enterprises. Creating a successful enterprise requires a careful and well-researched approach combined with a detailed knowledge of the market. Many entrepreneurs in the Netherlands are still not fully exploiting the capacities of their businesses. This is often due to lack of preparation and insufficient knowledge. Sometimes this can even lead to the (unnecessary) winding up of the business. The government will address the issues hindering the full exploitation of business capacity.

In October 2004, the Ministry of Economic Affairs published the Industry Memorandum: 'Heart for Industry'. The Cabinet sets out in the Memorandum its vision of the importance of industry to the Dutch economy and of the developments that industry faces. Companies operate in international markets with very many and very good competitors. Therefore, the business climate must put companies in a position to excel. To achieve this, the

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[139] The four hot spots are: the Eindhoven/Southeast Brabant 'brainport', as part of the Eindhoven-Leuven-Aachen top technology region, the East Netherlands region (the Twente, Wageningen and Arnhem-Nijmegen conjunction, the North Wing of the Randstad (including the Amsterdam and Utrecht region) and the South Wing of the Randstad (including Rotterdam).

government has fundamentally opted for economic activity and entrepreneurship, with a government that feels committed to industry and is able to create scope at the same time. In order to do so, the policy document identifies three tracks:

- Get the basic preconditions for the business climate in order. The basic conditions, like competition, infrastructure; quality of legislation; education; and efficiently functioning labour market and fiscal regime must be in good shape to allow companies to excel.
- Strengthen the modernising capability of business. An effective generic innovation policy is essential for companies in order to support the modernisation capability of all companies. As an extension to this generic innovation policy, the government must support innovation focal points, whereby excellent companies and knowledge institutions, including those operating regionally, can jointly capitalise on opportunities for modernisation.
- Give attention to specific sectors or groups of companies. Specific market conditions can cause obstacles for growth for individual sectors or specific groups of companies. If these problems form substantial obstacles for economic growth, the government must take measures to diminish sector-specific barriers.

The launch of these different policy documents has resulted in major changes in the instruments supporting the innovation system, and the institutional setting governing the actors of this system. Sections 9.3 and 9.4 describe the impact these policy documents have on instruments and the institutional setting concerning critical mass and focus of research and valorisation of research results.

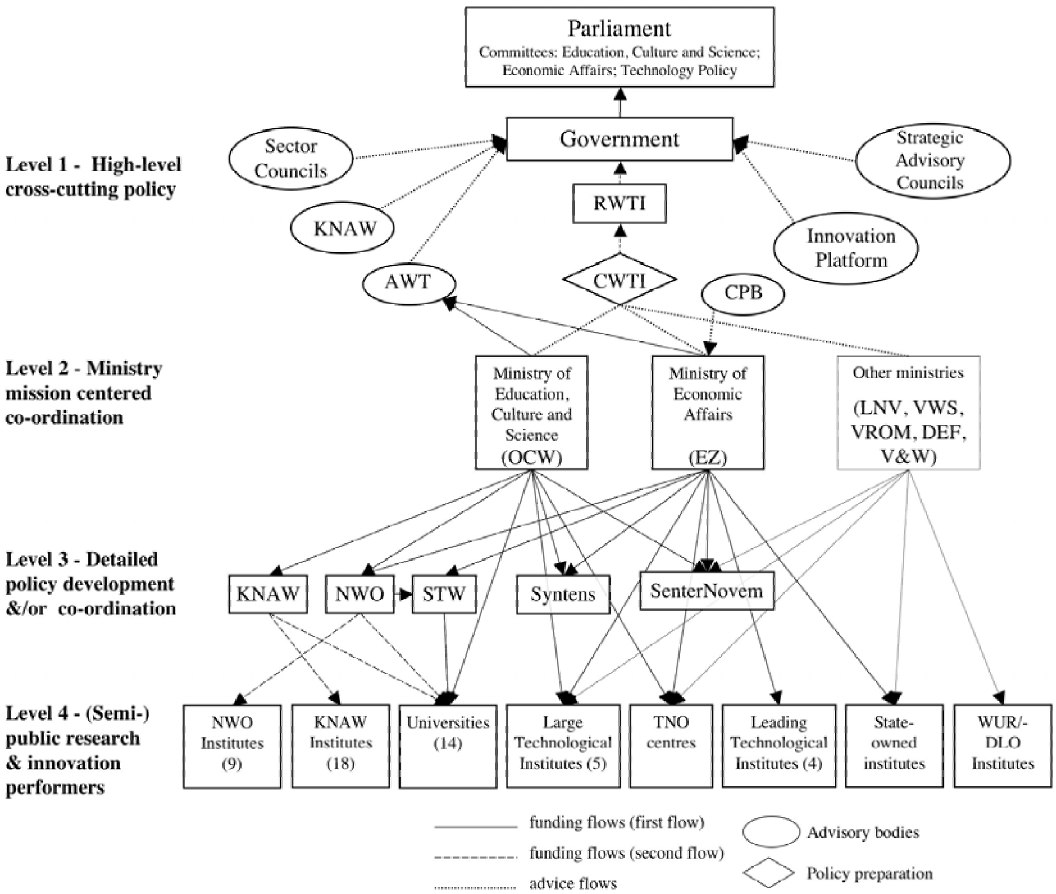
9.2.2 The key-players in STI policy

The NIS of the Netherlands is a complex system with many actors, funding mechanisms and relations, as indicated below. This report describes the main actors and supporting policies and instruments in relation to policy concerning "critical mass and focus of research".

The most important ministries involved in R&D and Innovation policy are the Ministry of Economic Affairs (EZ), and Ministry of Education, Culture and Science (OCW). The Ministry of Economic Affairs is the main governmental actor responsible for industry oriented R&D and innovation policy. The ministry of Education, culture and Science also plays an important role in defining innovation policy, but it focuses in particular on scientific research and education.

Historically, there has always been a strong 'division of labour' between science and basic research on the one hand and technology and innovation on the other, both in terms of policy design, funding and research performers. As a result, two different governance cultures in the science and innovation parts of the system have emerged. While the approach of the Ministry of Economic Affairs can be characterised as "hands on" with an active role in policy design, programme design and programme management, the approach of the Ministry of Education, Culture and Science is rather "hands off", delegating responsibilities to various organisations in the science and research system. However, at different levels in the system these two spheres are gradually moving towards each other.

Figure 9.1 Organisational chart of the innovation governance system



Source: TrendChart country report Netherlands 2006

The recent Cabinets (Balkenende II and Balkenende III)[140] identified R&D and Innovation as the main drivers for economic growth for the Netherlands. This is reflected amongst others in the policies of other ministries in the Dutch governance structure and in their annual budgets, which now in many cases explicitly address "knowledge and innovation". These ministries focus however not on general RTDI policy, but on research and innovation within their specific policy domain.

An important mechanism to coordinate efforts by all the different ministries concerning R&D and Innovation is the Council on Science, Technology and Information Policy (RWTI). The RWTI is a sub-council of the Council of Ministers. It prepares the decisions to be taken by the plenary Cabinet, and takes place normally a few days before the Council of Ministers, which meet once a week.

The agenda and the foreseen decisions are coordinated and prepared by the interdepartmental Committee on Science, Technology and Information Policy (CWTI). The CWTI

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[140] The Cabinet Balkenende II ended on 22/11/2006 with the elections. Currently a new coalition is being formed.

consists of high-level civil servants of all ministries involved, and meets about two weeks before the RWTI.

Also important to mention within the framework of this report is the Innovation Platform (IP); an advisory board to the Cabinet concerning especially innovation launched by the Cabinet Balkenende II in 2002 with the objective "to propose strategic plans to reinforce the Dutch knowledge economy and to boost innovation by stimulating business enterprises and organisations in the public knowledge infrastructure to work closely together". The Platform and its role / structure is based on the characteristics of some positive examples in Europe of similar organisations, such as in Finland. The Platform had a mandate for the governing period of the current Cabinet. The 18 independent members from government, industry and knowledge and education institutes have laid down their position after the elections held on the 22nd of November 2006. It is up to the new Cabinet to be formed to decide on the future role (continuation) of a new platform.

Other advisory bodies concerning R&D and innovation policy, which are important to mention within the framework of this study are:

- The Advisory Council for Science and Technology Policy (AWT): an independent advisory body that gives solicited and unsolicited advice to government and parliament on science, technology and innovation policy, and on information policy in the fields of science and technology
- In the area of research policy, so-called Sector Councils have an advisory role for the various ministers on specific policy areas in their sectors[141]. Sector councils carry out foresight exercises and make analyses of scientific and social trends.
- Furthermore there are various Strategic Advisory Councils, which occasionally advise the government on matters of science and technology policy[142].
- The Royal Netherlands Academy of Arts and Sciences (KNAW); which provides advise to the government on matters of science and technology, especially in the field of basic research.

Policy implementation is conducted mainly by two key agencies: SenterNovem and the National Research Council (NWO) [143].

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[141] There are currently 4 sector councils: Innovation network Rural Areas and Agricultural Systems (NRLO); the Netherlands Development Assistance Research Council (RAWOO); the Council on Health Research (RGO); and the Council for Research on Spatial Planning, Nature and Environment (RMNO). Not covered by the Framework Act, but using methods and having functions similar to those of a sector council is the Netherlands Study Center for Technology Trends (STT). Currently a study is done to establish the need for a sector council in four other fields: (1) public administration; justice and security; education; traffic, transport and infrastructure; employment, health and social security (Website of the COS at www.toekomstverkennen.nl). The Sector Councils will soon be replaced with / transformed in so-called "kenniskamers" (chambers of knowledge).

[142] Examples of these Strategic Advisory Councils are: the General Energy Council (AER), the Education Council (OR), the Council for Societal Development (RMO), the Council for Transport and Water Management (RVW), the Social Economic Council (SER), the VROM Council and the Scientific Council for Government Policy (WRR).

[143] Important to mention is the foreseen change in structure and role of the organisations involved in policy delivery of industry-oriented research and innovation, such as SenterNovem. The method of working of the implementing bodies will be changed, in order to evolve by 2008 into a 'one-stop-shop' for entrepreneurs with promising business ideas which need support. . This support will for a large part take place through so called innovation programmes, developed in close cooperation with companies, research institutes, governments and other actors.

- SenterNovem is an agency of the Ministry of Economic Affairs, which implements innovation schemes. It manages most of the technology policy programmes, particularly those that have some private sector input. SenterNovem also works for other ministries. In total it allocates in total about € 1.3 billion yearly.

- NWO, the Netherlands Organisation for Scientific Research, functions as a funding agency of the Ministry of Education, Culture and Science. It has a relatively independent position to decide on its strategy and programmes. The NWO encompasses all scientific fields. Its most important tasks are to provide grants for (excellent) research and research equipment and to co-ordinate research programmes. In addition, the NWO administers 9 research institutes. Part of NWO is the Technology Foundation (STW), which supports and finances scientific-technological research projects and promotes utilisation of results of research by third parties, and the Foundation for Fundamental Research on Matter (FMO). These NWO organisations employ approximately 400 FTE for programme management.

Research organisations in the Netherlands are relatively autonomous and define their individual development paths and strategies. The public science basis of the Netherlands can be divided into a number of types of organisations:

- The 14 universities in the Netherlands. Three of these are purely 'universities of technology' (Twente, Delft and Eindhoven), while the Wageningen University traditionally focuses on agriculture, natural resources and agro-food. The other universities also offer technology studies and research.

- A number of fundamental Research Centres that are either governed by the Netherlands Research Council NWO or its affiliated organisations (e.g. Foundation for Fundamental Research on Matter (FMO))[144] or the Royal Netherlands Academy for Arts and Sciences (KNAW)[145].

- Other actors in the knowledge infrastructure are the agricultural research institutes of the DLO Foundation (part of the Wageningen University and Research Centre WUR), several state-owned research and expertise centres and several other institutes in the fields of health and the social sciences.

- In addition the system has quite a number of non-academic public research organisations. The largest of these is TNO, the Netherlands Organisation for Applied Scientific Research, which is an independent contract research organisation[146]. There are five so-called "Large Technological Institutes" that conduct applied research and related activities, such as advising industry and government, in specific fields.

The business sector in the Netherlands is dominated by the service sector, with several of Europe's biggest players in banking, insurances and transport. The Netherlands also has a relatively high number of multinationals.

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[144] The Royal Netherlands Organisation for Scientific Research NWO acts as an umbrella organisation for nine so-called NWO Institutes.

[145] The Royal Netherlands Academy of Arts and Sciences (KNAW) acts as an umbrella organisation for 18 so-called KNAW Institutes, which are primarily engaged in basic and strategic scientific research and disseminating information.

[146] TNO is an independent contract research organisation established by law in 1930, with some 5000 employees. It is by far the largest (semi-) public research organisation in the Netherlands. TNO is an umbrella organisation with several research centres in five key areas: Quality of Life; Defence, Security and Safety; Science and Industry; Built Environment and Geosciences; and Information and Communication Technology.

Within the framework of this report, it is important to describe certain specific characteristics concerning R&D and innovation of the Dutch Industry sector:

- Seven multinational companies account for about half of the private sector R&D expenditure (Philips (including recent spin-out NXP), ASML, Shell, Unilever, DSM, Océ and AKZO). The 5% of largest R&D spending companies account for 75% of total private R&D expenditure.
- Since the end of the 1980s the Netherlands has experienced a structural shortfall in the field of private expenditure on R&D compared to the OECD average of around 1.5% of GDP[147]. Analysis shows that this is mainly due to structural factors: the share of knowledge-intensive industries in the overall economic structure of the Netherlands is below OECD average (sector composition effect). In addition, given the sector composition, the Netherlands spends little on private R&D compared with the OECD average (intrinsic effect). The latter is estimated to be largely due to poor foreign R&D investments in the Netherlands.
- The largest contribution (85%) to the growth of the number of enterprises engaged in R&D between 1995 and 2004 came from the service sector.
- Nevertheless the relative stability of the overall R&D expenditure in relation to GDP is through an increase of private sector expenditure, as expenditure in public R&D organisations has decreased[148].
- 44 of the companies appearing in the EU Industrial R&D Investment Scoreboard (2005 data) have their headquarters in the Netherlands. They include the EADS consortium (Airbus) and Philips, and also companies such as TomTom, but not Unilever and Royal Dutch Shell, which are UK registered. R&D expenditures worldwide by these companies in 2005 were €8,484 billion in total. It is clear that many of the companies on the list carry out very little of their R&D in the Netherlands.

The Industry sector is represented by the largest employers' organisation called the Confederation of Netherlands Industry and Employers (VNO-NCW). It represents the common interests of Dutch business, nationally and internationally, and it provides various services for its members. Members of VNO-NCW include 170 (branch) associations, which represent some 115,000 enterprises (including some 80% of all medium-sized companies and nearly all of the larger companies in the Netherlands). The Confederation VNO-NCW is the 'official voice' of (large) industries and is often represented in committees and discussion platforms.

In addition, there are also a few others operating in the innovation system, which are of importance especially within the framework of this report. These initiatives mostly function as networks or virtual institutes of existing actors that have a common thematic approach. They will be addressed in more detail in section 9.3.

In conclusion; the innovation system of the Netherlands represents many different research performers operating alongside each other, often on similar research domains and organised on a mono-disciplinary basis. This has led to a major policy concern in the last decade: the fragmentation of research activities, with none of the individual actors having sufficient critical mass necessary for building a position of global excellence.

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[147] Hugo Erken, Piet Donselaar, *The Dutch Shortfall in private R&D expenditure, An explanation based on empirical evidence*, Ministry of Economic Affairs, 2006.

[148] Statistics Netherlands (2006), *Kennis en Economie* (Knowledge and Economy), Voorburg.

9.2.3 Funding

In 2003, GERD / GDP was equal to 1.76%. The distribution of the total funding is given in Table 9.1. Table 9.2 specifies the allocation of funds per ministry, indicating their specific relevance / importance.

The main policy instrument used for supporting the public research infrastructure is the institutional funding to the universities and the research organisations. The Ministry of Education, Culture and Science and the Ministry of Economic Affairs alone spend nearly €2,5 billion directly on contributions to universities and research organisations, which is 82% of these two Ministries' budgets [149].

In 2003, university research received €2.430 billion per year. The total expenditure on R&D in the Netherlands was €8.4 billion. The research organizations received €1.253 billion in 2003.

Table 9.1 R&D by source of funding (percentage distribution, 2003)[150]

Government	Business enterprises	Other national sources	Abroad
• Ministry of Education, Culture and Science • Ministry of Economic Affairs • Others	• Large multinationals • Other enterprises	• Private non-profit organisa-tions (PNP) • Own funds universities	• EU • Foreign enterprises
36%	**51%**	**1%**	**11%**

Source: Science, Technology and Innovation in the Netherlands, Policies, Facts and figures 2006, Ministry of Economic Affairs, Ministry of Education, Culture and Science, September 2006

[149] This figure does not including the funding for the tax scheme WBSO and the funding coming from the BSIK funds.

[150] The percentage distribution does not exactly sum to 100% due to rounding off these percentages to unbroken numbers.

Table 9.2 R&D policy budget in the Netherlands, in Millions of Euro, 2005 and 2006

	2005	**2006**
Ministry of General Affairs	1.7	1.7
Ministry of the Interior and Kingdom Relations	2.1	1.7
Ministry of Foreign Affairs	76.0	80.1
Ministry of Defence	80.7	81.1
Ministry of Economic Affairs	539.5	485.4
Ministry of Justice	8.2	8.0
Ministry of Agriculture, Nature and Food Quality	213.2	200.4
Ministry of Education, Culture and Science	2 410.9	2 478.5
Ministry of Social Affairs and Employment	5.5	7.5
Ministry of Transport, Public Works and Water Management	125.3	133.6
Ministry of Health, Welfare and Sport	90.3	94.5
Ministry of Housing, Spatial Planning and the Environment	42.1	35.7
WBSO Tax deduction on R&D[151]	362.0	393.0

Source: MERIT Policy Mix Report, mostly from "Overzicht van de TOF-cijfers op kasbasis", Ministry of Education, Culture and Science 2006.

9.2.4 Response to EU policy

Lisbon agenda and 3% action plan

The Dutch government just recently set the Barcelona objective of 3% GERD / GDP explicitly as a target for R&D. Before, the objective for policy was to be "top 5 in Europe". The performance of the Netherlands relating to the 3% target is not overall positive if judged on key indicators (see figure 9.2 below):

- Gross domestic expenditure on R&D as percentage of GDP was 1.78 in 2004 and has dropped since 2000 (from 1.9%)[152].
- Public R&D expenditure as % of GDP is 0.75, which is above EU-15 average (EIS 2006) but has also dropped since 2000 (from 0.79%)[153].
- Business R&D expenditure as % of GDP is 1.01, which is far below EU-15 average. This figure has dropped since 2000 from 1.11%[154].

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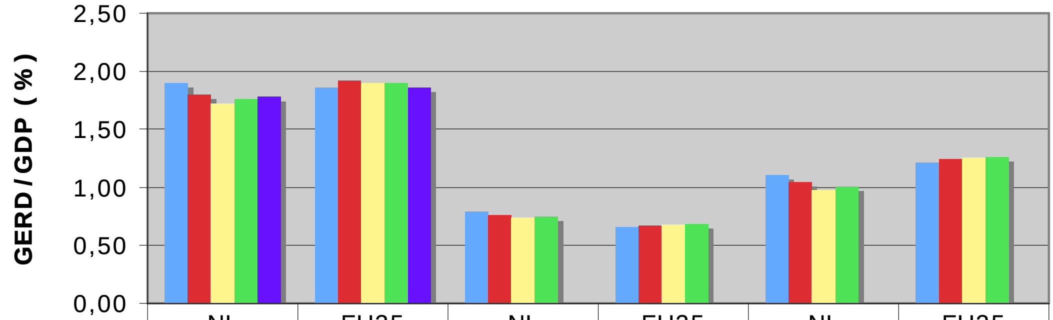
[151] The WBSO is a tax-scheme form the Ministry of Economic Affairs, but the Ministry of Finance allocates the funding.

[152] NRP 2006

[153] EIS 2006

[154] EIS 2006

Figure 9.2 Expenditure on R&D (NL - EU25)



	Gross domestic expenditure on R&D		Public R&D expenditures		Business R&D expenditures	
	NL	EU25	NL	EU25	NL	EU25
2000	1,90	1,86	0,79	0,66	1,11	1,22
2001	1,80	1,92	0,76	0,67	1,05	1,25
2002	1,72	1,90	0,74	0,68	0,98	1,26
2003	1,76	1,90	0,75	0,69	1,01	1,26
2004	1,78	1,86				

Source: EUROSTAT

Dutch participation in EU Framework Programme (FP)

Dutch participation in proposals for EU Framework Programmes has always been relatively high, with a high level of success in approval as well. Dutch project participants also operate relatively often as project coordinators, and their projects often are completed successfully.

Response to other European initiatives

The Dutch government does not adjust / modify its R&D and innovation policy to match it with the EU policy (on for example selection of technology fields, or funding mechanisms), nor does it actively participate in the formulation of EU policies and programmes to match the EU policy and programmes with the national policies and the characteristics of the Dutch innovation system. Although the attitude towards EU policy initiatives is changing, the government still merely seems to react on the proposals by the EC, in order to avoid possible conflicts with Dutch R&D and innovation policy and the interest of the actors of the Dutch innovation system.

The change in the attitude however has resulted in an active role of Dutch representatives in CREST and different expert groups involved in the implementation of the 3% Action Plan, and the active involvement of the Permanent Representation of the Netherlands at the EU in supporting Dutch public servants in their work in different working groups towards the meetings of the different Councils.

9.3 Critical mass and focus of research

The policies as mentioned in section 9.2.1 all address, in one way or another, “focus and mass”. This section will describe the impact of these policies on instruments, and the innovation system as such.

The Innovation Letter has until now had the most significant impact on (future) instruments and actors, in view of creating focus and mass. Introduction of the policy was followed by a review of the instruments supporting the actors of the innovation system, and the organisations involved in the implementation. This review of instruments indicated that the existing set was inflexible, insufficiently customised, not accessible or transparent enough and insufficiently coherent. A new set of instruments has therefore been developed that is characterised by: flexibility and customisation, resulting in more possibilities to enable companies to excel; fewer instruments with more coherence; more accessible helpdesks; fewer acquisition costs and administrative burden.

The renewal is presented in the policy document "Strong basis for delivering top performance: Renewed instruments for entrepreneurs from the Ministry of Economic Affairs" (September 2005). The new approach consists of two main elements:

- A basic package ("simple, quick and accessible") primarily aimed at SMEs to provide entrepreneurs with access to information and finance.
- More important is this perspective is the programme-based package ("inciting entrepreneurs to deliver top performances") targeted at "key areas", *i.e.* fields that have a powerful influence on the entire Dutch economy.

The set of instruments is currently being "tested" in practice to be developed further into an Innovation Omnibus in 2008. This Innovation Omnibus will offer a legal framework for various forms of financial support, ranging from Leading Technology Institutes, innovation oriented research programmes, development credits and feasibility studies. It lists the conditions for financial support within the programme-based package. A broad range of instruments is currently being placed under this omnibus in so-called modules.

The programme-based package is designed to create more focus and mass, as its most important objective. Within selected key areas, the businesses and knowledge institutions are invited to develop innovation programmes setting out aims, activities and the required resources. The programmes therefore rely on the organisational skills and (financial) commitment of the field. The project specific implementing body plays an active and leading role in the implementation process[155]. Each programme is unique and tailored to the needs of the specific sector. The participants themselves determine the most suitable form of organisation and what action is needed to reach the objectives. Within the programmes, project proposals can be submitted to The Ministry of Economic Affairs. The best proposals can be awarded with (financial) support.

This new approach for innovation policy by means of the programme-based package is based on the suggestions made by the Innovation Platform concerning fostering of innovation and research in specific areas as well as by different reports from the AWT. The Ministry of Economic Affairs has adopted the areas as identified by the Innovation Platform as "key areas" for the programme based approach: Flowers and Food, High-tech systems and materials, Water, Chemicals and Creative Industries. Three proposals have already been selected, while other proposals in the remaining key-areas are in the process of being developed and submitted. The three selected programmes are:

- "Point One", a programme in which industry and the public research infrastructure and the ministry cooperate in the field of nano-technology. The Ministry of Economic Affairs allocates by means of this programme a €50 million to this specific technology field.

[155] The programme-based approach already existed in the fields of 'ICT' and 'sustainable energy', and the Ministry of Economic Affairs continues this approach in these fields and introduced it in the policy areas of 'innovation', 'area-specific policy' and 'international business'.

- A programme in the field of Water Technology.
- Food and Nutrition Delta.

But not only the Innovation Omnibus contributes to the creation of focus and mass in research and innovation. Also the implementation of the other policies mentioned in section 9.2.1 has resulted in the formulation of many new instruments

In addition to the innovation programmes for selected key areas, support is available by the Ministry of Economic Affairs for excellent innovation projects that are outside the scope of these programmes. These smaller projects fall into the category of so-called "Challengers". These challengers can be an important source of information for the identification of new themes and programmes for the future. Therefore, the Challengers Credit supports excellent innovation projects, in which new products, processes or services are developed.

As mentioned before, within the framework of the regional focused policy programme 'Peaks in the Delta' of the Ministry of Economic Affairs, regions are invited to submit well-developed technology and innovation plans. An example is the South-East Netherlands region that has formulated the ambition to become one of the leading European regions in a plan called "View on the Top", for which they receive additional funding.

The Ministry of Education, Science and Culture has asked the Netherlands Research Council (NWO) to identify a series of themes as a basis for further actions to create focus and mass in the fragmented public research infrastructure. This is a follow up of the specific actions defined in HOOP 2004 and Science Budget 2004. As a response, NWO drafted a Strategy Paper Science Valued!, which identified 13 areas of focus for scientific research. The additional funds asked by NWO for this strategy are supposed to influence especially the funding of universities. The strategy has not yet been implemented.

The Ministry of Education, Science and Culture has furthermore established three so-called Societal Top Institute: NICIS (City Innovation Studies), HILL (International Law) and NETSPAR (Pensions, Ageing and Retirement). These institutes are similar to the Leading Technology Institutes (see section 9.4.4)

Furthermore, other (already existing) instruments are currently in place, which contribute to the creation of focus and mass (although it is not always their primary goal), or which are not a result of the policies mentioned in this section.

From the funds of Dutch gas exploits large consortia are funded from the BSIK programme to create focus and critical mass in research. In 2003 37 large consortia were chosen in the areas of sustainable system innovations, spatial planning, ICT, micro and nano-technologies, health, food and life sciences.

Another significant new measure is the Smart Mix. The aim of the Smart Mix is to promote focus and mass in excellent scientific research and to enhance the valorisation of results from research. The Smart Mix addresses the "knowledge paradox" by stimulating collaboration between the business sector and the knowledge infrastructure in specific key areas that are (will be) strategically important for the Netherlands.

The scheme aims to improve interaction and collaboration between knowledge users and knowledge producers in a large part of the knowledge chain. Each programme is executed by consortia of companies, societal organisations and knowledge institutes. The composition of the consortia will vary with the type of orientation. The new instrument has an annual budget of €100 million (from the extra strategic funds for the knowledge economy).

The Smart Mix is set up by the Ministry of Education, Culture and Science and the Ministry of Economic Affairs as a joint effort to avoid fragmentation of research funding and to strengthen demand-orientation within research infrastructure. The programme is managed by the Smart Mix secretariat, which is established by the national research council NWO and the innovation agency SenterNovem. The Smart Mix is not only aiming at projects with a high commercial value, but may also support projects with a high social value.

Besides the instruments mentioned above, several institutions have been established in the past that contribute also to the creation of focus and mass:

- The Ministry of Education, Culture and Science and the Ministry of Economic Affairs selected already several years ago a number of Leading Top Institutes (LTIs) in specific technological areas Food, Telematics, Metals and Materials, Polymers. Paragraph 7.4.4 explains in further detail these institutions. This instrument has been selected as one of the modules of the Innovation Omnibus. Recently the Ministry of Health has established a new institute in the field of Pharma. More LTIs will be established soon. The existing institutes will be continued within the framework of the program-based package.
- In addition, in the fields of specific key technologies temporary Task Forces (ICT-Regieorgaan, The Netherlands Genomics Initiative, Advanced Chemical Technologies for Sustainability - ACTS) have been set up to co-ordinate and execute thematic programmes. They have a semi-permanent status and are hosted by NWO.

The philosophy behind this concept / objective of creating focus and mass in the Netherlands is that a relatively small country does not have the potential and resources to address all fields of research and innovation. It should therefore focus research and innovation on areas in which the Netherlands could be leading in an international perspective, and which will contribute to sustainable growth of the economy. The rather wide variety of new and existing initiatives however raises questions concerning the different choices made for areas of focus, and the effect of all these different instruments / initiatives for the fragmentation of the knowledge infrastructure:

- Having reviewed the policy instruments for the science base and business oriented R&D, one can argue whether real choices have been made in the past few years. There is certainly overlap between the above-mentioned focal areas and there is also a danger funding exclusively a small number of technological areas.
- Almost all of the initiatives have been set up as virtual networks, thus leaving in tact existing institutional structures and adding new institutional layers on top of these networks. But setting up new networks has not achieved an increased international visibility of the 'centres of excellence' of the Netherlands as yet. The question arises whether too many 'spearheads' are being prioritised leading to sub-critical mass of all of them on a global scale. Given the complex and highly decentralised institutional system that has developed out of these many initiatives, institutional reform seems necessary. But at the same time there is no actor in the system with the capacity to manage / steer this process.
- In developing an excellent science basis by Dutch policy, the process of prioritising thematic areas have not been consistent and unambiguous. To steer the decentralised and fragmented public research towards more critical mass many initiatives have been put forward to achieve this, such as the Leading Technology Institutes, funding from the exploitation of the gas reserves to large consortia, initiatives such as the Netherlands Genomics Initiative, etc. Support for these large-scale initiatives (though short term; 5 + years) in relation to their goals and support has not been unequivocal.

9.4 Valorisation of research results

9.4.1 Research-industry co-operation

An important weakness of the NIS in the Netherlands is the inadequate interactions between public and private actors. The quality of Dutch Science & Higher Education is regarded as excellent. A recent report[156] by the OECD indicates that the Netherlands performs well in knowledge creation: scientific publications per capita are 6^{th} highest in the OECD and the citation impact is high at 25% above the worldwide citation average. But it seems the actors of the Dutch NIS are not able to commercialise the results of these efforts ("European Paradox").

The NIS in the Netherlands does not have a tradition of intense interaction between its actors. Universities could take more account of the knowledge needs of industry / society when defining their research efforts. Interaction is hindered by several factors such as mono-disciplinary layout of research at universities, culture, and lack of incentives for co-operation.

The problem is also that Dutch companies, in their efforts to further restrain their costs, try to outsource their pre-competitive research. It is questionable if increased outsourcing improves the innovative capacity of industry, but it underlines the importance of good co-operation between industry and the public research infrastructure. But companies seem to disregard knowledge of universities and research institutes when innovating. Analysis indicates that as a source for knowledge, firms rely heavily on their specific sector / partners in the production chain (own company, competitors, suppliers, clients etc.) or external sources (professional literature). The public research infrastructure is not often consulted as a source for knowledge. Figures on financing by industry of research by universities (HERD financed by industry) indicate improved co-operation (from 5.2% in 1999 to 6.5% 2003), but this level is just average in an international comparison. Financing by industry of research by public research institutes is high, which could indicate good co-operation[157]. However, data for the Netherlands should be interpreted carefully as they could include activities by public Research Institutes, which are conducted by private institutes in other countries.

The limited interaction between the actors of the innovation system may limit future innovation driven economic growth. Almost all financial innovation oriented instruments therefore focus on improving interaction, by supporting cooperation in R&D and innovation, in order to match supply of R&D to demand of knowledge and research as the basis for innovation. The instruments as described in the previous section all support this objective in specific strategic key-areas, and form the core of the initiatives of the Dutch government.

9.4.2 Commercialisation of research results

The translation of research results into market application will contribute to innovation driven economic growth. Within the framework of this paragraph, we will focus on policy supporting young research intensive SMEs (including high-tech start-ups and university

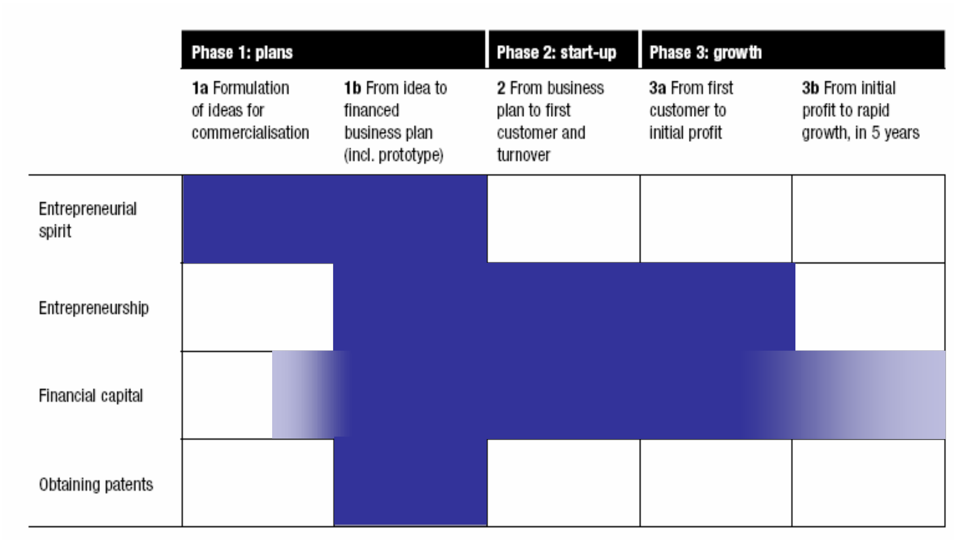
[156] Carey, D. et al. (2006), "Strengthening Innovation in the Netherlands: Making Better Use of Knowledge Creation in Innovation Activities", OECD Economics Department Working Papers, No. 479, OECD Publishing.

[157] OECD, MSTI 2006. Figures on financing by industry of research by public research institutes (GOVERD financed by industry) indicate a high level of co-operation.

spin-offs) as they play an important role in this process. More generic policy supporting cooperation between the actors of the innovation system, which contributes to the commercialisation of research results, is already addressed in other parts of the report.

Young research intensive SMEs face specific problems within the Dutch innovation system, which seriously hamper future innovation driven economic growth. An analysis conducted by the Ministry of Economic Affairs indicates that, regardless of the sector in which they operate, young research intensive SMEs encounter a number of specific obstacles at a very early stage in their operations. Even before the start-up of the company, the prospective high-tech start-up is confronted with a number of barriers that frequently result in the cancellation of the actual start-up. The figure below lists the obstacles faced by high-tech start-ups against the different phases in the lifecycle of a high-tech start-up.

Figure 9.3 Obstacles (coloured squares) faced by high tech start-ups, listed by lifecycle phase



The Ministry of Economic Affairs and the Ministry of Education, Culture and Science therefore launched a dedicated programme for young research-intensive SMEs entitled: TechnoPartner Action Programme: From Knowledge to Prosperity. The aim of this action programme is to improve the climate for high tech start-ups. This programme is implemented in addition to the proposed changes in the institutional funding of research institutes as described before, which also contribute to the creation of spin-offs, as they are regarded as efforts by universities to commercialize their research results. The total budget for TechnoPartner for 2004 - 2010 is €218 million.

TechnoPartner comprises an integrated package of interrelated concrete actions:

- TechnoPartner Office offers information and expertise to young research intensive SMEs, and creates an ongoing inventory and agenda of the obstacles faced by high tech start-ups. The office also implements the TechnoPartner Knowledge Exploitation Subsidy Arrangement (SKE) and the TechnoPartner Seed Capital Scheme.
- The aim of TechnoPartner Knowledge Exploitation Subsidy Arrangement (which started in 2004) is the more rapidly utilisation of scientific knowledge by high tech start-ups inside and outside the knowledge institutes. The SKE also includes a pre-seed facility that gives high-tech start ups the option to put more time and energy into the phase prior to the actual start, and a patent facility that enables a more "professional" approach to patents policy within the knowledge institutes.
The SKE focuses on public private consortia in which, a minimum of one public knowledge institute is represented per consortium; they can submit an application to take the knowledge exploitation in their region to a higher level. These consortiums can apply for subsidies for a number of "modules": Screening and scouting, Patents expenditure, high-tech start up support module (coaching, facilities, etc) and Pre-seed (loans for developing business plans - max €100.000)
- The TechnoPartner Seed Capital Scheme (which started in 2005) is a general fund-of-funds venture capital scheme to stimulate and mobilise the bottom end of the Dutch venture capital market, so that high-tech start-ups can satisfy their capital requirements in the early stage phase. Interest free loans / co-investments are available, providing up to 50% of the investment capital, for high tech funds, which have to pay some kind of results-dependent dividend in return. An amount of €24 million per year is available for participation by those specialised funds, up to €2.5 million per company (€0,8 million on average). The scheme is meant to fill the so-called equity gap.

9.4.3 Technology transfer by spin-offs

An interesting indicator reflecting innovativeness of society is the number of start-ups or the creation of new high tech firms. During the height of the 'new economy', the number of start-ups as well as its share of high-tech start-ups was relatively high[158]. Recent figures are not available. However, the current figure on number of university spin-offs created annually is about 30% to 40% lower than for the main competitors[159], indicating room for improvement for innovative business activity.

Universities do not seem to perform very well with respect to the commercialisation of results of research by creating spin-offs. Figures indicate that by number and turnover of spin-offs, the performance of universities is considerably lower than in other countries (1.95 spin-off per 1000 employees in the Netherlands compared to 2.53 for the main competitors)[160]. Patenting activities by universities are limited compared to the main competitors (and for just 19% of total university patents licensing agreements are negotiated, which implies that a considerable part of the patents is not being exploited). Unfortunately, no recent figures are available.

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[158] Kreijen, Van Scherrenburg and Van Tilburg (2003) "High-tech ondernemerschap in Nederland" Holland Management Review.

[159] Top Spin Internationaal (TSI) (2003), "Researchers op ondernemerspad; Internationale benchmarkstudie naar spin-offs uit kennisinstellingen", in: EZ-beleidsstudies, The Hague, June 2003.

[160] Top Spin Internationaal (TSI) (2003), "Researchers op ondernemerspad; Internationale benchmarkstudie naar spin-offs uit kennisinstellingen" EZ beleidsstudies, The Hague, June 2003.

Universities in the Netherlands receive their funding via three flows. The first flow of base funding (directly via the Ministry of Education, Culture and Science) is approximately 60%. The Netherlands Organisation for Scientific Research NWO together with the Technology Foundation STW (for the technical sciences) is responsible for allocating the second flow (10%), based on competitive grants. The third flow (30%) is acquired through contract research from third parties, including the EU Framework Programmes.

In 2003, university research received €2.430 billion per year; the research organizations received €1.253 billion.

The institutional setting in which universities operate stimulates research excellence, but does not reward efforts towards valorisation of the research. The Dutch government has therefore recently “reinterpreted” the so-called third mission of universities; emphasizing on the role they have to play in stimulating the valorisation of research and connecting with economic and societal issues. The government is currently considering the possibilities of using results on commercialisation of research as a way to value the performance of the universities, possibly resulting in changes in funding flows. But also the initiatives as described in section 9.3 support commercialisation of research, resulting in additional funding for the third flow.

Interesting to mention within the framework of this project are the so-called Valorisation Grants, launched in 2004 as part of the so-called SBIR-pilot (deadline for the last call ended in December 2006). Within the framework of this instrument, researchers at universities can apply for a support to create a spin-off from a public knowledge institute. The grant can be used for product-market analysis, for development of a prototype, for development of personal skills, for protection of intellectual property, etc. The grant consists of two phases; a feasibility study and a valorisation phase.

9.4.4 Public-private partnership

All the instruments described in section 9.3 support, in one way or the other, cooperation between the actors of the innovation system. But within the framework of this paragraph, we will describe in more detail the so-called Leading Technology Institutes (LTIs) as an example of public private partnership. The Dutch LTIs were already in 2003 identified by the OECD as a proven good practice in mobilising public and private research towards common objectives of high importance for the economy and society.

The Leading Technological Institutes (LTI) programme was launched in 1996 to increase innovativeness and competitiveness of Dutch industry by funding (virtual) centres of excellence for strategic-fundamental research. The LTIs are set up as public-private partnerships, funded by Industry (25%), Knowledge Institutes (25%) and Government (50%). Four LTIs were set up: the Wageningen Centre for Food Sciences (WCFS), the Dutch Polymer Institute (DPI), the Netherlands Institute for Metals Research (NIMR) and the Telematics Institute (TI).

The LTIs will be continued as a module in the Innovation Omnibus, in a combination with the Innovation Oriented Research Programmes (IOPs; Innovatiegerichte OnderzoeksProgramma's). An IOP is an umbrella programme, which consists of thematic sub-programmes. The main goal of the Innovation Oriented Research Programmes is to increase the accessibility of the public knowledge infrastructure for industry and to increase and intensify interactions between industry and public knowledge institutes.

9.5 Conclusions

In order to secure future economic growth, the Netherlands will have to increase its labour productivity level by strengthening the innovation system and improving its performance. The previous strategy focussing on deployment of a labour has reached its limits due to demographic changes.

The status and output of the innovation system can be regarded as good, based on different indicators, such as the quality of output of scientific research, patenting, financing of public research by industry, and the use of ICT and access to its applications. But it is also characterised by specific features and (structural) problems that will weaken its strong competitive position: there's an increasing shortage of highly educated people (especially in science and technology); the expenditure on R&D lags behind compared to main competitors; there are problems concerning financing of (early stages of) innovation; the interaction between the actors of the NIS is not yet intensive, resulting in inadequate exploitation of research results; and the history of funding mechanisms for the public research sector has led to fragmentation of research efforts across many universities, research institutions and virtual networks.

The government of the Netherlands has recently redefined its set of instruments supporting its innovation system, which addresses the issues mentioned above. This redesign has resulted in the implementation of new instruments, and the strengthening of existing ones, which contribute in one way or another, to the creation of 'focus and mass' as well as further valorisation of research results.

The philosophy behind the concept / objective of creating focus and mass in the Netherlands is that a relatively small country does not have the potential and resources to address all fields of research and innovation. It should therefore focus research and innovation on areas in which the Netherlands could be leading in an international perspective, and which will contribute to sustainable growth of the economy.

The rather wide variety of new and existing initiatives however raises questions concerning the different choices made for areas of focus, and the effect of all these different instruments / initiatives for the fragmentation of the knowledge infrastructure:

Having reviewed the policy instruments for the science base and business oriented R&D, one can argue whether in the past few years, choices have been really made. There is certainly overlap between the above focal areas and there is also a danger funding exclusively a small number of technological areas.

Practically all of the initiatives have been set up as virtual networks, thus leaving in tact existing institutional structures and adding new institutional layers on top of these networks. But setting up new networks has not resulted in an increased international visibility of the 'centres of excellence' of the Netherlands. The question arises whether too many 'spearheads' are being prioritised leading to sub-critical mass of all of them on a global scale. Given the complex and highly decentralised institutional system that has developed out of these many initiatives, institutional reform seems necessary. But at the same time there is no actor in the system with the capacity to manage / steer this process.

In developing an excellent science basis Dutch policy the prioritisation of thematic areas have not been consistent and unambiguous. To steer the decentralised and fragmented public research towards more critical mass many initiatives have been put forward to achieve this, such as the Leading Technology Institutes, funding from the exploitation of the gas reserves to large consortia, initiatives such as the Netherlands Genomics Initiative, etc. Support for these large-scale initiatives are however short term based (5 + years) in relation to their goals and support has not been unequivocal.

Figures indicate that although the Netherlands performs well in knowledge creation compared to its competitors; the actors of the innovation system seem not able to commercialise the results of these efforts ("European Paradox"), This is caused by the fact that the system does not have a tradition of intense interaction between its actors.

Interaction between the actors is hindered for example by the institutional settings in which universities operate, resulting in a mono-disciplinary layout of research at universities, and lack of incentives for co-operation. But companies also seem to disregard knowledge of universities and research institutes when innovating. Analysis indicates that as a source for knowledge, firms rely heavily on their specific sector / partners in the production chain (own company, competitors, suppliers, clients etc.) or external sources (professional literature). The public research infrastructure is not often consulted as a source for knowledge.

The Netherlands has a tradition in policy and instruments supporting cooperation between the actors of the system. Almost all instruments aimed at industry oriented R&D and innovation address this aspect. Figures however indicate that there are still opportunities for improvement, when compared to the main competitors.

For the first time however, the Dutch government is trying to intervene in the institutional settings of the public research infrastructure. The Ministry of Economic affairs and the Ministry of Education, Culture and Science are aiming at creating incentives for cooperation by changing the funding system. It is yet however too early to assess the impact of such initiatives.

10. Overall analysis

10.1 Introduction

In this final chapter we present some overall observations on the changing institutional setting in the set of benchmark countries (section 10.2), trends and issues regarding focus and mass (section 10.3) and valorisation (section 10.4) and more specifically some remarks on the role played by PPPs (section 10.5). We conclude with a set of overall conclusions and some best practices that might inspire Dutch STI policy in the last section (section 10.6). We would like to emphasize once again here that we are dealing with a quick scan for a limited set of countries, based on qualitative (mostly anecdotic) evidence that is sometimes hard to compare between countries. In these countries we have attempted to benchmark countries on a number of dimensions using orthogonal scaling. This scaling should not be taken too literally, but mainly helps to appreciate how the various countries are positioned vis-à-vis each other and more specifically how the Netherlands compares to the seven benchmark countries.

Before going into the various sections, we like to highlight two general observations that can be derived from the country studies. First, the attempts to create more value – however broad defined – and to arrive at more focus and mass in the (national) research portfolio seem to be at least partly motivated by the same motives. It is therefore sometimes difficult to differentiate between the two phenomena. Table 10.1 presents an overview of the arguments that we found in policy debates in the various countries. Note that all arguments summed up here start from the assumption that focus and mass is something worthwhile to strive for. But there are of course also arguments against focus/mass and (too much) valorisation. These include the loss of flexibility of the research system (because the portfolio becomes too narrow to deal with changes in the environment), inefficiencies associated with large research groups and organizations (decreasing returns to scale, including qualitative effects such as a lack of creativity), and the intermingling of roles of key actors which gives rise to fuzzy structures and responsibilities. Bringing too much focus into a research system might also come at a (heavy) price, especially if it is done in a rather bold top-down manner such as in the Research Assessment Exercises in the United Kingdom[161].

[161] The financing of research in the UK is stringently tied to the quality of the research. This has quickly lead to a concentration of university research in the best performing research groups. In the course of the process, less excellent (but still well) performing groups were abolished. This had considerable effects on the science and engineering disciplines. Almost 40% of all groups in physics, chemistry, and mechanical science were terminated. Nowadays a lot of resentment against the exercise is being voiced by local and regional firms because the disappearance of research groups on the neighbourhood has weathered the knowledge base of these companies and consequently diminished opportunities for valorisation.

Table 10.1 Arguments used (and their overlap) for focus and mass and valorisation[162]

Typical rationale behind pleas for more focus and mass ▪ Scientific excellence[163] requires a group size above a certain minimum level (critical mass), and focused attention in order to excel; ▪ Scientific excellence may generate more mass in research; ▪ Research is getting more costly and this demands more mass as benefit from scale economies in research (i.e. content) for example sharing expensive equipment and facilities; ▪ Mass allows one to benefit from economies of scale in the organisation and management of research (i.e. process)[164]; ▪ Internationalisation of research demands visibility and reputation and hence a certain scale and focus. International research collaboration requires focus and mass on selected themes; ▪ Small countries in an international competition can only excel in a few areas/disciplines and therefore should bring focus into their research portfolios
Grey zone where arguments apply to both focus and mass and valorisation ▪ When national research themes are in line with national economic specialisations research can contribute more to economic competitiveness (this requires both focus and mass and a well functioning local markets for knowledge where demand for and supply of knowledge meet); ▪ When national research themes are in line with societal needs, research can contribute more to societal welfare (this requires mass, and focus as some issues are country specific e.g. 'water management' in the Netherlands. Valorisation is needed to allow for the required knowledge transfer); ▪ More mass allows research groups to develop not only to develop more, specialised, knowledge, but also expertise to transfer this specialist knowledge into the hands of firms and societal organisations (i.e. valorisation); ▪ More mass allows for more variety within selected themes i.e. broadening and deepening at the same time. This allows (commercial or social) partners to adopt a one-stop shopping strategy when sourcing their knowledge needs; ▪ Fundamental research increasingly takes place in HEIs and RTOs and less so in (large) firms[165]. Rejuvenation of companies (and society) is increasingly dependent on specialist knowledge (focus) and knowledge transfer from academia (valorisation); ▪ Innovation increasingly takes place in open innovation networks. Therefore a research agenda that is recognisable and attuned to the needs of firms and societal organisations is needed. HEIs and RTOs should open up to these needs and this requires both focus and mass and valorisation; ▪ Excellent research (which often entails focus and mass) will always find (a) valorisation.
Typical rationale behind pleas for valorisation ▪ Underutilisation of the current scientific knowledge base; ▪ The economy at large should benefit more from public research investments (valorisation might help to improve overall competitiveness) as these are public investments after all; ▪ Society at large should benefit more from public research investments as many societal issues can be solved better using expertise derived from academia and these investments are public investments after all; ▪ Intermediate and final users can be an important source of innovation, so more demand driven research is needed (in fact this is the complement of valorisation); ▪ Better valorisation might contribute to a better embedding of science, technology and innovation in society. Societal support for science is more likely if the utilisation for day to day problem solving can be illustrated

[162] Note that in principle policy-makers are free to (and do indeed) pick and choose any of these arguments even though they might in some cases be contradictory.

[163] Interpreted here as self propelling, vital and productive research groups with high quality output.

[164] These static efficiency gains may be limited to support functions only, not to the research process itself.

[165] There seems to be a tendency within firms to diminish risks of investments in R&D by focusing on short term R&D in core areas of competence.

The second observation is closely related to the first one, namely that the exact relationship between focus and mass on the one hand and valorisation on the other hand is rather indistinct. As a result it is very difficult to determine the causality between the two goals. For instance, does more focused research at a larger scale lead to more and/or better opportunities for valorisation or does more valorisation lead to a more focused research effort? In the first (supply-driven) case, one could assume that focused research has relatively much economic impact – assuming it is in line with the underlying pattern of economic specialisation. In the second (demand-driven) case, a better link to potential beneficiaries of research is likely to lead to more focussed and specialized demand for research and hence to more focus and probably more mass.

10.2 Some observations on the changing institutional setting

While describing the institutional setting of STI in each of the seven benchmark countries it soon appeared that most of the settings have idiosyncrasies which affect the perspective on focus/mass and valorisation and the sort of policy measures taken. Furthermore we noticed that in a number of countries (Austria, Denmark, the Netherlands) the institutional setting is in a (semi-permanent) state of flux. Some of the major national specificities and trends in institutionalisation and STI are given in table 10.2 below.

Table 10.2 Idiosyncrasies and trends in institutionalisation of STI and STI policies

	National STI specificities/ idiosyncrasies	**Trends in institutionalisation and STI policies**
Austria	The Austrian STI policy system is rather complex and fragmented, although the situation is improved with the establishment of the Austrian RTD Council and various reorganisations and mergers at the agency level. The university sector is a dominant actor in terms of publicly funded R&D.	Despite successful programmes like Kplus competence centres to encourage industry to do more strategic R&D and improve the linkages between public and private research, Austrian research funding is still mainly focused on basic research. The university reform act (2002) is expected to have a substantial impact on university research (i.e. increasing quality of research, more focus, and more cooperation with industry).
Denmark	R&D on top of political agenda. Big question is how this will translate into real changes in the STI system	Less autonomy for HEIs and merger GRIs and HEIs
Finland	Very strong tradition in STI policy using a systems of innovation perspective and a tightly knit and well-functioning network of policy makers.	More autonomy for HEIs. Further STI plays an explicit role in regional development and STI policies are increasingly integrated in other policy domains (i.e. horizontalisation of STI policies)
Flanders	Innovation important issue. Science and Innovation responsibility of one Minister. Universities dominant in discussions and dominant beneficiaries (85-90% public STI budget is granted to universities)	Autonomy of universities high. Tendency towards less autonomy (but will remain high)
Ireland	Increased understanding that investments in STI are crucial to sustain economic growth in the future. STI policy is therefore a major element of the National Development Plan.	By the end of the nineties Ireland's STI policy had a major boost with substantial investments to build up critical mass and excellence in higher education research. This was then followed by more focused research funding on key areas that are of economic value to Ireland (mainly ICT and Biotech). Nowadays policy initiatives are launched to make Irish (start-up)

		firms benefit more from the results of (public funded) research in Ireland.
Netherlands	The history of funding mechanisms for the public research sector has led to fragmentation of research efforts across many universities, research institutions and virtual networks. However, hands off science (OCW) and more hands on innovation policy (EZ) traditions are gradually moving towards each other. Innovation is still high on the political agenda resulting e.g., in a prolongation (and restructuring) of the Innovation Platform.	Generic innovation policy is complemented with a more specific innovation policy leading to e.g., a programme-based package. The institutional settings of the public research infrastructure are increasingly being discussed and adapted in a similar vein. Other Ministries than the two core ones (Education and Economic Affairs) are also explicitly addressingknowledge and innovation in their specific policy domains. The political commitment to innovation is reflected in the continuation of the high level Innovation Platform.
Sweden	Research policy continues to play a central role in Sweden in order to maintain Sweden's position as a "research nation". Despite the highest level of R&D investments in the EU (more than 4% of GDP) the government is planning to invest additional money in R&D in the coming years.	A number of specific research areas are prioritised and receive additional research funding. There is more focus on supporting excellence in public policy. Valorisation of research features high on the STI policy agenda and is supported through a variety of new measures.
Switzerland	Absence of STI policy. Strict split between public and private sector.	Shift in power from (very strong) cantons to federal level. Bottom-up concentration in two federal HEIs

Albeit the fact that we have selected benchmark countries with a more or less similar profile (medium-sized economies, all but one are EU Member State) there are remarkably big differences between the respective institutional STI frameworks. To characterise the various benchmark countries vis-à-vis each other we defined some key dimensions on which we position the countries (using orthogonal scaling) indicatively. The results are given in figure 10.1.

Figure 10.1 Positioning the benchmark countries in terms of STI systems & settings

	AT	CH	DK	FI	FL	IE	NL	SE
1. Focus on basic or applied research								
Total government R&D expenditure	■■	■■	■■	■■■	■■	■	■■	■■■
Focus on basic research within public R&D	■■■	■■■	■■	■■■	■■■	■	■■	■■■
2. STI structure								
Complexity	■■■	■	■■■	■■	■■	■	■■	■■■
Coherence	■	■■■	■	■■■	■■■	■■■	■■	■■■
Turbulence	■■■	■	■■■	■■	■	■	■■■	■
3. Embedness national STI policy								
in broader national strategy	■■	■	■■■	■■■	■■■	■■■	■	■■■
in international perspective	■■	■	■■	■■■	■■	■■	■■	■■■

10.2.1 Focus on basic or applied research

The scores on total government R&D expenditure (GERD) are directly taken from the figures in section 1.4. Finland and especially Sweden spent significantly more than the other countries. They are the only two countries that already – comfortably – meet the Barcelona targets. Ireland is still clearly below the average which can be partly explained by the very low initial investment figures[166]. Public R&D expenditure has however significantly increased during the last decade and the current growth rate is the highest among the benchmark countries. In contrast to Ireland the Netherlands, which is at the bottom of the intermediate group, is not catching up. Its GERD growth rates are rather modest.

The Irish policy is also different when it comes to the relative share of basic research within public R&D. Investments and policy actions are predominantly geared towards applied sciences. This can be partly explained by the fact that the science base in Ireland has historically been very small, and today is still relatively modest compared to the other benchmark countries. Austria, Switzerland and Flanders have a bias towards basic science, Sweden and Finland focus on basic and applied research at the same time – thus one seemingly does not exclude the other – but stress the importance of scientific excellence in applied research (the ‘high-tech’ approach).

10.2.2 Structure of the STI framework

The complexity of an STI system is mainly determined by the number of actors and the definition of the roles of the various players (e.g., a clear division of labour). Complex systems might be functioning better in complex (e.g., constantly changing) environments but there is a trade-off – such systems require a careful co-ordination between the numerous actors.

The degree to which research and innovation policies are integrated or coordinated give rise to a specific set of institutions and policies. More practically the latter refers to a situation where typically a Ministry of Education and a Ministry of Economic Affairs develop their own set of institutions and policy philosophies and coordination is hard to realise. More widely countries differ considerable in the degree to which STI policies are interpreted narrowly or seen as part and parcel of various policy domains (i.e. differences in the degree of horizontalisation of STI policies). The role of the universities in funding and prioritising research and especially their level of autonomy also differs. The benchmark countries also vary considerable in the number and size of non-university intermediary research organisations.

In each country there are specific sets of permanent and/or temporary research or innovation councils. These councils play distinctive roles in agenda setting or deriving at an overall STI strategy. The degree to which they are effective in aligning the various actors in the STI system varies greatly.

The comparison of the coherence within the STI systems should take the differences in complexity into account. Complex systems are more difficult to manage than simpler ones. This partly explains the high scores on coherence for Ireland, Flanders and Switzerland. The situation in Austria and Denmark on the other hand is characterised by a high degree of complexity and a low degree of coherence. As a results, there is a lot of turbulence because constant makeshift solutions are needed to keep the system going. Sweden seems to have managed to couple a complex system with a relatively high degree of coherence but this comes at a price: this is a static equilibrium and it is difficult to change the settings. The relatively low adaptability might for instance explain why the extremely high levels of expenditure on R&D have not resulted in comparable levels of economic growth. Finland has a rather hands on but nevertheless coherent manner of managing its STI

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[166] The Irish economic miracle (‘the Gaelic tiger’) during the 90’s was based on the very successful policy of the Irish government to attract direct foreign investments. It is only fairly recently that the government is making significant structural investments in public R&D.

system and is therefore able to adjust its relatively complex system (e.g., due to the importance of regional policy) to changing circumstances. In terms of complexity, the Dutch system is comparable to the Finnish system but it has less coherence. It has the common split between Education and Economic Affairs and lacks a strong overall vision and strategy.

In nearly all countries considerable policy efforts are aimed at focus and mass and valorisation. There are however differences in the way these efforts are being effectuated. First, some countries (Austria, Denmark, the Netherlands) have a more hands on mentality than others and hence show more policy turbulence (e.g., high frequency of new specific policy actions). Secondly, some countries (Finland, Sweden) seem to be more successful in aligning the levels of policy formulation, the institutional level, and the level of research groups than others. Policy turbulence – i.e. policy discussion and new policy initiatives – in itself does not necessarily lead to major changes at the level of institutions and research groups. In fact those countries that seem to be more successful have managed to align the levels of policy-formulation, the institutional level and the level of the research groups. Although we deal with a limited set of data or evidence here, it seems that the more successful countries show relatively little turbulence in their STI policy frameworks. Put differently: boosting excellence in research and/or valorisation is a long-winded process which is not helped by frequent changes. It seems that at least in some cases leaving the system in peace might work out better than constant fine-tuning.

10.2.3 Embeddedness of the national STI strategy

The major challenge of the formulation of a coherent national STI strategy is to combine the seemingly different goals of steering at relevance for industry and steering at scientific excellence. In nearly all cases a high degree of coherence goes with a high embeddedness of the STI strategy in an overarching national strategy. There are a number of countries that have defined a clear overall development and/or growth strategy and from this derive the overall direction of the narrower STI strategy. This seems to help to view the STI system and an integrated system and to manage it as such. The two countries with the most developed overall growth strategy, Finland and Sweden, have already advanced to the next geographical level and have explicitly embedded the national system in turn to the international system. Finland for instance takes a highly pro-active stance towards the developments at the EU level. Switzerland is an exceptional case in the sense that it is able to score high on coherence (although the complexity of its STI system is relatively low) without the presence of any explicit national strategy or other kind of grand scheme. The Swiss policy strongly emphasises scientific excellence – as does the Finnish policy – but for the rest has a very hands off approach.

10.3 Trends and issues in focus and critical mass of research

In the STI policy debate, focus and mass are often presented as two necessary ingredients to improve the general quality level of scientific research. The two issues are tightly intermingled but aim at different goals. Focus is needed to give (a clearer) direction to the content of STI agendas whereas mass can be about research (i.e. content) and about the process of organising research and research infrastructures (and at the micro-level, managing research at the level of institutions and research groups).

Whether the two are complementary or supplementary cannot be said beforehand. One can increase focus without increasing mass. Likewise more mass does not necessarily generate more focus. For instance, at the micro level of a research group, introducing a clear split between the research and administrative processes might lead to more focus on research per se. Subsequently, the establishment of a separate professional administrative (sub)unit in turn requires a certain critical mass.

Figure 10.2 Positioning the benchmark countries in terms of policy action on focus and mass

	AT	CH	DK	FI	FL	IE	NL	SE
4. Occurrence of arguments in policy discussions								
mass in research (content)	■■	■	■■■	■	■■	■■■	■■■	■■■
economies of scale in administration (process)	■■	■	■■	■■	■	■	■	■■
5. Broad measures to structure development national STI system								
tradition of recurrent multi year plans	■	■■■	■	■■■	■■	■■■	■	■■
tradition of foresight exercises	■	■	■■	■	■	■■	■	■■
6. Focus in research agendas	■	■	■	■■■	■■	■■■	■■	■■
7. Tactical use of EU funding								
to get more focus	■	■	■	■■	■	■	■	■■
to boost mass	■■■	■	■	■■■	■	■■■	■	■■
8. Regional policy								
importance of regional dimension	■	■■■	■■	■■■	■	■■	■	■■■
degree of coordination between regions	■	■	■■	■■	■	■	■	■■

10.3.1 Arguments in policy discussions

Overall mass in research appears more prominent in policy discussions than economies of scale in administration[167]. With regard to the first dimension, a striking finding is that the countries which attribute the least importance to mass in research (Finland, Flanders, Switzerland) are exactly those countries which put most emphasis on scientific excellence. This seems to suggest that – at least in the policy debate in this three countries – size does not matter for scientific performance[168]. Another important observation is that at least in Switzerland and Flanders the apparent lack of focus and mass is accompanied (or compensated?) by a strong emphasis on the supporting infrastructure for business R&D.

The strong emphasis on mass in research in Ireland is a logical consequence of the small size of its research base. It has only a few strong research areas, most notably in computer sciences and biotechnology. The official STI policy is centred around the same areas and thus reinforces the historically, bottom-up grown situation.

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[167] In some cases, the ‘degree of professionalism’ of a recipient institute (i.e., the quality of its administrative organisation) does play a(n indirect) role in the assessment of funding applications. This issue is especially at stake on the EU level (e.g., FP funding). The Danish Research Councils for instance have argued that the establishment of dedicated administrative units will foster collaboration at the national and especially at the international level. In a similar vein, the call for ‘multidisciplinarily research’ in research proposals, which was found in almost every country, also incites increases in critical mass.

[168] But note that mass might still be regarded as an important issue albeit for other dimensions, e.g., valorisation of scientific results (see hereafter, 10.4). A possible explanation of the fact that focus and mass do not seem to play a major role in (the tiny territory) Flanders is that it already has a very long tradition in collective research centres (ever since WW II) and that the notion of focus and mass might thus already have been internalized. In Switzerland, the pursue of critical mass is very much a bottom-up process. Due to severe financial restrictions institutions (cantonal) universities are increasingly seeking collaboration. At the same time, the two federal universities attract the bulk of science and engineering students and the concentration is still increasing.

In Denmark, we found one remarkably case of a funding agency that operates diametrically against the dominant national stress on mass in research. In times of tight budgetary constraints it spreads its budget evenly to a maximum number of recipients. Only when more budget is available it concentrated the (additional) budget on a limited number of recipients[169].

In Denmark, the increase of mass in (administrative) processes is also a predominant item on the political agenda and in fact the driven force behind the large-scale consolidation of the STI system. It is assumed that the operation will generate substantial cost-savings. However in practise the efficiency gains will be fairly limited because the mergers are mainly organisational in nature (basically the merger of several Boards)[170]. No physical mergers are involved.

10.3.2 Measures to structure the development of the national STI system

The use of recurrent multiple (usually five) year financial plans is an important feature of the national STI regimes in Ireland, Finland and especially Switzerland. The changes in the successive plans are fairly limited. The use of these kind of long-term financial planning indicates a long-term perspective on the development of the STI system (and the country at large). The plans are also a stabilizing factor in itself. In fact in all the countries that use multi year plans turbulence in the STI structure is low (see Figure 10.1).

The plans do, however, have another position in each of the three countries involved. In Switzerland, in the absence of an overall national development strategy, the five year plan is in fact the central piece in the national R&D policy. In Ireland, the plans are used as the main tool to implement the overall national development strategy. In Finland, the long-term planning is an autonomous force in itself but is adapted towards the overall national strategy in each of the successive rounds. That is, the long-term view remains intact (e.g., a constant rise of GERD over a very long period of time) but the changes that are being made are geared towards the changes in the national development plan which reflects in turn changes in the wider (international) environment[171].

Overall, the popularity of (large-scale) foresight exercises is on the wane. This is probably because the significant efforts that are being made usually do not result in particularly surprising results (see hereafter). Another impeding factor is that the results of foresight exercises are often not used in the formulation of the actual R&D agenda. A clear example is Denmark which gives the procedure of the foresight exercise a prominent role in its national growth strategy but takes the content of the exercise simply off the shelf from a previous one done by a former (opposite) government. In this respect, Ireland is an obvious exception. It has really used the results of its foresight exercises to draft the national development and research agenda. It is the only benchmark country in which the foresight exercise and the long-term financial planning are consistently linked.

Another remarkable exception to the general trend is Finland. Although it is generally regarded as one of the leading countries in the field of STI management, it has never used

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[169] The prime motive of this ‘anticyclical survival funding’ seems to maximize the breadth of the research portfolio of a country in order to be able to coop with unforeseen changes (cf. complexity of systems and complex environments).

[170] The motives seem rather political than economical. For the national government it is easier to deal with one Board than with several (highly autonomous) ones.

[171] For example, the major part of additional funding in the latest update of the five year plan is earmarked for the newly established ‘International Centres of Excellence’.

foresight exercises. That is, up until 2005 when the Finnish government launched the first ever foresight project in the field of STI policy (FinnSight 2015).

10.3.3 Focus in research agendas

The notion of focus and mass applies to all levels involved (international/EU; national; regional; local/institutional; research unit) both in a horizontal and vertical way. That is, there should be sufficient focus and mass at each individual level (horizontal coordination) and sufficient focus and mass across the levels (vertical coordination). In theory, vertical coordination should also lead to (more) focus and mass at each subsequent level. In order for the focus and mass exercise to be effective, this would ultimately involve that all research at a lower level should be fit into the research agenda at a higher level – and all remaining research would not be supported.

In practise it seems that such a purely top-down driven process is rare. In some of the benchmark countries (e.g., Switzerland) a national strategy was absent altogether. Other countries clearly invest heavily in the formulation of such an overarching strategy (e.g., Denmark) but it remains to be seen to what extent that strategy actually influences the formulation of tactical and especially operational strategies at the lower levels. Thus the mere existence of a national strategy does not contribute to the coherence of the STI system.

The definition of a research agenda which is initiated from the highest level (e.g., supported by a foresight exercise) is inherently limited to the main lines. In all benchmark countries we found the same main research themes, namely ICT, biotechnology, and nanotechnology (sometimes complemented by energy/environmental technology) – regardless of the fact whether a clear strategy was being used or not. Thus it seems that (elaborate) strategy efforts are not necessary to arrive at these themes. Furthermore, the themes are still so broad that they do not really bring focus – the devil is in the details. Distinctive differences between countries only start to appear at the level below the main theme, e.g. the tactical choice for a certain field or application area within biotechnology[172].

Nevertheless, a (top-down) national strategy could certainly improve (bottom-up) SWOT-analyses but only if it focuses on general societal goals rather than specific scientific fields. The intermediate tactical level then becomes the pivotal place where the broader societal goals are being translated into more specific application areas. Thus the national strategy gives the future direction for a country and the tactical strategy translates that into a framework in which the existing strengths at the lowest level should be fit[173].

The balance between vertical and horizontal coordination is rather precarious. Too much (or too less) concentration at one level could lead to fragmentation at other levels. It seems to be very difficult to bring about radical changes in the system without disturbing the balance and incurring heavy casualties (cf. the Research Assessment Exercise in the UK, see footnote 137). Instead, in many countries (e.g., Switzerland, Finland) a bottom-up division of labour has arisen with some top universities operating at the international level, most universities at the national level, and the polytechnics at the regional level. A strong emphasis on scientific quality seems to somehow translate in a more or less spontaneous

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[172] A (bottom-up driven) detailed SWOT-analyses might be more useful to work at this level than a (top-down) broad forecasting exercise (cf. Flanders and to some extent Ireland).

[173] The added value of a national strategy is also linked to the notion of mass. If a country or region (e.g., Ireland, Flanders) has limited research capacities in terms of critical mass it more or less automatically attains focus because it has fewer research units at the lowest level to start with.

(bottom-up) hierarchical division of labour between the research units[174]. In most countries, the financial constraints for research funding are being tightened and more competition for funding is being introduced[175]. However in most cases research groups still have a lot of autonomy to define their own research agendas. Furthermore, several countries have also introduced competitive funding for institutions (instead of individual researchers or research groups). In Sweden, for instance, universities compete for national funding (Linnaeus Grant) but they are free to choose their own topics. The selection is purely on scientific merits – the universities therefore focus on their particular strengths. In a similar vein, Denmark has granted more autonomy to universities but has simultaneously increased the share of competitive funding. There are less but bigger prices to be won[176].

The vertical division of labour between some universities operating at the international level and the remaining bulk at the national and/or regional level is also reflected in the recent introduction of so-called 'international Centres of Excellence' in Finland and Sweden (Berzelii Centres) on top of the existing layer of conventional (national) Centres of Excellence[177]. In terms of coordination it is of course interesting to see how the research agendas of these two types of Centres are being connected. In theory, the national Centres should operate on the intermediate tactical level and the overall direction should be given by the international Centres.

10.3.4 Tactical use of EU funding

Zooming in on the vertical coordination between the highest levels (i.e. EU and national STI policy) some countries seem to use the EU research agenda as a lever to gain some additional influence over the lower levels (Ireland, Austria). For instance, national funding is explicitly linked up with EU funding. Other countries (Sweden, Finland) are actively adapting both levels to each other (either by pro-actively steering the EU agenda and/or [re]oriented the national agenda) while some other countries leave the European challenge (also in terms of administrative hurdles…) to the lower levels (Denmark). Obviously, the two countries that embed their STI policy into a broader international perspective (again Finland and Sweden) are also the two countries that tactically use EU funding to get more focus in their national research. Overall, though, the EU research agenda is predominantly used to bring mass into the national STI system, much more than focus.

10.3.5 Regional policy

Too much focus and mass on the national level might frustrate developments at the regional level. This is at least a recurrent theme in the policy debate in Sweden, where it is said that the building of critical mass at the national level is detrimental to the development of knowledge-based regional development. Nonetheless this does not necessarily

[174] In other words, most Boards of institutions and research groups that do not meet the highest scientific quality criteria seem to be perfectly able to shoulder their responsibility and climb down a peg or two.

[175] There is a general shift from general university to direct funding (see 1.4). In some cases (e.g., Denmark) basic funding is supplemented by earmarked (strategic) funding. In other cases (e.g., Finland) basic funding remains constant but all additional funding is in strategic research.

[176] It remains to be seen how this will effect the strategic behaviour of universities, i.e., whether it will increase competition or foster collaboration ('co-competition') between the universities.

[177] In terms of numbers, there are usually 4-5 international and 20-30 national Centres of Excellence. Note that Austria, with has a complex STI system with low coherence, has no international Centres but over 70 national Centres of Excellence.

have to be the case (as it seems to be the case in Finland). If every region focuses on its own particular strength that might very well be embedded in an overall national strategy. The proof of the pudding is if there is any effective coordination occurring at the national level, i.e., overlap at the regional level is minimized (not every region is focusing on the same theme).

In most smaller countries (in a geographical sense), for obvious reasons the regional dimension is less prominent in discussion on focus and mass and in Flanders not relevant altogether.

10.4 Trends and issues in valorisation of research results

Valorisation is increasingly part and parcel of standing policy. The legitimisation of investments in public research is implicitly linked to the notion of valorisation. It also explicitly appears in research funding criteria, ex ante or ex post evaluation of research projects and bigger constellation, and most visibly in the charters of universities (‘third mission’).

There is a broader idea that public research should eventually deliver value but whether this refers to value to the society at large or to a more narrow economic interpretation often remains unclear. This could be partly explained by the fact that a more precise definition would immediately bring two conflicting views to the surface that are underlying the issue of valorisation. From one extreme the view is that any public research which cannot be directly translated into market value is of no (real) use. From the other side, the true value of public basic research is exactly that it is *not* being tied to concrete industry needs. In a similar vein, there are perpendicular views on the issue of flexibility. The adherents of the first view argue that the ability to adapt to ever more dynamic global circumstances comes from the focus on a limited number of strategically chosen application areas. The proponents of the second view on the other hand claim that flexibility comes from keeping open as many as possible research directions (provided that these meet certain minimal quality levels).

Figure 10.3 Positioning the benchmark countries in terms of policy approach towards valorisation

	AT	CH	DK	FI	FL	IE	NL	SE
9. Public-private research collaboration								
relative number of joint projects (aimed at focus & mass)	■	■■■	■	■■■	■■	■	■■	■■■
relative number of formal PPPs (aimed at focus & mass)	■■■	■	■■	■	■	■■	■■■	■■■
relative number of formal PPPs (aimed at valorisation)	■■■	■	■■	■	■■■	■■	■■	■
10. Role of universities and polytechs (HEIs)								
importance of 'third mission'	■	■	■■	■■■	■■	■■	■■	■■■
development of commercial activities	■	■■	■	■	■■	■■	■	■
11. Aim of valorisation								
economic goals	■■	■	■■	■■■	■■■	■■■	■■■	■■
societal goals	■■	■■	■■	■■■	■■	■	■	■■■

10.4.1 Public Private research collaboration

Given the broad range of possibilities to implement valorisation policy it could very well be integrated into existing policy measures and structures. However, similar to adjusting funding streams, the striving for valorisation is often embodied in new (types of) institutions such as establishing technology transfer offices, programmes aimed at generating more spin offs from academia or the creation of competence centres or institutes like the Leading Technological Institutes in the Netherlands.

it is evident that public private research collaboration features quite high in a considerable number of the benchmark countries. However not all public private collaboration schemes are formal Public Private Partnerships. There are numerous policy instruments to arrive at and/or improve valorisation, ranging from stimulation collaboration between universities and private firms, stimulating entrepreneurship, creating spin-offs, merging GRI with universities, revising the mission of universities, changing funding criteria and so on. Especially the latter instrument (improving valorisation via – light tough – regulation) is often underestimated. On the contrary, the importance (and frequency) of formal partnerships between universities and firms (usually involving PPP-constructions) in valorisation policy seems to be overestimated. For instance, in most Nordic countries the number of formal Public Private partnerships is relatively low compared to the number of other types of public private research collaboration. In Switzerland, formal PPPs are almost absent altogether but there are a great number of (informal) joint project between universities and firms, usually on a personal base.

10.4.2 Role of universities and HEIs

The concept of the 'third mission' for universities and HEIs has already been around for quite some years but is has only recently been (at least more or less officially) embraced by most countries and by the EC. Exceptions are Austria and Switzerland (not an EU member state) that both have a relatively orthodox view on the role of universities and that are characterised by a cantonal system. This leads to a kind of natural division of labour between the federal universities (e.g., the ETH's in Switzerland) that focus on 'high science' and are oriented towards the global level and the regional universities and HEI's that focus on applied science and are more oriented towards their direct regional surroundings. In Finland, there appears to be a similar split but the societal task of the universities goes much beyond the informal one in Swiss and Austria. The third mission of public research institutes is directly linked to the issue of regional development, which is regarded as the top priority in the overall development plan for Finland. Thus, at the regional level, tight clusters of universities, polytechnics, (regional branches of) GTI's and regional development centres are positioned as the engine of technological and social innovation and economic growth. The third mission now also makes public research institutes responsible for developing regional knowledge potential and for making knowledge and know-how available to users through collaborative effort.

The importance of the third mission of universities is not directly linked to commercial activities of HEIs and polytechnics – rather the opposite pattern emerges. In countries where the societal role is emphasized (Finland, Sweden, to a lesser extent Denmark) commercial activities are limited or even forbidden (Denmark). In Switzerland on the other hand the third mission is of little importance (and least formally) but universities are relatively active in the private realm. These activities are concentrated on the federal universities (ETH's) and are based on the high science profile of these institutions (the 'US biotech model').

10.4.3 Aims of valorisation

There appears to be a trend across the board to put more emphasis on broader societal goals in STI policy (e.g., aging, social cohesion, sustainability etc.). One of the consequences is that at least in some countries (Finland, Swiss) the (still modest) share of social sciences in innovation policy is on the rise, not only in basic but also in applied research (e.g., to support pressing policy problems, embodied in dedicated Centres of

Excellence). Another consequence is that the notion of multi-disciplinarity has gained much importance lately. Social sciences are needed to bridge the gap between hardcore natural sciences and engineering and the aforementioned broader societal goals. The striving for multidisciplinary groups also has repercussions for focus and mass since such groups are inherently bigger than their mono-disciplinary peers (mass) and thought to be better able to deal with demands from industry (focus).

The issue whether the direction of public research has to be driven by industry demand or scientific supply is obviously related to the particular view on valorisation. In the first case the responsibility for the actual valorisation of research is always in the hands of the private sector. In the latter case, there could be a more differentiated task for HEIs, ranging from a passive to a more active role. In some countries (Finland, especially Swiss) there is a clear division of labour between universities, polytechnics, and private enterprises. Academic research should first and foremost be of excellent quality. Scientific hotspots will naturally attract the attention of the private sector. Polytechnics on the other hand should focus on applied research and have the responsibility to actively disseminate the results of their research. Grosso modo then the responsibility for HEIs for valorisation is inversely proportional to the scientific stature of their work. This is in sharp contrast to the view that excellent scientific research will directly lead to (commercial) valorisation of the results by the academic researchers and universities themselves (cf. the US).

10.5 The role of PPP

Within the limited scope of this comparative study the focus was on the role of the concepts ‘focus and mass’ and ‘valorisation’ in the policy discussions in the benchmark countries and the way policy discussions were transferred into actual policy actions. The limited scope of the research left no room to study in detail how policy actions were implemented, and in what way the balance between public responsibility and private initiative was organised. Nevertheless, same general conclusions can be drawn.

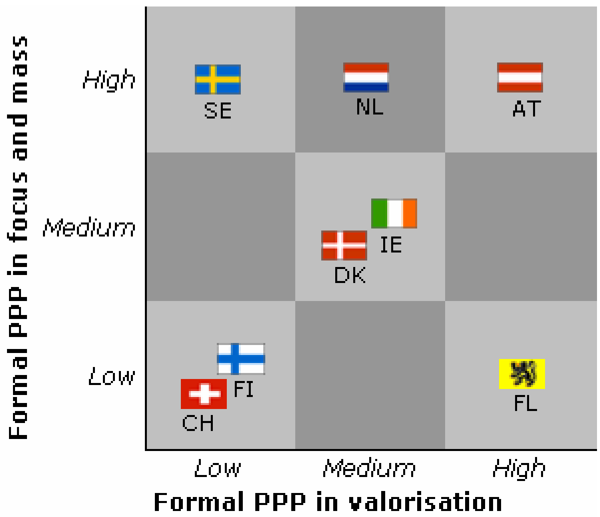
First of all, there appears to be a great variety of PPP constructions, varying from situations where there is no formal private public cooperation to situations were the research agenda is defined by industry and government together, and research expenses are shared, and all sorts of constructions in between.

Table 10.3 Some examples of PPP constructions for focus/mass and valorisation in the benchmark-countries

	Focus and mass	*Valorisation*
Austria	Kplus, Christian Doppler Society	Kindnet
Denmark	Multi million industries	Action Plan PPP on innovation
Finland	-	-
Flanders	The 4 research institutes	Several sector or technology oriented competence centres
Ireland	PAT's	-
Netherlands	Bsik consortia, Leading Technology Institutes, Innovation Programmes EZ	Smart Mix, Leading Technology Institutes, Innovation Programmes EZ
Sweden	Various	Berzelii centres
Switzerland	-	CTI

To bring some structure into the great variety of PPP constructions, in Figure 10.3 the use of formal PPPs[178] in focus and mass is plotted against the use of formal PPPs in valorisation (see Figure 10.3). Given the limited amount of data conclusions based on this figures should be treated with caution. Nevertheless, some striking patterns occur.

Figure 10.4 Positioning the benchmark countries in terms of the use of PPPs in policies aimed at focus and mass and valorisation respectively



First of all, the figure shows an almost maximum variation in the use of formal PPPs for valorisation and focus and mass – the scores of the countries are neatly divided across the

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[178] Defined as organisations with shared responsibilities by public and private partners *and* shared financing.

matrix. Secondly, the degree to which formal PPPs are being used for focus and mass seems to be related to the use for valorisation (the diagonal in the figure). Countries that score high on one kind of use also do so for the other kind of use and the other way around. Obvious exceptions are Flanders and Sweden. Thirdly, some of the countries that have a very strong performance in innovation score boards do not use formal (sic!) PPPs as a policy instrument at all (Finland, Switzerland), or only for creating focus and mass (Sweden). With such a small sample this may be a coincidence, but some extra research on the use of PPPs for esp. valorisation might be considered a good idea. A plausible assumption is that other methods are more effective in this stage of innovation (like e.g. the Swedish sector dialogues).

PPP for focus and mass has often the form of competence centres like the Dutch LTI programme or the various Austrian and Swedish programmes. PPP do not seem to be suited for sectors were the financing possibilities of the sector are small (i.e. in sectors were the average company is small and R&D expenses are low) .

10.6 Conclusions

In this section we wrap up the main findings on the institutionalisation of STI, focus and mass, valorisation and the role of PPPs herein as presented in this chapter. In table 10.4 we listed some of the more inspiring examples that we came across in the various country studies (i.e. the overview is not exhaustive at all). For details we refer to chapters 2-9. In our view these main findings and possibly inspiring examples are instrumental in discussing the way processes of focus and mass and valorisation are shaped in the Netherlands and the role played by PPPs. We think these deliberations typically should be part of a wider discussion and possibly meta-evaluation as to how the wider Dutch innovation system is governed.

1. As to the STI frameworks it can be concluded that the institutional setting against which processes of focus and mass and valorisation takes place is complex and varies tremendously between countries (limiting possibilities for immediate cross country learning). Most countries show idiosyncrasies that affect the way in which they deal with focus and mass in and valorisation of research and the sort of policy measures taken. The country studies revealed that in most countries considerable policy efforts are aimed at focus and mass and valorisation. However, policy turbulence – i.e. policy discussion and new policy initiatives – does not necessarily lead to major changes at the level of institutions and research groups. Boosting excellence in research and/or valorisation is a long-winded process which is not helped by frequent changes, which may even affect policy coherence negatively.
2. Policy rationales for aiming at focus and mass and valorisation may overlap in practice. As a result the two phenomena are sometimes hard to differentiate and causality between focus and mass on the one hand and valorisation on the other hand is fuzzy and hard to pinpoint. In the last few years we witness a development where focus is used as an instrument to guide research into areas that are relevant for the national industry, and in that way increase opportunities for (national) valorisation.
3. The various country studies revealed that working on focus and mass in practice means introducing of new instruments, new institutions and funding channels more than redirecting the course of the steamship of research itself as this is a slow process which cannot be accomplished overnight.
4. Formulation of overall economy wide STI strategies are most productive if linked to the formulation of tactical and especially operational strategies at the lower levels. Especially the tactical level is important as this seem to be the level where country

specific research portfolios on selected technologies and themes can be formulated and made operational. The notion of focus and mass applies to all levels involved (international/EU; national; regional; local/institutional; research unit). A careful balance between vertical (focus and mass across the levels) and horizontal (i.e. focus and mass at each level) coordination is needed. Too much (or too less) concentration at one level could lead to fragmentation at other levels. In terms of vertical coordination between the highest levels (i.e. EU and national STI policy) some countries seem to use these levers (compared to the Netherlands) more intensively to influence the national STI infrastructure and/or agenda or pro-actively influence the EU-agenda than other countries.

5. Valorisation is increasingly part and parcel of standing policy. There are numerous policy instrument to arrive at and/or improve valorisation, ranging from stimulation collaboration between universities and private firms, stimulation entrepreneurship, creating spin-offs, merging GRI with universities, revising the mission of universities, changing funding criteria (i.e. changing in regulation and instrumentation) and so on. Especially the instrument of improving valorisation via – light tough – regulation is often underestimated. On the contrary, the importance (and frequency) of formal partnerships between universities and firms (usually involving PPP-constructions) in valorisation policy seems to be overestimated. However, similar to adjusting funding streams, the striving for valorisation is often embodied in new (types of) institutions

6. Apart from the well-known economic motivation for spurring valorisation, attention for societal valorisation is on the rise. There appears to be a trend across the board to put more emphasis on broader societal goals in STI policy (e.g., aging, social cohesion, sustainability etc.). leading to an upsurge of social sciences in applied research and a call for more multidisciplinary research.

7. As to the use of PPP we observed that all sorts of PPP constructions can be found, varying from situations where there is no formal private public cooperation to situations were the research agenda is defined by industry and government together, and research expenses are shared, and various sorts of constructions in between. PPP for focus and mass often has the form of competence centres. However, PPPs are just one of the many ways of deriving at focus and mass and valorisation. One might consider the use of a PPP in cases of uncertainty and risk and the need for considerable budgets. Further, industry needs to show enough strategic ability, need and preparedness to use PPP. This makes PPP's in practice less suited to sectors that are dominated by SMEs.

8. Among the benchmark countries we found substantial variation in the use of formal PPPs for valorisation and focus and mass. There might be a relation between a culture of consensus seeking and the use of PPP. The use of PPPs is not necessarily associated with a strong STI and economic performance as some of the countries that have a very strong performance in innovation score boards do not use PPPs as a policy instrument at all (Finland, Switzerland), or only for creating focus and mass (Sweden).

Table 10.4 Examples of instruments used for focus and mass and valorisation that may inspire the Dutch policy discussion

- Austria: Kplus/Kind/net as examples of how a fairly broad array of valorisation instruments contributes to focus as well
- Denmark: Multi million industries initiative (although isolated)
- Finland: international centres of excellence & national centres of excellence
- Finland: pro-active strategy towards the EU research agenda
- Flanders: valorisation as explicit criterion when selecting applications for supporting R&D projects by IWT
- Flanders: comprehensiveness of valorisation measures (5 groups) and the attention for 'societal valorisation'
- Ireland: new research funding (mostly PRTLI and SFI) that typically contributes to focus in existing well performing research areas within ICT and biotech
- Sweden: Berzilii centres that contribute to focus and valorisation
- Sweden: branche dialogues as an example of non-pecuniary PPP
- Switzerland: strong focus on scientific excellence having priority over anything else
- Switzerland: clear split public and private sectors

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