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Science, Technology and Innovation Policies in Selected Small Countries

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Abstract: KNOGG, an EU-financed thematic network, studies the role of ST&I policies in driving economic growth in six small European countries. It aims to develop guidelines at the EU level for improving knowledge-based growth in small European economies. This second report of the project interprets the current ST&I policy regimes in the six KNOGG countries, using the EU Innovation Trend Chart database and country reports as a point of departure. It extends the EU data to include national research systems, as well as institutions critical to the formulation and implementation of policy. It quantifies and benchmarks the resources devoted to innovation policies and highlights the differences between small countries pursuing a self-sustaining innovation-oriented growth strategy and those following the technology-diffusion or catch-up path to economic growth.

Key words: NIS, institutions, research system, framework conditions, industry innovation, benchmarking

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Tiivistelmä: EU-rahoitteinen KNOGG-projekti tutkii tiede-, teknologia- ja innovaatiopolitiikan (ST&I-politiikan) vaikutusta kuuden pienen eurooppalaisen kansantalouden taloudelliseen kasvuun. KNOGG:n tavoitteena on tuottaa EU-tasolla toimintasuosituksia, miten luoda edellytykset tietoon ja osaamiseen perustuvaan taloudelliseen kasvuun pienissä maissa. Tässä KNOGG-työn toisessa tutkimusraportissa esitellään kuuden KNOGG-maan soveltamia tiede- ja teknologiapolitiikkoja käyttäen hyväksi EU:n keräämää numeroaineistoa (EU Innovation Trend Chart) ja kustakin maasta kerättyä taustatietoa. Raportissa esitellään kansalliset tutkimusjärjestelmät ja instituutiot sekä tarkastellaan ST&I-politiikan tavoitteita ja toteutusta eri maissa. Raportti kuvailee ja arvioi eroja, joita syntyy siitä, että jotkut maat tavoittelevat taloudellista kasvua innovaatioihin perustuvalla politiikalla ja joidenkin maiden strategia painottuu teknologiadiffuusion hyväksikäyttöön.

Asiasanat: Kansallinen innovaatiojärjestelmä, tutkimus, instituutiot, benchmark

Foreword

Rapid technological change in the 1990s and its contribution to economic growth has made many governments aware of the importance of the technological change and knowledge. The discussion about the role of science, technology and innovation policy has become more intensive within the European Union and also in the new member countries.

This report is the second deliverable of the EU–financed research project 'Knowledge, Growth and Globalisation - Science and Technology Policy as a Growth Factor in Smaller Economies' (KNOGG), which focuses on the experiences of small European countries. KNOGG participant countries are Finland, Greece, Hungary, Ireland, the Netherlands and Slovenia. The first report of the KNOGG project was published in the VATT-Reseach Reports series with the number 91.

This report surveys the current state-of-art regarding Science, Technology and Innovation Policy in each participating country, and provides necessary background information for policy guidelines for the European Union.

The six KNOGG countries vary greatly in their innovation governance. Some of them have more sophisticated structure for national innovation policies compared to the others.

Helsinki, March 2003

Reino Hjerppe

Acknowledgements

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Executive Summary

"Identify the current state-of-the-art regarding STI Policy in each participating country and provide necessary background information to prepare policy guidelines for workpackages 4 and 5"
(Technical Annex p.17)

The objective of this second workpackage of the KNOGG thematic network is to identify and analyse the innovation policies of the six participating countries and to trace the relationship between policy and performance in so far as this is reflected in the European Innovation Scoreboard[1] and other indicators of capacity to innovate. This exercise is facilitated by the ”First Action Plan for Innovation in Europe”[2], which provides a common analytical framework for innovation policy in Europe.

Building on the Action Plan, the Innovation Directorate of DG Enterprise pursues the collection and repeated updating of information on innovation policies at national level. All six KNOGG countries participate in this venture which is called the *Trend Chart on Innovation in Europe*[3]. As of now, the Trend Chart coverage and depth of analysis varies considerably between countries and the project has been tracking innovation policy developments only since January 2000. As a result, this workpackage was augmented by national innovation policy analysis supplied by the KNOGG partners. The Trend Chart has a further serious limitation if used as an exhaustive data-source for this project:, namely, it concentrates on the innovation policies currently being pursued by each country and has little to say about the presence or absence of governance institutions and an appropriate research knowledge-base to articulate and sustain, respectively, those policies.

Institutions and their history are important and are critical to understanding the distinctive innovation policy regimes of individual countries. That is why Section 1 of this study looks at institutional developments, their emergence and maturity and the extent to which they drive the innovation system. The six countries discussed here vary greatly in their paths towards economic enhancement and innovation governance. Some have placed the innovation imperative at the centre of government and have appointed ministers to sponsor innovation. Others are struggling to get political commitment after episodes of economic and political disruption and ideological change.

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[1] 2001 Innovation Scoreboard, Commission Staff Working Paper, SEC(2001) 1414, 14.09.2001.

[2] COM (96) 589 final: First Action Plan for Innovation in Europe, launched by the EC in 1996.

[3] www.cordis.lu/trendchart/.

Section 2 of this workpackage looks at the infrastructure for the creation and diffusion of knowledge in the partner countries, an area that is not well captured in the Trend Chart policy reviews. This infrastructure is conventionally referred to as the research system and is the heartbeat of every country's innovation system. It includes basic and applied research institutes and, critically, intermediaries and other institutions that provide a bridge between research output and commercialisation. Many accession countries are heirs to a strong tradition in science and basic research but struggle to compensate for a deficit in technological universities and industry-oriented research institutes. This in turn impedes the development of bridging institutions such as technology acquisition instruments and technology transfer services that provide a critical link between knowledge suppliers and knowledge users.

Institutions and technology support agencies that drive innovation policy, together with a well functioning research system, are the building blocks of a knowledge-based economy but some chemistry must be added to achieve the knowledge-based growth postulated in the KNOGG Framework model (see figure 7.1). This chemistry is provided by each country's 'national innovation system' which gives it the capacity to absorb and use new ideas and technologies from within and without its boundaries. Knowledge becomes the most important resource and learning the critical economic process. The exploitation of knowledge spillovers is developed through intense co-operation and interaction between the components of the national innovation system. Section 3 presents, in diagrammatic form, the national innovation system of each country, showing the institutions that formulate policy and the agencies that implement it. A brief description of the strengths and weaknesses of their national innovation system is added by each partner.

We turn next to the Trend Chart project, described earlier, which collects, updates and analyses information on innovation policies in the member states and in the applicant countries, under the following three-way classification: Fostering an Innovation Culture, Establishing a Framework Conducive to Innovation and Gearing Research to Innovation. The Trend Chart database was used to examine how the six KNOGG countries performed in relation to these dimensions of an innovation system.

Section 4 highlights country differences in measures to foster an innovation culture. Particular emphasis is placed on the role of education and professional training in upgrading the innovative capability of individuals. The mobility of researchers and engineers between universities and other elements of the research system and between both of these and the business sector, is used as an indicator of knowledge flows. Country differences are very obvious in these areas and also in the extent to which policies exist to improve awareness of the economic and social returns to ST&I among key decision-makers and the general public.

Establishing a framework conducive to innovation is the subject of Section 5. Issues examined here include country policies to remove barriers to competition, simplify administrative procedures and ease financial constraints on innovation. Improvements in the legal and regulatory environment also come under this heading as do efforts to protect intellectual property and reduce the costs and complexity associated with patenting.

Up to this point, workpackage 2 has been descriptive because there are no metrics to quantify and calibrate country performance in areas such as ST&I institutions, technology infrastructure and innovation culture. It is proposed to change the direction of the enquiry now towards industry-oriented innovation policies where performance indicators are more developed and quantification of resource allocation more feasible. Ultimately knowledge-based growth is a function of a country's capacity to generate new and improved products and processes. Sections 6 and 7, therefore, are an attempt to quantify the resources allocated by the KNOGG countries to industry-oriented innovation policies and to calibrate country performance in this domain, using the EU Innovation Scoreboard and other innovation output instruments

The third and final pillar of the Trend Chart policy classification system, Gearing Research to Innovation, in theory, covers similar ground. Its stated objective is to analyse policies ”to improve the way in which the fruits of research are transformed into products, processes and services and, hence, contribute to competitive advantage and social good”. But the focus, in practice, is on research-driven innovation whereas the current study places equal emphasis on diffusion policies to stimulate the flow of knowledge from knowledge creation to knowledge application. In recent years high performing economies have made strong progress in improving the knowledge distribution power of their national innovation systems. They have set up technology transfer institutes, and science and technology parks. They have promoted industry clusters and networking initiatives. Universities have embarked on measures to make their research accessible to industry. Companies have also contributed by improving their absorption capacity through initiatives such as skill enhancement and technology monitoring

For this reason the KNOGG countries were benchmarked on eight industry-oriented innovation policy objectives, representing best practice in promoting innovation across all stages of the innovation process from knowledge generation to knowledge application. These policies extend well beyond support for R&D in single firms and investment in new high-tech firms to a range of networking and knowledge diffusion measures. They also include policies to improve the absorptive capacity of firms such as the deployment of innovation intermediaries and schemes to improve the capability of firms to acquire and use technologies and innovations from external sources.

This quantification of resources that are allocated to industry innovation goes well beyond the range and depth of analysis associated with the EU Trend Chart. Each KNOGG country supplied data on the resources it allocated, in the most recent year, to each of eight firm-based policy interventions. The data for the six countries were standardised as share of country GDP and displayed in bar-chart form in Section 6 of this study. These charts give some broad insights into factors that differentiate the firm-level innovation policies of successful innovation regimes from those of less successful ones.

The risks of a too rigid interpretation of the financial data are discussed in the final section of the workpackage. All countries encountered difficulty, some more so than others, in disaggregating innovation budgets to the level of detail required. A minority of countries have sophisticated, integrated technology packages that provide support across a range of intervention points in the innovation process. More importantly, resource allocation is not a surrogate for impact or effectiveness. Many of the ”softer”, knowledge-intensive innovation supports are not resource-intensive and have to be qualitatively assessed.

A final word on a new concept that is gaining currency in the context of transforming national innovation systems, namely social capital or social capability. The underlying proposition is that social capital is a prerequisite for developing a sustainable innovation system. High innovation dynamics depend on trust-based relationships and intensive exchange of confidential information and tacit knowledge, in other words an accumulation of social capital. It is not proposed to speculate here on how social capability can be acquired except to say that, judging by their comparative economic success, small countries may have an inherent advantage because of a greater density and frequency of interaction between people and between institutions.

Contents

1 Institutions to Support STI

1.1 Introduction

A country requires an enabling institutional framework to exploit the true potential of its STI capability.

The EC Communication (2000), *Innovation in a Knowledge-Driven Economy*,[4] noted that all Member States had invested considerable effort in developing new structures for innovation policy. Three main activities could be discerned:

- new administration structures to support the ”system” nature of innovation
- building awareness of the needs of innovation, and promoting a more intense dialogue between Science, Industry and the General Public
- developing a strategic vision and innovation foresight

Some countries have initiated major re-definitions of ministerial competencies or even created ministries whose innovation-fostering objectives are clear from their title. A minority of countries have created ”innovation councils” or extended the role of their traditional ”science councils” to include innovation. Such high level co-ordination structures are crucial in overcoming ”territorial thinking” and counter-productive struggles among ministries.

The first European Report on Science and Technology Indicators (1994)[5], commenting on the institutional restructuring in Member States in the early 1990s, also noted that an enlightened STI policy implied widespread consultation with STI policy stakeholders including the public.

1.2 Elements of the Institutional Framework

When we speak of the institutional framework we refer to two levels, institutions involved in STI policy formulation and institutions operating at policy execution or implementation level. There is a co-ordination role attaching to both groups. There is also the need for policy coherence at the wider macroeconomic sphere whereby STI policy must be articulated with related policies such as industrial, trade, competition and education policies.

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[4] COM(2000)567 final: ”Innovation in a knowledge-driven economy”; adopted by the Commission on 20 September 2000.

[5] EC DGXIII (1994), The European Report on Science and Technology Indicators (ERSTI) 1994.

Well-designed STI institutions exert a vital galvanising force on the STI infrastructure (as well as directly on the STI performance of the private sector) through supports and regulatory controls, and especially through public funding. The performance of the STI institutions has profound implications for the economy and a progressive administration is marked by the structures put in place to ensure informed and transparent decisions.

The principal differentiating characteristics of the ”STI institutions block” are:

- Maturity of the STI policy regime – some countries enjoy a substantial headstart in the development of their national STI system, and possess formidable path dependent and cumulative learning advantages.

- Government commitment – how wholeheartedly has government bought into the view that STI is the predominant engine of economic growth in the modern world? Government commitment is reflected in the relative prestige of STI functions in a country’s ministerial portfolios, and is particularly affirmed by the existence of an explicit STI ministry (what we called ”an STI voice at cabinet”) or at least a very prominent STI division in the principal economic development ministry. Another indicator is the publication of an STI White Paper(s) charting government’s espousal of STI-driven growth. A telling test of government resolve is the share of the government budget allocated to the state STI budget.

- STI Policy Co-ordination – this task is typically carried out by inter-departmental committees or advisory councils set up to tackle common STI issues and look for efficiencies in STI investments. An important task for such a body is to agree the annual STI budget.

- Policy Implementation – are there executive agencies dedicated to implementation of STI policy and what is their intermediary role and position in the chain from policy to client level?

- Policy Evaluation – are countries adopting ”international best-practice” evaluation procedures to achieve innovation in policy?[6] Are these evaluation procedures ad-hoc or systematic?

- Access to Policy Makers – to what degree do governments invite and promote effective dialogue between the STI stakeholders (public S&T organisations, private enterprise, expert groups etc) concerning policy formation and delivery. The make-up of the advisory bodies is an indicator of the inclusivity of government thinking. Foresight exercises form an important starting point for such a dialogue.

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[6] An example is the EU Logical Framework Methodology.

- Foresight – Foresight constitutes a systematic attempt to observe the long-term future of science, technology, society, the economy and their mutual interactions in order to generate knowledge with which to effect social, economic and environmental improvements based on well founded projections. It is not enough to establish a clear and efficient methodology to conduct foresight. It is also vitally important to ensure that foresight outcomes are taken into consideration in policy debates and decision making. Only in this way can its maximum benefits be obtained.

Maturity

Finland is the KNOGG frontrunner in terms of the earliest elaboration of an S&T policy. It was already looking at ways of deploying science and technology resources as an arm of industrial policy in the late 1970s, a decade before other KNOGG countries had formally progressed beyond the educational aspect of these resources. The Ministry of Economic Affairs in the Netherlands continued to formulate industrial policy from a macroeconomic perspective until the mid 1980s. It was around this time also that the EU Cohesion Countries, including KNOGG members Ireland and Greece, were first in a position to articulate significant technology policies, greatly facilitated by the support of Structural Funds. The Candidate Countries (CCs) have still to succeed in releasing their technology policy from the shadow of their educational Ministries. In the early 1990s Finland consolidated its lead with its espousal of the holistic NIS approach. Other KNOGG members are only now beginning to get to grips with the institutional and policy implications of this new appreciation of the nexus between innovation and competitiveness.

Government Commitment

If technological innovation is to deliver on its potential for economic growth, Government vision and commitment is the key. This commitment can be discerned from the administrative configuration through which STI policy is expressed and executed. Clues lie in the strength of ”the STI voice in Cabinet”, in the reliance placed on technology and innovation by the main productive sector ministry[7] (some countries have an explicit ST I division within this ministry), and in this ministry’s influence over the research infrastructure.

Finland is a good example of a country with a strong STI voice in Cabinet, reflected in the relatively high public budget allocated for industry-oriented innovation measures.[8] This voice is articulated in its powerful Science and Technology Policy Council (STPC) chaired by the Prime Minister and attended by seven other cabinet ministers.

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[7] Typically the Ministry of Enterprise and Trade, or the Ministry of Economic Affairs.

[8] See Finnish Barchart in section 5.

There are strong links with STI policy at government level in the Netherlands. The prime minister chairs the RWTI (the Council for Science, Technology and Information Policy) which is the main S&T advisory board of the government. Other members of this Council include the chairmen of AWT and WRR, and the three chairman of the inter-departmental commissions on Science (IOW), Technology (IOT) and Information policy (ICI). In the course of its reorganisation in 2001, the setting up a ”Directorate of Innovations” by the Ministry of Economic affairs (MEZ) signalled an intensified commitment to growth through innovation. Recently the ICT portfolio has been added to the MEZ.

Ireland’s administrative configuration is somewhat ambivalent. It appointed a junior Minister for Science and Technology in 1987 but junior ministers do not sit in cabinet. More recently the Science and Technology portfolio has been added to the Trade and Industry portfolio of the deputy Prime Minister. An inter-departmental committee on S&T reports to a cabinet sub-committee on STI which is chaired by the Taoiseach. This committee was designed to overview STI policy and prioritise the annual Science Budget, but it has remained dormant since the establishment in 1997 of ICSTI, the Irish Council for Science, Technology and Innovation. ICSTI is a high-powered advisory body manned by leading academics and industrialists and includes the chief executive of Forfas. It meets regularly to scrutinise STI policy but it has no ministerial presence and lacks political weight.

In Greece the Ministry for Development has a General Secretariat for Industry (the GSI) and one for Research & Technology (the GSRT). Having both secretariats within the one department means STI goals must exert some influence on mainstream industrial policy but GSI is very much the dominant secretariat by dint of its large budget and the influence of the junior secretariat is limited.

STI policy in the two KNOGG Candidate Countries is still overly influenced by the science community. The Hungarian government advisory body (STC) is heavily influenced by the Ministry for Education and the Hungarian Academy of Sciences. In Slovenia the Technology portfolio is held by the powerful Ministry of Economy but this ministry is overburdened with disparate portfolios and STI is not given a high priority.

STI Policy Co-ordination

The broadening of the scope of innovation and the highly interactive nature of the NIS concept present a major co-ordination challenge. Where there is a leading ministry in charge of STI policy, e.g. Hungary’s Ministry of Education, it is generally expected to look after the overall co-ordination role. Where policy formulation is more evenly divided, an inter-departmental or other advisory council may perform the role as in the case of Finland, Slovenia and Ireland. The authority of this co-ordination role may be formal and mandatory or informal and advisory. While the Finnish STPC has only an advisory role the high-powered calibre of its members means that its recommendations are treated most seriously.

In the Netherlands there are separate inter-departmental commissions for scientific policy (IOW), technology policy (IOT) and for ICTs. It is left very much to individual high ranking civil servants to establish inter-departmental commissions on ad-hoc STI-policy matters. In Hungary and Greece there is little inter-departmental co-ordination, with each department focusing on its own sectoral agenda.

Co-ordination may also be required at the implementation level, and options include informal open exchange of information, cross membership on boards of parallel agencies, or the use of umbrella co-ordinating bodies.

STI Policy Implementing Agencies

In Finland implementation of technology policy is implemented by eight agencies working in close co-operation with the Ministry of Trade and Industry. TEKES, the National Technology Agency,[9] was set up in 1983 and has an annual funding of the order of € 400m, two thirds designated for industrial R&D and the remainder for research in universities and public research institutes. One of the chief goals of TEKES is to facilitate co-operation between companies, universities, research institutes and other public organisations. Fifteen regional Employment and Economic Development Centres (TE Centres) operate at the regional level and provide support and advice to SMEs. Tekes technological expertise and services are available to entrepreneurs via these Centres.

Ireland has two enterprise development agencies, Enterprise Ireland (EI) for indigenous enterprise and the IDA for foreign-owned enterprise. Both of these promote STI as part of their developmental remit. In the late 1990s they opted to concentrate on ”integrated business solutions” which moved them further towards an intermediary role and away from direct provision of technology services.

In the Netherlands, the MEZ and OCW Ministries delegate executive STI tasks to specialist agencies such as SENTER which executes stimulation measures in the areas of technology, environment, energy, exports and international co-

[9] Besides Tekes other implementing agencies are the Geological Survey of Finland GSF; the Technical Research Centre of Finland VTT; the Safety Technology Authority TUKES; the National Consumer Research Centre; the Centre for Metrology and Accreditation MIKES; the Foundation of Finnish Innovations; the Finnish Standards Association SFS.

operation, and SYNTENS which specialises in business and technology supports for SMEs.

The characteristic of the Greek policy system is that ministries are not only policy makers but also policy implementation agencies. Policy is implemented by the General Secretariats of the respective ministries. Hungarian policy implementation is, like Greece, characterised by a centralised administration by department personnel.

In Slovenia a ”Law on Organisation and Funding of Research and Development” was submitted to parliament in January 2000, and proposed, among other measures, the establishment of two agencies – an Agency for Scientific Research and an Agency for Technological Development. The bill was vehemently opposed by the Universities and the Academy of Sciences (other sections of the research community, particularly in the research institutes and business sector, supported the bill) and was returned for re-drafting. The new Law inaugurating both agencies was adopted in November 2002.

STI Policy Evaluation

The Science and Technology Policy Council of Finland publishes a science and technology policy review every third year, analysing past developments, drawing conclusions and making proposals for the future.[10] The STPC also provides guidelines and monitors evaluation activities in various elements of the NIS. Finnish ministries organise evaluations of agencies under their jurisdiction and the agencies in turn commission evaluations of their own programmes e.g. Tekes evaluates the effectiveness of technical R&D support while the Academy of Finland is responsible for evaluating basic research.

In the Netherlands a policy evaluation philosophy is embedded in all S&T policy measures that involve co-ordination among participating ministries (Economic Affairs, Education, Culture and Science, Finance and Agriculture and Fishery).

In the case of the Cohesion Countries, Ireland and Greece, EU CSF programmes include an evaluation discipline and both countries acknowledge the benefits of this imposed ”institutional learning”. Likewise participation in the EU RTD Framework Programme has introduced Hungary to the rigours of evaluation.

In the case of Slovenia the mid-term research programmes (basic and applied) are regularly evaluated by peer reviews, mostly conducted by domestic experts. It is intended that similar evaluations will be conducted for the targeted research programmes.

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[10] Its next Policy Review will be published in 2003, under the title ”Knowledge, Innovations and Internationalisation”.

Access to STI Policy Makers - Democratic Policy Making

Finland deploys a corporatist system of policymaking, canvassing the views of the broad community of STI stakeholders including employer and employee organisations. This prevents ‘top down’ directives and ensures smooth implementation and co-ordination of policies.

The Dutch Ministry of Education, Culture and Science employs an Advisory Council for Science and Technology (AWT) comprised of representatives from the HE sector and Industry. The establishment of an Irish Council for Science Technology and Innovation (ICSTI) in 1997 was a decisive initiative in bringing the informed views of HE and especially Enterprise to bear on Irish STI policy making.

The Greek National Council for Research and Technology (NCRT) was modernized in its composition and structure in 2001 and now includes representatives from the Federation of Greek Industries. Neither the Hungarian Science and Technology Policy Collegium (STC) nor its secretariat body, the Scientific Advisory Board (SAB), contain representatives from Industry.

In Slovenia a Science and Technology Council serves as an advisory body to the government in matters of STI policy. Its chairperson and members are appointed by government. This Council currently suffers from an academic bias. In the new law, parity is guaranteed in the membership of academic and business people. A Technology Development Council advises the Minister of Economy on the design and implementation of technology policy. This body already has a high level of enterprise representation and its president comes from the private enterprise sector.

Foresight Exercises

As a result of the initiative from Finland’s Science and Technology Policy Council, the Ministry of Trade and Industry formed a Research and Foresight Studies unit in 2000. The emphasis is on seeking optimal strategies to exploit the most promising development paths.

At the request of the Minister of OCW, the Dutch Advisory Council for Science and Technology (AWT) carried out or commissioned a number of foresight studies in the field of science and technology. An extensive strategic foresight study was started in 1992, focusing on the role of information science in the Netherlands for the decade ahead. In 1998 a strategic foresight study called Infodrome was carried out to advise the Dutch government on the future ICT society. A final report was presented in December 2001.

In Ireland ICSTI instituted a Foresight consultative process in 1998 and this culminated in the allocation by Cabinet of very substantial funds towards building a national strategic research capability in the key technologies of Biotechnology and ICT.

Greece began its technology foresight odyssey in the early 1990s with an exercise extending to the year 2021. It was too top-down and failed to make an impact. A more consultative approach was adopted in 2001 resulting in the establishment of a new organisation to pursue technology foresight in a more systematic way. First results are imminent.

Hungary's NCTD instituted a comprehensive Technology Foresight Program (TFP) in 1998, using a bureau (4 to 5 people) and a Council of Permanent Experts. An important aim of TFP was to facilitate dialogue between business representatives and policy decision-makers.

The Slovenian government organised a round table discussion on Foresight issues in 2001 and drew up a plan of action. Expert institutions will be invited to present project proposals under selected co-financing schedules.

2 STI Infrastructure: National Research Systems

2.1 Introduction

The STI infrastructure comprises both knowledge generation and knowledge distribution components, together with the underlying administrative system of databases, publications, libraries, science centres and museums, statistics, standards, intellectual property, etc. These are the repositories of the economy's store of scientific and technological knowledge and they also have a function in ensuring its effective diffusion and use. Because of the growing dependence of industrial innovation on science, a universal policy objective is to orient the infrastructure more towards industrial research and to establish bridging institutions that reach out to industry.

In this section we examine the availability of public research performing institutes and associated research funding institutions in the KNOGG countries. Within the research institutes we draw a distinction between basic/strategic and applied/industrial research, and we also note the existence of bridging institutes and intermediaries to diffuse the results of research to industry.

2.2 Profiles of Country STI Infrastructures

Finland

In Finland the Academy of Finland acts as the research council for basic research, and the majority of its funding is channelled to research conducted in universities. While some of the top universities of technology carry out very high quality theoretical research these universities also have very close links with industry and are among the foremost bridging institutions. Research in Finland’s 29 polytechnics is of a more applied nature relevant to the world of work.

The premier Finnish applied research organisation is VTT, the Technical Research Centre of Finland. VTT is a non-profit organisation founded in 1942 and employs over 3000 personnel. It engages in two types of activity, commercial contract research for private and public clients, and self-financed research undertaken to maintain its competitiveness and to anticipate the future needs of its clients. In its commercial activity it services some 5000 clients per annum and generates a turnover of approximately 200 million euros. In the latter activity it receives support from the Ministry of Trade & Industry.

VTT conducts its activities in close interaction with both industry and other research institutes and universities, thus performing a vital bridging role between basic and industrial research in various technological fields. It also works closely with government authorities responsible for co-ordinating and funding technology policy.

Other applied research institutes include the Agricultural Research Institute, the Environment Research Institute and the Finnish Geodetic Institute. Their work is predominantly for public sector missions.

SITRA is an interesting and significant Finnish bridging institution. It was set up, in conjunction with the Bank of Finland, in 1967. It now operates under the supervision of the Finnish Parliament as an independent public foundation for R&D. It has secure financial standing and expertise in venture capital deployment and this enables it to initiate operations designed to break new ground and to anticipate future challenges. SITRA co-operates closely with ministries, universities, research institutes, centres of technology, and especially with Tekes. It is a catalyst in technology transfer, owning several TT companies with close ties to university personnel. It also plays an important role in providing fora where politicians and policy-makers can discuss future STI trends and strategies.

The SME Foundation is another example of a Finnish bridging institution. This private foundation, supported by government funds, develops and promotes business management skills, principally in small and medium sized enterprises (SMEs). Founded in 1971, its active supporters include the Ministry of Trade and Industry (KTM), the Regional Development Fund of Finland Ltd (Finnvera Oyj), the Confederation of Finnish Industries and Employers (TT), the Federation of Finnish Enterprises (SY) and the Finnish Institute of Management (LIFIM).

Netherlands

In the Netherlands basic research is performed predominantly by the nine universities. Principal funding comes from the Department of Education (OCW) either directly or via the Dutch Research Council for Scientific Research (NWO) which has a budget of €382m, the bulk of which is allocated according to a competitive system of peer review. The trend shows more industry financing of university research which in turn leads to more industry-oriented research.

The Netherlands has several large public institutions that perform basic research including the GTIs – five large technology institutions involved in Energy, Maritime, Aerospace, Water and Environmental studies respectively. The DLO-institutes, former research organisation for the agricultural sector, were merged with the Wageningen University Research Centre in 2000. Fundamental research is also performed by the large Dutch MNEs such as Phillips and Shell.

Applied research in the Netherlands is, for the most part, the preserve of private enterprise, although some public research institutions such as ECN may work in collaboration with private enterprise.

Sectoral strategic research is performed by the four Technological Top Institutes (Dutch Polymeer Institute, Netherlands Institute for Metals Research, Telematica Institute and Wageningen Centre for Food Sciences). These TTIs are centres of excellence which aim to bridge the 'gap' between fundamental and applied scientific research.

TNO provides the principal link in the innovation chain between fundamental research and its practical application This organisation is the leading contract research organisation in the Netherlands. Its services are aimed at clients in both the corporate and public sectors. The organisation employs 5,400 professionals and its consolidated turnover in 2001 amounted to EUR 514 million, of which EUR 100 million was foreign turnover. TNO favours a multidisciplinary approach with researchers specialising in a wide variety of scientific disciplines.

One of TNO's main objectives is to intensify relationships with the business world, a policy that is being pursued along different routes. Success has already been achieved in undertaking large, collaborative, strategic R&D projects with R&D-intensive companies, and there are special projects geared towards the SME sector. Commercial and market-geared activities are undertaken through TNO Management B.V., a subsidiary whose consolidated turnover amounted to nearly EUR 55 million in 2001.

In addition to its public research activities in Defence and Public Safety, Quality of Life, and the Natural and Built Environment, TNO focuses on two core business areas:

- Advanced Products, Processes and Systems
- ICT and Services

Ireland

The Irish research system is characteristic of a late-developing industrial economy with over 90% of fundamental research performed within the university sector. Virtually no basic research is performed in indigenous industry or in foreign-owned industry. There is also a dearth of basic research institutions in the public sector.

The Irish national development plan 2000-2006 contains an unprecedented government commitment to public research at national level. Prompted by the 1998 Foresight initiative, it has targeted more than €1.5bn for basic research in areas of strategic importance. This research is being carried out in the Higher Education sector and in public research institutes.

Ireland also suffers from a dearth of applied research organisations (except in the agriculture sector). With the CSF funding for 1989-1993 efforts were made to attach centres of applied research to a number of third-level colleges. Eight so-called Programmes in Advanced Technology (PATs), covering areas such as advanced manufacturing technologies, new materials, biotechnology and opto-electronics were established. The great hope was that they would in time develop into active bridging institutes, but spanning the gap with industry proved problematic and several of these centres had to be subsumed back into the Colleges.

Greece

In Greece 19 HEIs (universities, technological educational institutes and university research institutes) are complemented by 12 technical-educational institutions (the equivalent of the former UK polytechnical colleges) which received university status in 2001 to comply with the Bologna declaration. HEIs perform the vast majority of basic research.

The bulk of applied research is performed in-house by private enterprise. Private research is supported by sectoral research associations in food and drink, textiles, ceramics and aquaculture. These are augmented in some areas by government research centres and private-non-profit institutes. An industrial Systems Institute has been set up to enhance the uptake of integrated production systems

Hungary

Hungary has a long tradition in basic research. The Hungarian Academy of Sciences (HAS) was established 1825 and was reconstituted in 1994. HAS includes 37 research institutes and research centres, and also supports research teams in Universities. Following the political changes in 1989 university research budgets were severely reduced resulting in a 25% haemorrhage in research personnel in the following half decade. Only in the last few years has this decline been reversed due to a strong increase in support from the central budget.

Public support for research is administered by four departments of the Deputy Secretariat of State for R&D in the Ministry of Education. The names of the four departments are: international, special technology, organisation and co-ordination, and strategic research.

The government launched its National R&D Programmes (NRDPs) ”framework” in 2000, based on the STC/SAB document ”Science and Technology Policy

2000". A Programme Governing Body (PGB) has been set up to oversee the NRDPs.

Hungary actively supports participation in international research fora including EU Framework Programmes IV and V, EUREKA, CERN and COST.

Applied research in the public sector was traditionally undertaken by institutes attached to branch ministries, but the majority of these were closed down during the transition. The Ministry of Agriculture still retains 11 research institutes, and there are research institutes in the ministries of Health, Environment, and the Economy.

The Zoltan Bay Foundation is a non-profit organisation which operates its own network of applied research institutes. The objective of this foundation is technology demonstration and diffusion. It was established by the first Hungarian government after the 1989 changes, based on the German Fraunhofer model to promote the economic exploitation of the internationally respected R&D results achieved by Hungarian scientists and engineers. Since 1993 three Bay institutes have been inaugurated close to major universities: these institutes specialise in biotechnology (Szeged), logistics and production technologies (Miskolc), and materials sciences (Budapest).

Hungary boasts several other bridging institutions including the Hungarian Business Promotion Foundation, the INNOTECH Technical University Innovation Park, the Debrecen Science & Technology Park, the National Business and Innovation Centre (funded by EU PHARE and now a member of the EDN network), the Puskas Tivadar Foundation and its associated National Technology Institute, and the Hunfarian Centre for Technology Transfer. The challenge for policy makers is to achieve greater co-ordination and efficiencies in the deployment of these institutions.

Slovenia

In Slovenia fundamental research is predominantly carried out in the two major universities – Ljubljana and Maribor – and in the Academy of Sciences and Arts.

Industry-oriented research is mainly left to private enterprise. During the transition there was severe downsizing of R&D units in these private companies resulting in a 'brain drain' of more than 3,000 researchers. A number of these researchers have formed their own companies and are in a position to offer research services to industry.

Sources of research funding in Slovenia include the Ministry for Education, Science and Sport (the responsible body being the National Council for Research and Development with its six research committees organised on broad disciplinary lines). The Slovenian Science Foundation provides limited grants for scholarships abroad.

Slovenia has made some progress in setting up intermediary organisations to bridge the Science-Industry divide. There are three technology parks centred around HEIs in Ljubljana, Maribor and Nova Gorica. These parks provide premises and facilities as well as support services to some 50 technology-based companies.

Various professional associations such as the association of engineers play catalytic roles in establishing links between research and industry. An Innovation Relay Centre (IRC), set up under the Fifth RTD Framework Programme, has been transformed to concentrate on technology transfer and innovation in enterprises.

3 National Innovation Systems

The National Innovation System (NIS) approach is based on a holistic perspective of an economy. It strives for balanced development of all the STI elements including the knowledge producers and users, and enabling actors such as knowledge-intensive business services, the ICT infrastructure and capital markets. The strength of an NIS rests on the density of interactions and feedback between the actors and on the emphasis placed on learning through co-operation and networking.[11] The concept of innovation itself is extended beyond technology to include organisational and policy innovation.

Having reviewed the KNOGG member country STI policy and infrastructure blocks in some detail in the foregoing sections, the STI institutional framework in each country is now summarised. A chart is presented of the principal institutions in the National Innovation System of each country and an accompanying note describes the principal actors and linkages in that system.

3.1 Note on the Finnish National Innovation System

Technology forms an essential part of Finnish economic policy particularly in active long-term development. ST&I policy has been progressing from discrete scrutiny to a more comprehensive approach, in which the producers and users of knowledge and the various interactive relations between them are regarded as an entity, known as the national innovation system. Technological know-how is the Finnish trump card also in international comparisons of real competitiveness. The International Institute of Management Development (IMD)[12] placed Finland third in the 1999 comparison in overall competitiveness, due to good technology and research co-operation, technology development and application, utilisation of new information technology and good administration. The World Economic Forum (WEF)[13] states that the level of technology know-how in Finland is the highest of the 53 countries compared.

The major components of the innovation system are education, research, product development and knowledge-intensive business. New knowledge is produced by universities and polytechnics, by research institutes and business enterprises. The

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[11] Since knowledge which enables the use of information is embedded in the fabric of institutions (von Tunzelmann (1995)), the effectiveness of the whole innovation process, from basic research to learning by imitation through to delivering the new product to the market, is bound to be affected by the quality of the organisational structures and networks in the economy. These will determine an economy's ability to learn and interact with others, its capacity to absorb and use new ideas and technologies from within and without the economy, and to use to the full the different sources of knowledge embedded within networks and organisations.

[12] IMD World Competitiveness Yearbook 1999.

[13] WEF Global Competitiveness Report 2001.

foremost users of knowledge are enterprises, private citizens, and policy-makers and administrations responsible for societal development. In addition, the system is characterised by wide-ranging international co-operation.

The primary task of science and technology policy is to ensure a balanced development of the innovation system and the promotion of co-operation within it. Another increasingly important element is co-operation with other societal sectors, such as economic, industrial, labour, environmental policies and social and health care services. Networking is a key element in the development of activities and organisations. The prerequisites for knowledge-based development are created within different policy sectors.

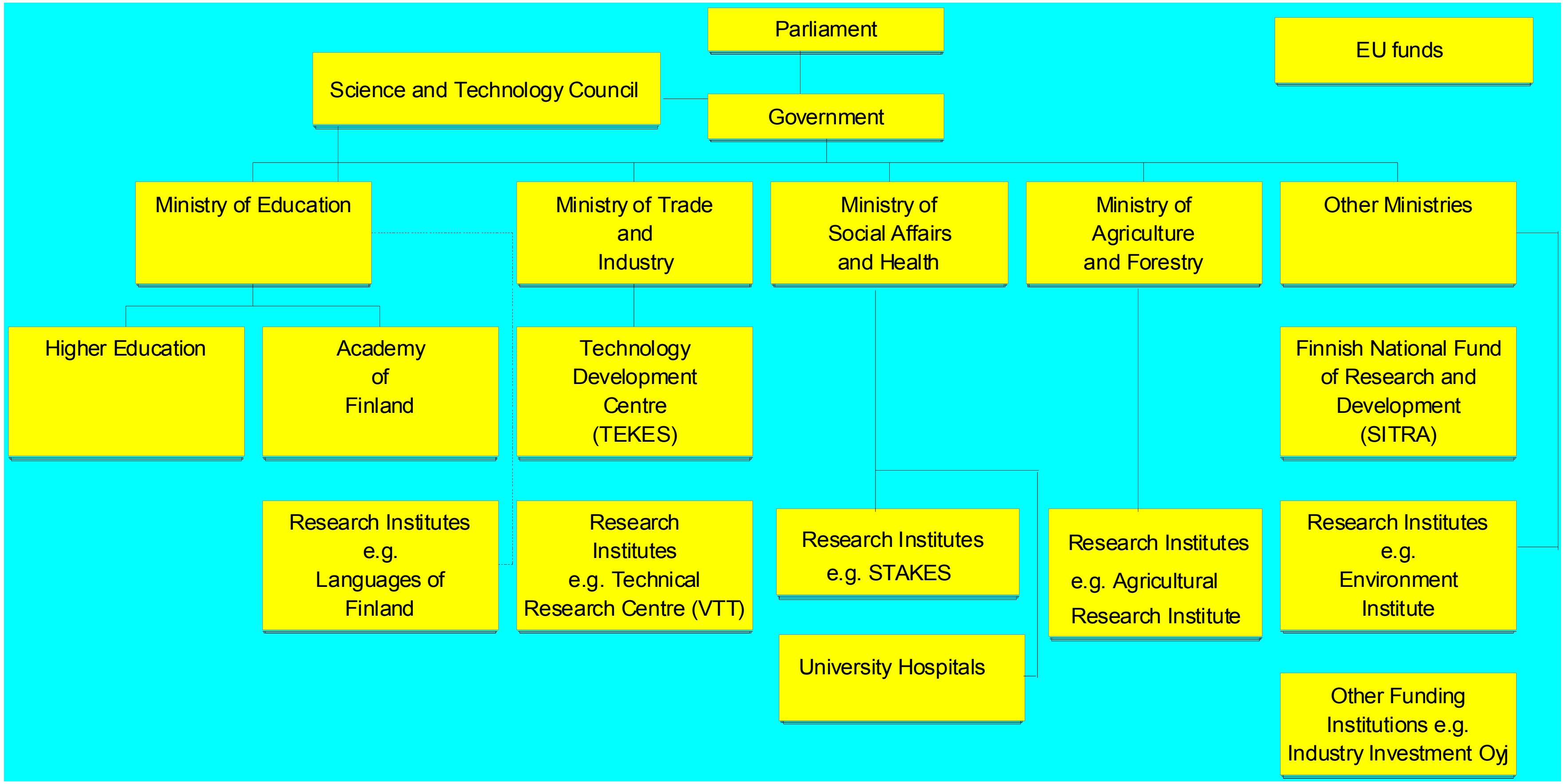
National science, technology and innovation policies in Finland are formulated by the Science and Technology Policy Council, which is chaired by the Prime Minister.

The foremost science and technology policy organisations are the Ministry of Education and the Ministry of Trade and Industry. The Ministry of Education is responsible for matters relating to education and training, science policy, higher education and the Academy of Finland. The Ministry of Trade and Industry is responsible for matters relating to industry and technology policy, the National Technology Agency Tekes and the Technical Research Centre of Finland (VTT). Nearly 80% of government research funding is channelled through these two ministries. They supervise the implementation of national STI policies in the various research centres and in education.

The network of Finnish universities and polytechnics, technology centres, science and technology parks, centres of expertise and other similar operations has promoted innovation in various regions in Finland to such an extent that it is possible to speak also of regional innovation systems.[14]

[14] Science and Technology Policy Council of Finland.

Figure 3.1 Principal Institutions of the Finnish National Innovation System



Evaluation practices meet to a large extent the ”best-practice” principles defined by the OECD. The STPC provides guidelines and monitors evaluations activities in various parts of the NIS. Ministries organise evaluations of the agencies under their jurisdiction and the agencies in turn evaluate their own programmes and research fields.The Academy of Finland is responsible for evaluating basic research, while Tekes evaluates the effectiveness of technical R&D support. Reviews ordered by the Academy of Finland revealed a that the negative findings do not always lead to action. Tekes hosts a specific evaluation unit but it also commissions external evaluations. The evaluations of government research institutes have in some cases led to radical change in administrative structures or in research agendas. At the KNOGG National Workshop, however, several participants voiced or implied concerns relating to the functioning of the learning and feedback mechanism, as well as rigidities encountered when the reallocation of budgetary resources was concerned.

The STPC ensures that other policies are co-ordinated with ST&I policy. For example, industrial policy and S&T policy are designed together, and the development of the NIS also provides the guiding principles for education policy. Environmental policy strongly encourages the development of new technology. Regional, labour market, economic, fiscal, energy, health and welfare policies all interact closely with ST&I policy. The most important instruments in this regard are the cluster programmes, the Centre of Expertise Programme, the education programme of the IT workers, and the new arrangements for the venture capital business.

3.2 Note on the Netherlands National Innovation System

The National system of innovation in the Netherlands consists of many organisations and institutions. There are several ways to describe a system of innovation. Systems of innovations can be outlined with reference to policy making, funding, major institutes, fields of interest etc. The Netherlands Chart in figure 2.2 presents a broad outline of the Dutch system along the lines of formal structure (institutions), funding and major fields of operation. At the top comes the decision making organisations, parliament and government. The parliament and government are advised primarily by AWT (the Advisory Counsel for Science and Technology Policy), by WRR (the Netherlands Scientific Council for Government Policy) and by RWTI (the Counsel for Science, Technology and Information Policy). The chairman of the RWTI is the prime minister; other members are the chairmen of AWT and WRR, and the three chairman of the inter-departmental commissions on science (IOW), technology (IOT) and Information policy (ICI).

The ministries of Education, Culture and Science (OCenW) and Economic Affairs(EZ) are the co-ordinating ministries for S&T policy-making. To a large extent, the tasks and responsibilities of the Ministry of Education, Culture and Science are confined to the field of science while the Ministry of Economic Affairs concentrates on technology and stimulating innovation in the private sector.

Below the level of ministries come the institutions responsible for policy research and advice. The main bodies at this level are

- SCP (the Social and Cultural Planning Office) which offers advice to all ministries and is not affiliated to any particular ministry
- CPB (the Netherlands Bureau for Economic Policy Analysis) funded by EZ
- RIVM (the National Institute of Public Health and the Environment) funded by several other ministries

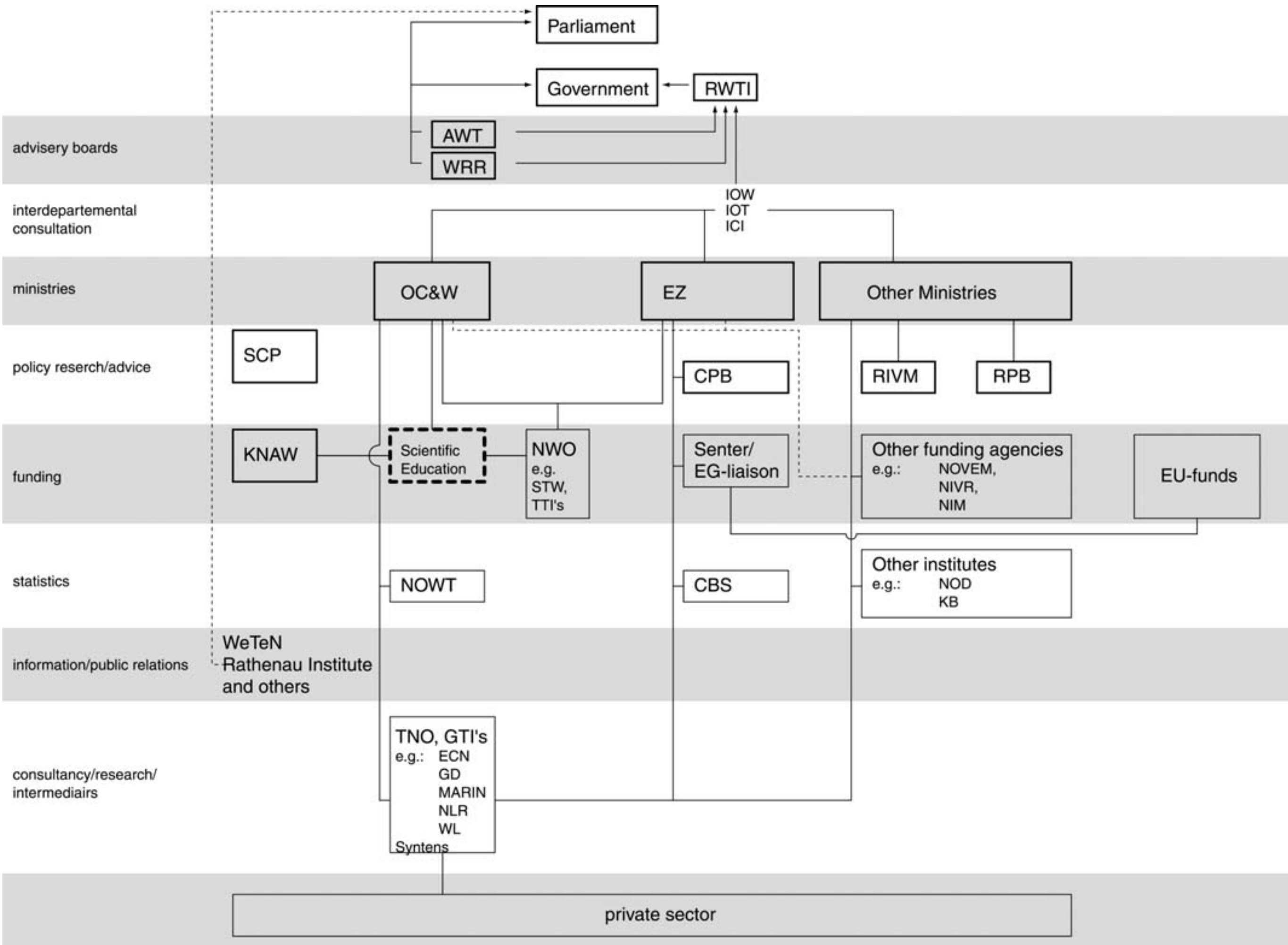
The main bodies at the funding level are

- KNAW (Royal Netherlands Academy of Arts and Science)[15]
- NWO (Netherlands Organization for Scientific Research)[16]
- Senter (executing policy measures aimed at stimulating innovation in the private sector and co-ordinating and facilitating research funded by the EU).

[15] The KNAW not only funds research and research institutions but is also involved in maintaining and monitoring the quality of scientific research (peer-reviews) and advising on S&T-policy.

[16] NWO promotes scientific research at Dutch universities and research institutes and seeks to raise the quality of this research. NWO also promotes the dissemination and use of research results achieved wholly or partly with NWO support. STW (Foundation Science of Technology) is a sub-organisation of NWO and its primary task is to stimulate and facilitate applied scientific research in co-operation with the private sector.

Figure 3.2 Principal Institutions of the Netherlands National Innovation System



Institutions involved in the management of information and statistics play an important role in the measurement and evaluation of the effects of S&T policy measures and their impact on innovation and economic growth. NOWT (Netherlands Observatory of Science and Technology) monitors the combined effects of the S&T policy measures of all institutions involved in S&T. CBS (Statistic Netherlands) is involved in gathering and reporting statistics. CBS collects information about all aspects of innovation and co-operates with EuroStat on Community Innovation Surveys.

The ”WeTeN”[17] foundation and the Rathenau Institute are the main bodies on the level of public relations on technology. The latter institute acts in an advisory capacity for the parliament and for government.

A very important aspect of the Dutch system of innovation is co-operation and dissemination of knowledge among the public and private sectors. TNO and the GTI's are semi-public institutions that conduct 'free' and contract research on various fields of technology.

3.3 Note on the Irish National Innovation System

Ireland's system of innovation reflects the country's late industrialisation and a reliance on importing innovation through FDI for nearly half a century. Some of the elements of a national innovation system, invariably found in developed economies, are missing and the system generally does not have a high intensity of interaction between elements. The existing elements can be grouped under four headings: the higher education/research system, innovative firms and R&D performers, risk-funding finance and government funding and regulation. Virtually all basic and strategic research takes place in the higher education sector. There are no stand-alone institutes for basic or mission-oriented industry research (except for food /agriculture and health). Business sector research is expanding from a low base but is inhibited by the limited amount of R&D undertaken by foreign-owned branch plants in the host country. Venture capital markets have gained a foothold in recent years and have stimulated start-up activity particularly in the software sector.

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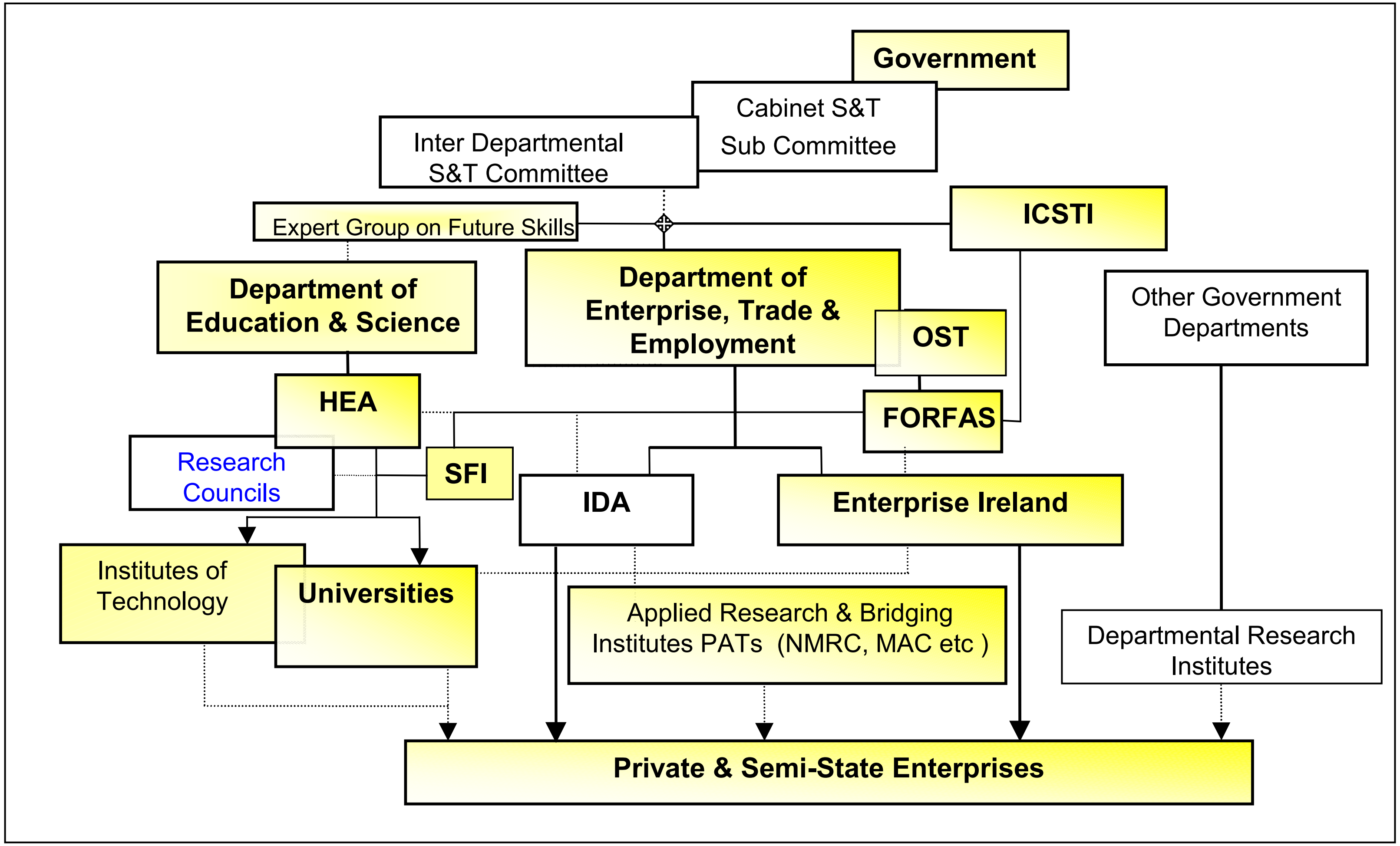
[17] Dutch acronym for the word ”to know”.

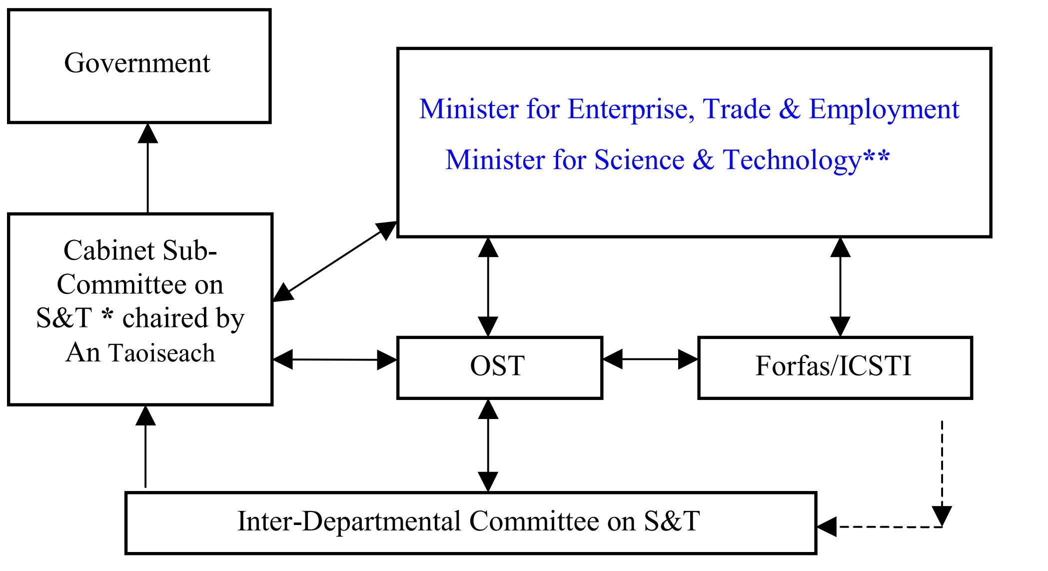
Figure 3.3 Principal Institutions of the Irish National Innovation System



Efforts during the 1990s to promote dynamic linkages within the Irish innovation system have achieved limited success. Intermediary institutions and technology brokers, designed to bridge the gap between the external research system and industry, have not prospered in the absence of applied and industry-oriented research institutes. Networking, industry clusters, sub-supply and sub-contract linkages – barometers of the health of an innovation system – are underdeveloped. Government agencies have achieved short-term results by promoting knowledge creation and venture capital markets but the same energy and resources have not been committed to technology transfer and technology diffusion initiatives. Figures for 2000 indicate that 77% of the industry support budget was allocated to knowledge creation.

It is important to point out that the Irish ST&I policy institutions are of very recent vintage. A government minister with responsibility for Science and Technology was first appointed in 1987 but the country had to wait until 1996 before an integrated policy formulation and regulatory system was put in place.

Figure 3.4 The Irish STI Policy Development and Advisory System



* Ministers of Agriculture, Food & Rural Development; Education & Science; Enterprise, Trade & Employment; Environment & Local Government; Health & Children; Marine & Natural Resources; Public Enterprise

** The Minister for Science & Technology is appointed to both the Department of Enterprise,Trade & Employment and the Department of Education & Science

Figure 3.4 purports to show the institutions involved in formulating and implementing policy. The cabinet sub-committee under the Prime Minister nominally guides ST&I policy but this cabinet sub-committe is not very active and policy direction resides for the most part with the Irish Council for Science Technology (ICSTI) operating through Forfas. This body, which is representative of government, industry and academe, has been very active since its establishment in 1997. It does however lack the authority of its Finnish counterpart to ensure expeditious implementation of policy directives. The Irish innovation system is also slow to respond to the findings of independent and expert evaluations wherever policies are not achieving their objectives.

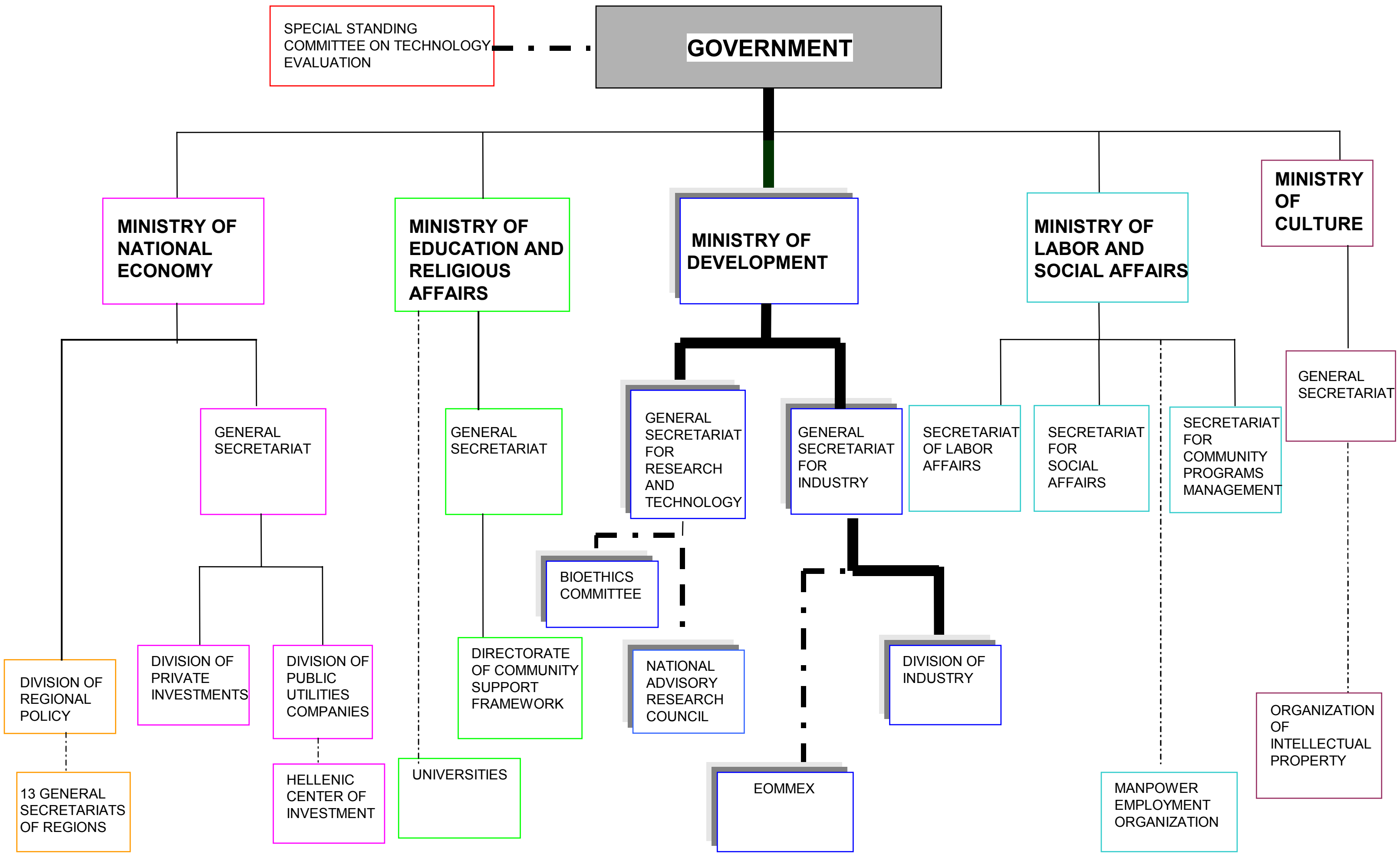
3.4 A Note on the Greek National Innovation System:

The key characteristics of the Greek NIS are:

- Traditionally limited interaction between all actors involved; in particular the business sector undertakes limited research and innovation activities and finances even less, Policies have tried to remedy that in the last decade with some but limited success. There is no general co-ordination mechanism.
- The characteristic of the Greek governance system is that the ministries are not only policy but also implementation agencies. Thus policy is designed and implemented by the same actor. A variety of intermediaries and regional development companies act as intermediaries and support mechanism but the ultimate responsibility lies always with the competent Ministry. Evaluation mechanisms are not established and most schemes have not gone through a formal evaluation. The most relevant among them are the Ministry of Development, the Ministry of National Economy, the Ministry of Labour and Social Affairs and the Ministry of Education and Religious Affairs.

In the Ministry of Development the key actors for innovation are the General Secretariat for Industry (GSI) and the General Secretariat for Research and Technology (GSRT). The two Secretaries share responsibility for the part of the Operational Programme ”Competitiveness”, which includes research, industry, energy and tourism. The GSRT, the key agency for research and innovation, is responsible for the strategic planning and the implementation of national research and technology policy. The GSRT aims at improving competitiveness in the Greek economy, transferring technological know-how from research centres to the productive sector and re-structuring and reinforcing the research sector's human resources. The improvement of the quality of life of the Greek citizen is also a fundamental objective. The GSRT is responsible for the supervision of the major research agencies and technology intermediaries.

Figure 3.5 Principal Institutions of the Greek National Innovation System



The GSI has the task to support and inspect the Greek Industry, to protect the environment from industrial activities, to create the industrial policy of the country and to supervise several agencies such as the National Standards Organisation, the Organisation for SME support, the National Industrial Development Bank, etc.

The Ministry of National Economy offers incentives for private investment including technology modernisation of companies and monitors the Operational Programme for the Information Society. A Special Secretariat for the Information Society was created in 2001 for this purpose.

The Ministry of Education and Religious Affairs is responsible for the development of human capital in all levels. The Directorate of the Community Support Framework is responsible for the planning and implementation of the Operational Programme for Education and Initial Vocational Training II, which was launched in the framework of the third CSF (2000-2006). The Ministry supervises and funds the 18 HEIs of the country, as well as the TEIs, which are now in the process of becoming HEIs themselves. The administrative role of the Ministry and its influence on university policy is probably higher than in the other member states.

The Ministry of Labour and Social Affairs is responsible for the Operational Programme for Employment and Vocational Training and for the Community Initiative ''Equal'' both launched during the third CSF (2000-2006).

3.5 Note on the Hungarian National Innovation System

Parliament

The Parliament deals intensively with questions of STI and passes laws and decrees on issues affecting the Hungarian State. The main parliamentary body working in this area is the Education and Science Committee. Other committees dealing with STI issues include the Economic Committee, the Budgetary and Financial Committee, the Environmental, Cultural and Regional Development Committees, the Social Organizations' Committee, and the Committee for European Integration. Committee Presidents report their comments and proposed amendments in the plenary sessions of Parliament.

The Advisory Organs of the Government

The government established two supporting organs to help develop and promote its STI policy. The Science and Technology Policy Collegium (STC) was established in October 1999. A year later a supporting S&T Advisory Board was set up with two sections, an administrative unit and a scientific-professional unit.

The role of these two organisations is to provide back-up support for decision-makers and to evaluate and coordinate the STI policy decisions.

Ministries dealing with R&D activities

The central institution responsible for science policy activities is the Ministry of Education. Research and innovation is dealt with in the four departments of the Deputy Secretariat of State for R&D (international, special technology, organization and co-ordination , strategic).

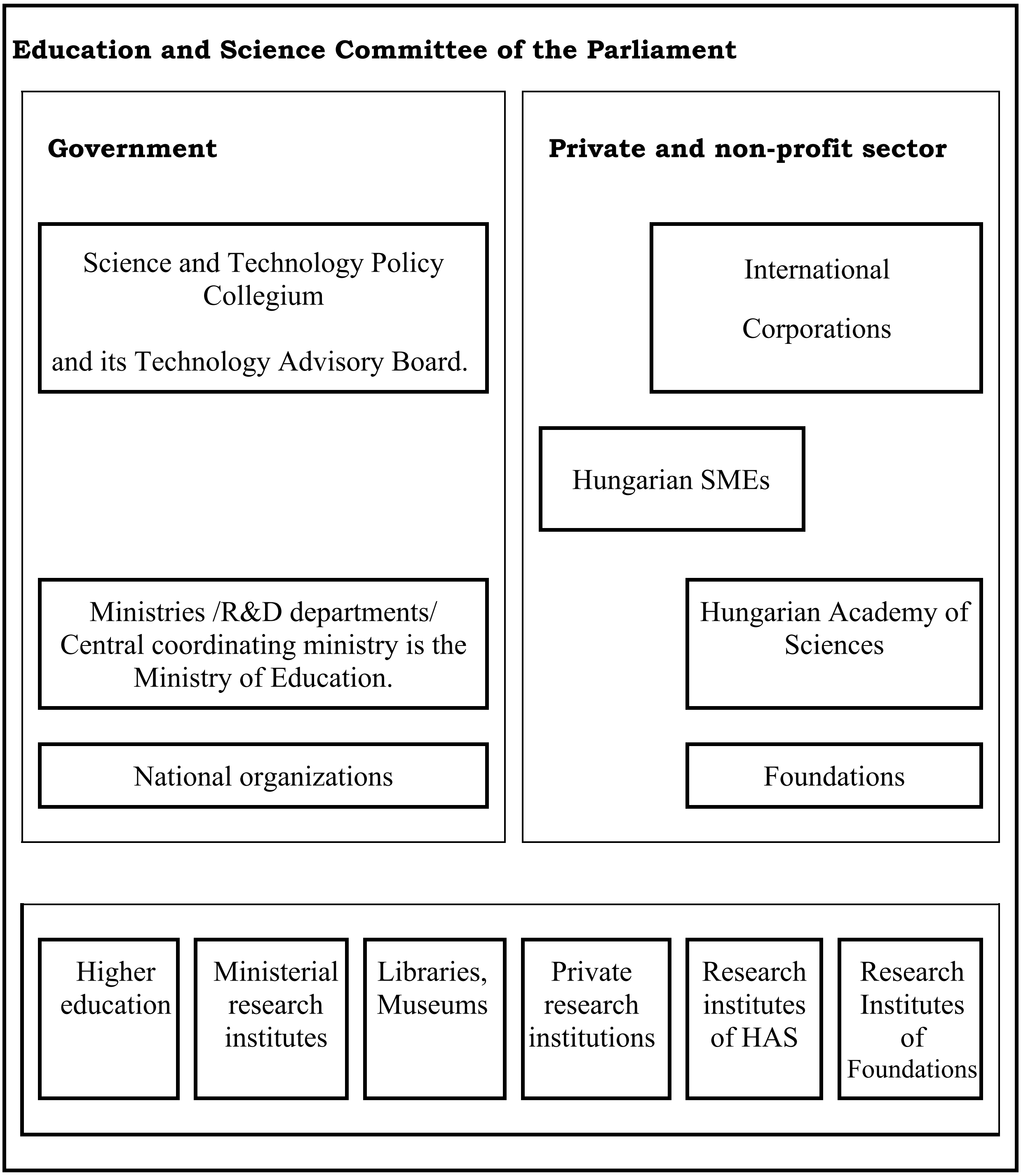
The sectoral ministries also carry out R&D support activities and their work is coordinated by the Science Advisory Board in the Ministry of Education. The R&D support programmes operated by the Ministry of Education and the other ministries are financed from specified funds in the state budget. The Ministry of Economy is the main coordinator of government relations with private firms including the different supports for R&D offered to the enterprise sector.

Hungarian Academy of Sciences (HAS)

HAS was established in 1825. Its activity was discontinued between 1848 and 1870. Since then HAS evolved to become the centre of scientific life in Hungary. Headquartered in Budapest, the Academy also has regional research committees in the main intellectual centres of Hungary.

The 1949 law set out the present role and authority of the Academy. In the late 1980s HAS underwent further reforms and the law XL 1994 made HAS a self-governing scientific public body entrusted with the promotion of scientific research, the diffusion of scientific results. It was to act as the public face of Hungarian science. The Parliament has recently commissioned HAS to identify and map the strategic issues that face the nation at the turn of the millennium, and to propose solution pathways. This work is coordinated by the Program Council supported by the Operative Program Committee.

Figure 3.6 Principal Institutions of the Hungarian National Innovation System



HAS network of Research Institutes

The institute network of HAS consists of independent professional institutes and sponsored research labs in universities. There are forty-nine research institutes and one hundred and thirty-nine university research groups in the HAS network, organized on the basis of scientific disciplines. The institutes of HAS are predominantly focused on basic research though a few also get involved in applied research projects. The EU has nominated five HAS institutes as centres of excellence.

Research institutes sponsored by ministries

In former times applied research, experimental development and business application projects were primarily the responsibility of institutes of the branch ministries. The bulk of their revenues came from industrial contracts but they also received limited state financing. After the political changes they were either discontinued or reorganized into private research firms. In 2002 only one or two ministries retain research institutes receiving state funding. The Ministry of Agriculture controls eleven research institutes and the Ministry of Health operates over two dozen research units in the health centres and other professional institutions supervised by this ministry.

Enterprise Research laboratories

Business research facilities were the greatest casualties of the systemic change and transition. During the first half of the 1990s the number of researchers working in enterprise cut by half. Many of these were inefficient and their elimination did not represent a major loss from an economic point of view. Moreover, concurrent with the decline of traditional businesses several other sectors developed new independent R&D facilities. In addition, a number of foreign-owned companies, preponderantly in the ICT sector, established R&D departments in Hungary. This 'functional deepening' was encouraged by special incentive schemes. For the most part the research is focused on adaptations and customising. There are also a number of specialized SMEs providing R&D contract services.

Universities and other research organizations

There are other public organizations in Hungary involved in research, including university departments, libraries, and the institutes of foundations. While there are no specialist research universities most of the main universities are important centres of research. Some of them participate in co-operation programmes with Hungarian and international firms, particularly in applied research and experimental development.

3.6 Note on the Slovenian National Innovation System

Science and Technology Council:

This is the main advisory body to the Government in matters of STI policy

Ministry of Economy:

Since the re-organisation of the former Ministry for Science and Technology this is the main executive body responsible for setting up and implementing STI policy in Slovenia. The principle actor is its Enterprises Development and Competitiveness department (Innovation and Technology unit), which is responsible for the co-financing of business R&D projects and innovations, innovation infrastructure etc.

Ministry for Education and Sport:

Responsible for funding R&D activities in research organisations and higher education institutions. It also co-finances innovation infrastructure.

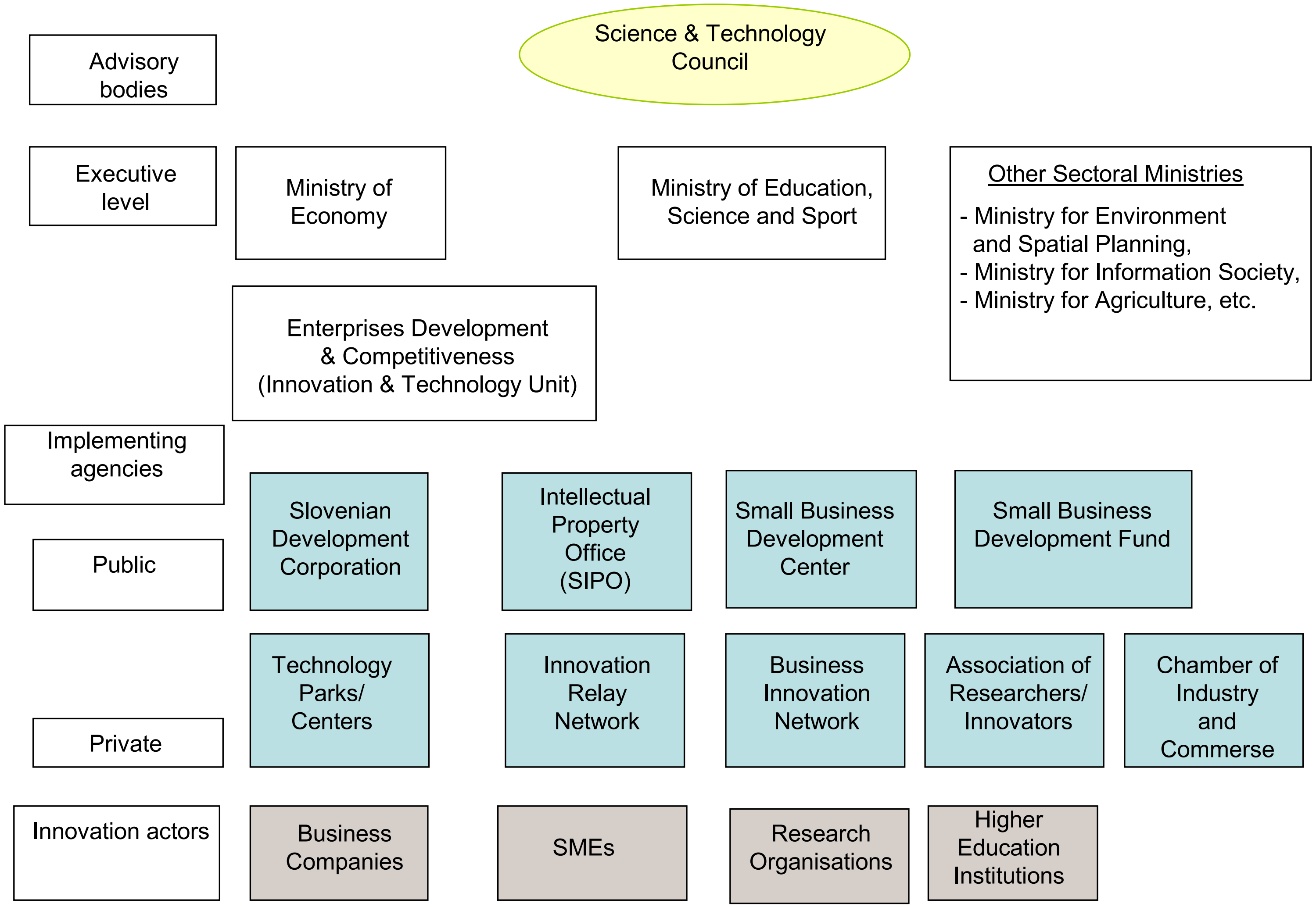
Other Ministries:

Ministries for Environment and Spatial Planning, for Information Society and for Agriculture part-fund research and innovation activities in the areas of their specific interest.

Slovenian Development Corporation:

Under its programme of development project financing it provides long-term financing for development projects of business enterprises (co-financing under favourable terms). This includes support for the transfer of R&D results and innovations into commercial use. It also includes the improvement of quality and competitiveness, based on innovation and new technologies, and the establishment of new firms based on new own products and technologies. The Small Business Development Centre (SDC), the major Slovenian post-privatisation institution, is going to be dissolved in the near future, to be replaced by an alternative institution, not precisely defined as yet. The new law on R&D envisages the establishment of a Technology Agency within this institution and a special fund fostering technology development.

Figure 3.7 Principal Institutions of the Slovenian National Innovation System



Intellectual Property Office:

Provides for the protection of intellectual property and is responsible for including Slovenia in the international system of intellectual ownership. It is responsible for the procedures for acquiring and protecting intellectual ownership rights and provides information on intellectual property to interested business partners.

Small Business Development Centre:

Its primary task is coordination of a promotional network for small business. It supports innovation by co-financing of innovation projects, advising on preparation and marketing of innovations and by coordinating activities at a country, regional and local levels.

Small Business Development Fund:

It gives soft loans, guarantees and interest rate subsidies for SME projects. It co-finances SME projects and innovation infrastructure (such as technology parks and centres).

Technology Parks/Centres:

Infrastructural development aimed at providing supports at the sectoral or regional level, with the purpose of transfer of knowledge and technology into business practice. They offer advisory services, easier access to new technologies, better transmission of R&D results and innovation into commercial use in business firms.

Innovation Relay Network:

The Slovenian Innovation Relay Centre is part of the European network of Innovation relay centres. Its aim is to promote the transfer of technologies and the exchange of research results across member countries, to promote the transfer of research results into commercial practice and to provide advice in the area of innovation. It intermediates between demand and supply for new technologies among business firms.

Business Innovation Network:

Slovenian Business Innovation Network operates as a section of the Small Business Development Centre. It was established with the aim of organising networking and providing information for innovators. It provides advice, educational and informational services and other support to innovators. It also finances organised presentations by Slovenian innovators at home and abroad, and co-ordinates innovation activities at regional and local level.

Association of Innovators/Researchers:

Associations of innovators and researchers are involved in active cooperation and in promoting innovation and R&D activities in various institutions at different levels.

Chamber of Industry and Commerce:

This chamber does not have its own funds for the support of innovation activities, but - in addition to its advisory role in the formulation of Slovenian STI policy – it supports technological development through its advisory services. These services are open to potential innovators and they also assist intermediaries trying to link firms to sources of new or improved technology.

4 Measures Designed to Foster an Innovation Culture

The promotion of a genuine innovation culture was the first of three action areas proposed in the First Action Plan for Innovation in Europe. Particular emphasis was placed on the crucial role of education and further training in the context of skills acquisition, relevant to enhancing the innovative capability of individuals. Specific training in organisational and management practices was also a key dimension of this Action, enabling enterprises to keep abreast of best practice in business and technology management. The mobility of researchers and engineers was highlighted as an area to be further developed, in particular the mobility of senior staff from education or research to industry. The Action included generating among politicians and policy makers an awareness of the importance of STI to economic growth and the need for continuous policy evaluation and benchmarking. Innovation can only flourish if it is understood and accepted by society and it is imperative to raise awareness and support for STI among key decision-makers and the public at large.

4.1 Education and Initial and Further Training

In Finland the higher education system is very well developed and regionally extensive, offering a study place for about one third of the relevant age class. In the near future, the aim of the Ministry of Education is to increase the number of graduates and PhDs, such that higher education degrees should be available for 70% of the age class by the year 2004.

'Graduate schools' for postgraduate students were initiated in 1995 and operate in most fields of science. The number of PhD graduations doubled during the 1990s to reach a volume of 1165 in 1999. This volume is planned to increase to 1400 in 2004.

The Academy of Finland sponsors centres of excellence on the campuses of universities and research institutes. These research centres are co-financed by the host institute, the Ministry of Education, TEKES and other external sources. Some 43 centres will be in operation by the end of 2002.

The higher education system as a whole offers places for 66% of the relevant age group (universities 29 %, polytechnics 37 %). Finland's 29 polytechnics are geared to more practically oriented training for professionals. Most are multidisciplinary, regional institutions and give particular weight to contacts with business and industry. Resources devoted to R&D are much smaller than obtains in the universities.

In general the supply and demand for education and training are well balanced. The very rapid expansion of fields such as ICTs resulted in a shortage of graduates in the mid 1990s but the Ministry of Education responded to the challenge. A five year programme costing €170 million[18] was launched in 1998 to increase the number of ICT degrees by one third during the years 1999-2006. Adult education and further training has also focused on skills linked to the information industry.

The Netherlands has a long history of education aimed at vocational training. In 1996 the vocational system was upgraded, and again, in 1999, further steps were taken to boost supply with the inauguration of Regional Education Centres (ROCs).

Like many other countries in Europe the Netherlands operates an ongoing awareness programme to stimulate participation in higher education and research in the field of beta-sciences and technology. Nevertheless the number of students choosing 'hard science and technology' subjects continues to decline.

The Irish National Development Plan 2000-2006 included an allocation of €6.8bn for education and training objectives to prepare its citizens for the Knowledge Age. There is a target to increase the second level completion rate from 50% to 65% by 2004, with half of these proceeding to third level qualifications.

The RTDI-Education priority in the Irish National Development Plan (NDP) has allocated €800m for basic and strategic research capability in the HE sector to bolster the supply of S&T research. It is hoped that this generous NDP funding will increase the transfer rate from graduate to post-graduate studies in science and engineering.

The Greek government provides scholarships to boost the output of S&T post-graduates and to orient them towards applied research areas in co-operation with enterprise.

Following the transition, Hungary has made a strong investment in its education system, with the numbers taking third level education doubling over the 1990s. Availability of qualified people in some fields, especially ICTs, is becoming a problem. The educational institutions are being encouraged to modernise their approach to content and delivery and to offer syllabi more in tune with the skill requirements of the new economy.

[18] A government decision on May 2000 voted an additional appropriation of 1 billion Euros to universities, polytechnics and the Academy of Finland for content production.

The Slovenian Ministry for Education, Science and Sport continues to promote Slovenia's 'Young Research Programme'. The aim of this programme is to provide 'new blood' for the knowledge-intensive enterprise sectors. There are fears that the recent re-organisation of Science and Technology into two separate departments may mean that researchers will receive less incentives to pursue industry-oriented research and that the supply of graduates for the 'new economy' may shrink.

4.2 Mobility

Finland benefits from considerable international mobility within the HE sector thanks to the efforts of the Academy of Finland and CIMO, the Centre for International Mobility. National mobility is much less prominent and there are no specific policy measures to encourage graduates to seek post-graduate education or teaching posts in different universities from those where they first graduated. Researcher mobility between the HE sector and private enterprise is not strong.

Table 4.1 shows that, despite the mobility problem, Finland is still a clear leader in the number of researchers in business per 10,000 labour force.

Table 4.1 Researchers per 10,000 Labour Force 1997

	Business	Education	Government
Finland	36	34	15
Ireland	18	32	2
NE	17	15	10

UNICE 2000 Benchmarking Report – Stimulating Creativity and Innovation in Europe.

The Netherlands operate a 'Knowledge Carriers in SMEs' mobility scheme to enhance the innovative capacity of SMEs. Companies are subsidised for hiring 'knowledge carriers', recent graduates with a Master's degree. The graduate undertakes an agreed innovation project directed at product/process, organisational or market innovation. The scheme is restricted to SMEs with a maximum of 100 employees. They must hire the knowledge carrier for at least 32 hours on a weekly basis for a minimum period of one year.

Studies have reported a reluctance on the part of Irish HE staff to move from the HE sector into industry because of career considerations. There has been some mobility success with the Programmes in Advanced Technology (PATs) and the Advanced Technology Research Programme (ATRP). In these cases the vehicle tends to be a spin-out rather than taking up a position in an existing company. Due to an acute shortage of qualified personnel in certain sectors, particularly ICTs, Ireland commissioned a study in 2001 to identify best practice in attracting researchers from abroad.

Greece operates schemes encouraging graduates to work on co-operative pre-competitive projects with industry. The hope is that the resulting close interaction will lead to more permanent tenure in the host enterprises.

Hungary participates in the many programmes that encourage international mobility of students and researchers within the HE sector viz Leonardo, Socrates and the ERASMUS programme. There is moderately frequent contact between researchers in the HE and industry sectors, but mobility is not so common.

A recent survey of Young Researcher fellowships in Slovenia indicated that 90% of PhDs remained on in academic posts while most MSc recipients went to work in industry. Anecdotal evidence suggests that PhDs experienced difficulties in working for companies that did not have a track record of hiring staff at this level. Particular friction developed with incumbent older engineering staff. The significant financial rewards made MSc holders more motivated to persevere in the private sector.

4.3 Raising the Awareness of the Larger Public

One concrete measure in Finland aimed at raising awareness of the benefits of research and innovation among the wider public is the organisation of various competitions and prizes for successful new inventors and innovators. The INNOFINLAND scheme offers awards to innovative, fast-growth firms.

A number of institutes in the Netherlands are involved in raising public awareness of Science and Technology. One such organisation is the WeTeN foundation which was established to run large-scale public awareness campaigns to alert the public to the benefits of Science and Technology. In 1999 WeTeN was re-organised to deepen its expertise in public relations. Its major brief is to co-ordinate the awareness initiatives of all other institutes involved in S&T, including the KNAW, NWO, TNO, Rateneau Institute and others. One of its important goals is to popularise S&T among the youth by means of television programmes, a science museum (NEMO), and special education programmes.

Forfas, Ireland's National Policy and Advisory Board for STI and Enterprise, operates an STI Awareness Programme which includes a major annual STI conference. The programme sponsors publicity and awards for innovative firms and S&T journalists. It also operates a 'skills awareness' programme which encourages second level students to pursue S&T disciplines at third level.

The Greek government offers annual awards for its 'most innovative' firms. There are programmes targeting second level students to take up studies in S&T. An 'Open Gates' programme spreads awareness of S&T benefits among the general public. The government actively encourages inbound international Science conferences and fora as an effective mode of learning.

Surveys of public opinion in Hungary in the second half of the 1990s mirrored the universal unease at many recent developments in science and technology. The Science and Technology Policy Council (STPC) has been mandated to co-operate in informing the public regularly about the current problems and issues in research and development policy. The Hungarian Foresight Programme and the Széchenyi National Development Plan both served to raise the awareness and involvement of the wider public. More specific awareness programmes include the Mecenatura programme launched in August 2001. Its fourth sub-programme had specific awareness-raising measures including student competitions, technology magazines and R&D-related TV programmes.

The Slovenian Science Foundation's annual Slovenian Science Festival is that country's primary instrument in the communication of developments in science to a wider public

4.4 Fostering Innovative Organisational and Management Practices in Enterprises

In Finland the Ministry of Labour instituted a National Workplace Development Programme in 1996 to promote innovative organisational and management practices in enterprises. The chief goals of the programme were to boost productivity and the quality of working life. The programme aimed to achieve this by developing human resources and helping the workforce to reform their model of co-operation. During its first 3-year term in 1996-1999, €16 million was budgeted for the programme. These funds were used to start 300 development projects affecting nearly 50,000 people. The program has been continued for the period 2000-2003.

In the Netherlands the Participation Companies for New Technology-based Firms (PMTs) was designed to boost the amount to be invested in New Technology-based Firms (NTBFs). A critical application of these funds is the procurement of experienced hands-on management to guide the fledgling founders through their first turbulent years.

The Irish National Institute of Technology Management (NITM) was established to raise the profile and capability of technology management in Irish-based enterprises through teaching, research and policy input. The Institute was established in 1997 under the auspices of Enterprise Ireland, as part of its Initiative in R&D Management with funding from the European Social Fund. The NITM is hosted by the Smurfit Business School in University College, Dublin, and is a joint activity of the Engineering and Commerce faculties.

Enterprise Ireland provides its client companies, particularly its SMEs, with a benchmarking service to facilitate process improvement and the absorption of technology and know-how. The benchmarking service addresses the full business gamut – strategy, finance, marketing, research, production operations and human resources.

The Greek 'Certify Yourself' scheme supports SMEs in the manufacturing, services, tourism, and commerce sector to achieve the quality assurance system ISO 9001/2000. A 'Network yourself' measure has been introduced to acquaint 50,000 SMEs with the fundamentals of e-business and the opportunities offered by the Internet. KETA, the 'Centres of Entrepreneurial and Technological Development' scheme, was set up to improve the skills of personnel in centres of entrepreneurial and technological development who, in turn, can provide consultancy services to Greek companies.

There are several support measures in Hungary to encourage firms to achieve quality certification, most notably the PHARE Technological Development and Quality Management Program (TDQM). Management skills are also transferred to indigenous firms who imitate the good business practices of MNEs. The INTEGRATOR linkage programme is specifically designed to take advantage of these skills spillovers.

Training in the management of technology and innovation is a proven mode of inculcating innovative organisational and management practices in enterprises. Slovenia is introducing innovation management courses in its premier business schools (e.g. the Bled School of Management). It also exploits its regional development centres as pathways for the dissemination of best practice management techniques.

4.5 Support to Public Authorities and Innovation Policy Makers

In 1999 the Finnish Ministry of Trade and Industry set up a working group to highlight the need to raise the STI awareness of public sector officials. The high profile of the Science and Technology Policy Council is instrumental in ensuring that good back-up support is provided to public sector officials engaged in formulating and implementing STI policy. SITRA, the Finnish National Fund for Research and Development, seeks to provide such support where needed.

Every year in the Netherlands there is a 'Technology Lecture' on a specific topic related to new developments in science, technology and economics. This lecture is organised by the Ministry of Economic affairs.

Irish policy makers have created a culture of policy learning and are anxious to keep abreast of best international practice in STI policy. Initiatives such as the

DG Enterprise Trend Chart project are embraced as valuable policy databases for benchmarking purposes. International policy studies are undertaken but this is still on a relatively ad hoc basis.

Slovenia has just experienced a turbulent decade in political and administrative life and government personnel have not enjoyed the stability and continuity of tenure necessary to pursue policy learning strategies in their specialist areas.

4.6 Promotion of Clustering and Co-operation for Innovation

Finland runs a Centre of Expertise Programme aimed at enhancing regional competitiveness by strengthening innovation, renewing the industrial structure and creating new jobs within selected areas of expertise. A second initiative, the Cluster Programmes, supports firms that create or use research results in an industrial cluster setting. Cluster programmes are funded out of the Programme for Additional R&D Funding.

The cluster concept is a key consideration in Finland's approach to STI policy. It gained currency following the publication of the "National Industry Strategy" by the Ministry of Trade and Industry in 1993. Motivating factors were the publication of The Competitive Advantage of Nations, Michael Porter (1990) and the results of a cluster research programme undertaken by ETLA, the Research Institute of the Finnish Economy. The concept has become a cornerstone in new industrial policy thinking since the mid-1990s. One of the main arguments in its favour is the increasing belief that measures addressing the general business environment of enterprises constitute the most effective policy. The cluster concept fits in very well with the emphasis on interactive learning in the NIS approach. Moreover, cluster-building is a central objective of the prevailing school in regional policy.

In the Netherlands there are cluster-building programmes in the life sciences, in nano-technology, new materials, chemicals, and in information technology. The "Maritime Research" subsidy scheme promotes enterprise development in the maritime sector by stimulating knowledge flows between companies and research institutions.

Ireland has succeeded in establishing an ICT cluster largely driven by FDI. Past national strategies of investing in education and training delivered rapid productivity growth and the strong human resource base was an important factor in the attraction of the MNEs. However, the Irish experience demonstrates that skills and training are a necessary but not sufficient condition for success in global markets. There was also a role for targeted, flexible industry policies in the context of an active partnership with unions, business and the community. The role for the Government in this context has been characterised as the

'Flexible Developmental State': the aim is to nurture post-Fordist networks of production and innovation, attract international investment and link these local and global technology and business networks together in ways which promote development. The policy will be severely tested in the current climate of a major contraction in the international flow of FDI.

The Slovenian Ministry of the Economy operates a programme to subsidise the cost of establishing pilot industrial clusters. There are also fiscal incentives to support networking by firms. There is currently a lively debate among policy makers on how to exploit networking and clustering for regional development. It is anticipated that the regional development centres and, particularly, the technology centres should provide active hubs for this effort.

5 Establishing Favourable Framework Conditions

Although innovation calls first and foremost for a certain attitude of mind – creativity, a sense of initiative, an entrepreneurial spirit, organisational rigour and a willingness to embrace social, geographical and occupational mobility – it is unable to develop without a conducive legislative, administrative and financial environment. This was the goal of the second element in the First Action Plan for Innovation in Europe. The main prerequisite for fostering a spirit of innovation is unfettered competition. To this the First Action Plan added priorities relating to intellectual property, administrative simplification and amelioration of legal and regulatory environments.

5.1 Competition Policy

Finland rode the global wave of deregulation in the 1980s, transforming the formerly highly regulated economy into an open market model. Deregulation measures were accelerated during and after the serious depression in Finland at the turn of the decade.

Legal harmonisation with the EU 'acquis' and directives accelerated liberalisation in the run up to EU-Membership in 1995. Today, few sectors remain restricted, positioning Finland well up to average European standards though there remains scope for further progress. The state continues to hold a stake in 46 major companies of which 11 are quoted on the stock market, among them a key telecommunications company. Sectors with entrenched monopolies are proving difficult to liberalise e.g. the state-owned railways and other transportation niches. However, in most industries, publicly owned companies are now subject to the same competitive conditions as private companies. The energy and forestry sectors have been opened up to competition and regulation is restricted to monitoring by the relevant authorities.

The Netherlands is in the middle of its deregulation process. Telecommunication has been liberalised completely. Power plants are now privatised (most of them bought out by foreign energy companies like Reliant, Electrabel and EON). All transportation is private except for the main railway company (NS) and some local transportation (Amsterdam and Rotterdam). The market for electricity has been liberalised for large companies and further privatising is imminent. The electricity network remains in the public sector.

In Ireland solid progress was made in introducing competition in the utilities sector in the 1990s, largely in response to EU requirements. The Competition Acts of 1991 and 1996 empowered the Irish Competition Authority to apply general competition law across the entire economy.

Greece's competition law and its Competition Authority have not been strengthened as effectively as is the case in other EU member states. Re-organisation of the Competition Authority and supporting policies are in train. As regards the deregulation of utilities, the telecommunications sector is completely deregulated and the energy sector is being addressed.

The first competition law enacted in post-socialist Hungary came into force in 1991. This law was broadly modelled on Articles 85 and 86 of the Treaty of Rome, which serve as the principal competition law of the European Union. Like other pioneering laws it has since been amended to a significant degree, responding to several years of enforcement experience and to the requirement for "harmonisation" of competition laws in the EU Association Agreement. The potential impact of the amended Hungarian competition law on R&D and on the process of innovations is difficult to evaluate.

The Slovenian Office for the Protection of Competition in the Ministry of the Economy has been authorised to issue final irrevocable decisions on competition policy matters. The Ministry also has a Section for Internal Market Protection, mandated to protect the free movement of goods. To date achievements are mixed with respect to the deregulation of utilities. In transport the railways remain in public hands but the legislation has been harmonised with the EU acquis. The new law on energy has opened the market for electricity. In telecommunications fixed-line telephony is still in state hands but in mobile telephony a competitive market structure has been introduced. The capital market is now completely open to competition.

5.2 Protection of Intellectual and Industrial Property

In 1998 the Ministry of Education set up the Lindqvist committee to clarify the basic problems and prospects that Finnish researchers faced in the area of Intellectual Property Rights (IPR). The committee recommended an amendment to the laws governing IPR so that researchers and lecturers at universities and other similar institutes would essentially enjoy the same rights as those enacted in private sector firms. The amendment was not carried because of conflict among the stakeholders. IPR issues are very challenging and difficult to resolve in collaborative projects involving universities, research centres and companies.

The Netherlands complies with all aspects of EU law on IPR. Researchers and staff at HE institutions are afforded the same protections as those enjoyed by researchers in the private sector. There are no specific government programmes to raise the awareness of IPR among HE research staff; this is considered the responsibility of the HE sector itself.

Greece has several IPR schemes to encourage and reward inventors. Researchers and staff at HE institutions are not accorded the same protection of IPR as their counterparts in the private sector.

The Slovenian Intellectual Property Office was moved to the Ministry of Economy to take advantage of synergies between intellectual and industrial property rights. Slovenia recognises all major international IPR treaties including TRIPS, WIPO and the Paris Convention for the Protection of IP

The challenge for policy makers is to develop IPR awareness programmes in SMEs and reduce the costs of protection. There is also the problem of very rigid IPR legislation in public institutions. This impedes the equivalent treatment of researchers in public institutions with private sector researchers.

5.3 Administrative Simplification

Finland consolidated its TE regional centres to streamline the service to their client base. There are also several ongoing government programmes to ease the administrative burden on SMEs.

A 'one counter' policy is being implemented for all levels of government in the Netherlands. The degree of customer satisfaction varies from one service and department to another.

The Irish civil service participated in a Strategic Management Initiative (SMI), consisting of a wide range of measures intended to bring about improvement in the delivery of public services. The initiative was launched in 1994 with three key aims:

- public bodies would contribute to economic and social development
- an excellent service should be provided to the public
- resources (finance, staff, etc.) should be used effectively by public bodies

Hungary adopted its general rules of State Administration procedures in 1957, marking a major step forward in administrative efficiencies. More than forty years on, the General Rules are in need of a general overhaul. In some places they are too complicated, in others not thorough enough. There is a need for a new code suitable to the needs of the new democratic dispensation.

The Greek administration system is characterised by bureaucracy and inflexibility, and has an unenviable reputation for inconsistencies and delays. One bright area is the progress in e-government. The revenue system has been digitised for income tax and VAT.

An anti-bureaucracy programme was adopted in Slovenia in November 1999 with the aim of establishing an efficient administrative environment for enterprises. The programme included plans:

- to decrease significantly the costs of setting up new enterprise
- to shorten the time required and simplify procedures for setting up enterprises (14 days)
- to eliminate all barriers which prevent faster growth of SMEs
- to eliminate discrepancies between individual laws and by-laws
- to introduce labour and employment legislation and regulation which provide for flexibility of SMEs and for social security of employees
- to develop the 'one-stop-shop'

Implementation of the programme has been hampered by poor co-ordination among the different ministries and related government bodies.

5.4 Amelioration of legal and regulatory environments[19]

Finland is currently conducting a study of its regulatory system with OECD guidance. There are no Finnish policy measures relating to this area submitted on the Trend Chart. However, there are several SME programmes that include elements of regulatory amelioration.

Changes in the regulatory system in Ireland have been fragmentary and in many cases undertaken in response to market liberalisation, as a result of EU directives or associated with particular privatisation issues. In 2001 an OECD study of Ireland's regulatory system was commissioned. The report drew up a comprehensive policy framework for regulatory reform, setting out the broad principles to be followed. The government is currently in the process of implementing its recommendations.

The central thrust of economic policy in the Netherlands is to strengthen competitive markets and to decrease regulatory and administrative burdens. In 2000 legislation on the establishment of new firms was revised and the process of start up was greatly simplified. Onerous legislative stringency only applies where public health, security and the environment are at stake.

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[19] Regulatory reform means a restructuring of the laws and institutions that govern economic activity so that they have, as a priority, a consumer orientation, but balanced by the need to promote investment in traded goods and services. Regulatory reform is not the same as deregulation: in some cases consumer interests can be better served by introducing new regulations, and in other cases by getting rid of existing regulations.

In Slovenia an Association of Consumers was established in 1990 as an independent, non-profit, non-governmental organisation to represent, inform, and advise consumers. An Office for Consumer Protection, within the Ministry for Economy, was established in 1994. This office is responsible for both formulation and implementation of consumer protection policy. Priority areas are education, information and consumer advice. The principal aim is to raise consumer awareness in areas where their interests might be threatened. A second goal is to raise the quality of goods and services.

6 Industry-Oriented Innovation Policies: Quantification of Resource Allocation

The STI policies identified in the previous sections of this paper focused on the context within which innovation is most likely to take root and prosper. Economic progress however is ultimately determined by the extent to which individual firms respond to the stimulus of their environment and introduce new and improved products and processes. All industrialised countries now supplement their institutional and macro-economic supports for innovation with a portfolio of highly focussed industry-oriented innovation policies. Firm and industry-based innovation policies were designed primarily to compensate for market failure while macro policies are intended to prevent systemic failure. For that reason there is no guarantee that micro policies that are successful in one national environment will achieve the same success when transposed elsewhere.

The focus of this section is to identify the range of industry-oriented policies that obtain in each of the six participating countries. A first approximation of the priority this activity is accorded in a particular country can be gauged from the share of GDP, or of the national STI budget, allocated to promoting innovation in the business sector. A qualitative assessment is also needed of how that budget is distributed across the value chain of knowledge that embraces knowledge creation, knowledge acquisition, knowledge distribution, knowledge application and knowledge use.

We pause briefly here to reflect on the critical role performed by the firm in a knowledge-based economy and how that role differs fundamentally from that of research organisations, whose primary function is to create new knowledge. Firms spend a great deal of time tracking and scanning external sources of knowledge to identify opportunities to exploit existing knowledge rather than to create new knowledge. Richard Nelson calls this 'a process of cumulative improvement and variegation'. He claims that the development of new and improved products and processes will always be the function of the firm rather than the research system. In the case of technologies that are in the public domain, further progress is contingent on a detailed knowledge of their strengths and weaknesses and areas where improvement would yield commercial results. This knowledge tends to reside in firms who make and use the technology and who interact constantly with other firms and with customers, suppliers and intermediaries.

A small minority of firms with intensive in-house R&D capability do create some new knowledge leading to significant innovations. Keith Pavitt found that, in the UK, two-thirds of all significant innovations were produced by a small coterie of "innovation producers", confined to five specific sectors of the economy. For the vast majority of firms, however, innovation takes the form of adaptation, incremental learning-by-using and learning-by-doing, and absorption of both tacit and codified knowledge mainly from external sources. Small and medium-sized firms dominate the industrial landscape in the indigenous sector of all six participating countries and this bias is overwhelming in the case of Ireland and Greece. The most pressing need for most of these firms is not financial subsidy for knowledge creation (R&D) but better access to information about technology acquisition, transfer and diffusion. This knowledge is best obtained through demand-driven initiatives such as improved inter-firm co-operation, participation in industry clusters, networking and shared programmes.

We identify below eight industry-oriented innovation policy objectives based on a survey of best practice in developed economies. The sequence tries to adhere to that of the knowledge value chain, moving through a number of stages from objectives pertaining to knowledge creation to objectives pertaining to knowledge use.

- Support for R&D (knowledge creation) in single firms. This is a response to perceived market failure. Easing financial risk by providing a public subsidy is the easiest to implement and the most common form of industry-oriented innovation policy
- Improving Framework conditions for High-tech Start-ups (mainly knowledge creation). Support for high-tech start-ups with an integrated package consisting of seed capital, incubator facilities and expertise
- Risk Capital for High-tech Firms (knowledge creation). Recognises the heavy investment in intangible assets (mainly R&D) and long gestation period between concept and commercialisation
- Support for R&D Co-operation by firms (knowledge distribution). Includes co-operation between firms and between firms and research organisations. Recognises the importance of collaboration between different actors within the innovation system
- Improving the Exploitation of Public Knowledge by firms (knowledge application). Technology transfer services from universities and public research organisations to industry including IPR protection
- Support for Knowledge Diffusion. Diffusion is stimulated through inter-firm networking, industry clusters, demonstration projects etc. These schemes may be classified as R&D co-operation but knowledge diffusion is an inevitable by-product
- Support for Human Mobility (knowledge diffusion). Schemes to place technology graduates in SMEs and for improving human mobility between academia and industry
- Improving the Absorptive Capacity of Firms (knowledge use). The greatest deficit for many SMEs is an inability to use technologies and innovations that

are available for their business from external sources. Consultants and intermediaries can help bridge this gap. Innovation management programmes also help

The five country bar-charts, presented below, provide details of allocations to each of the above policy objectives, expressed as a share of the total industry-oriented innovation budget.

Figure 6.1 Finland : Annual Expenditures by Objective in 2001 (€m)
Total 287 €m ~ 0.218% GDP

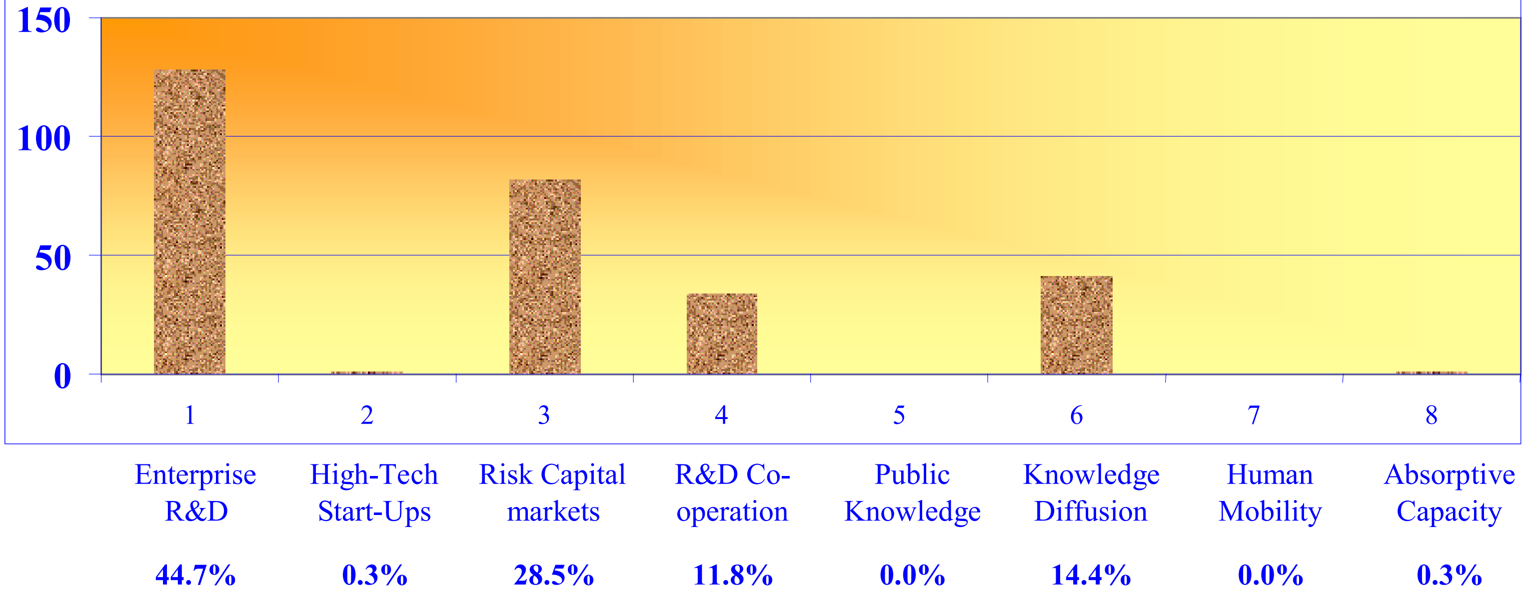


Figure 6.2 NE : Annual Expenditures by Objective in 2000 (€m)

Total €657m ~ 0.094% GDP

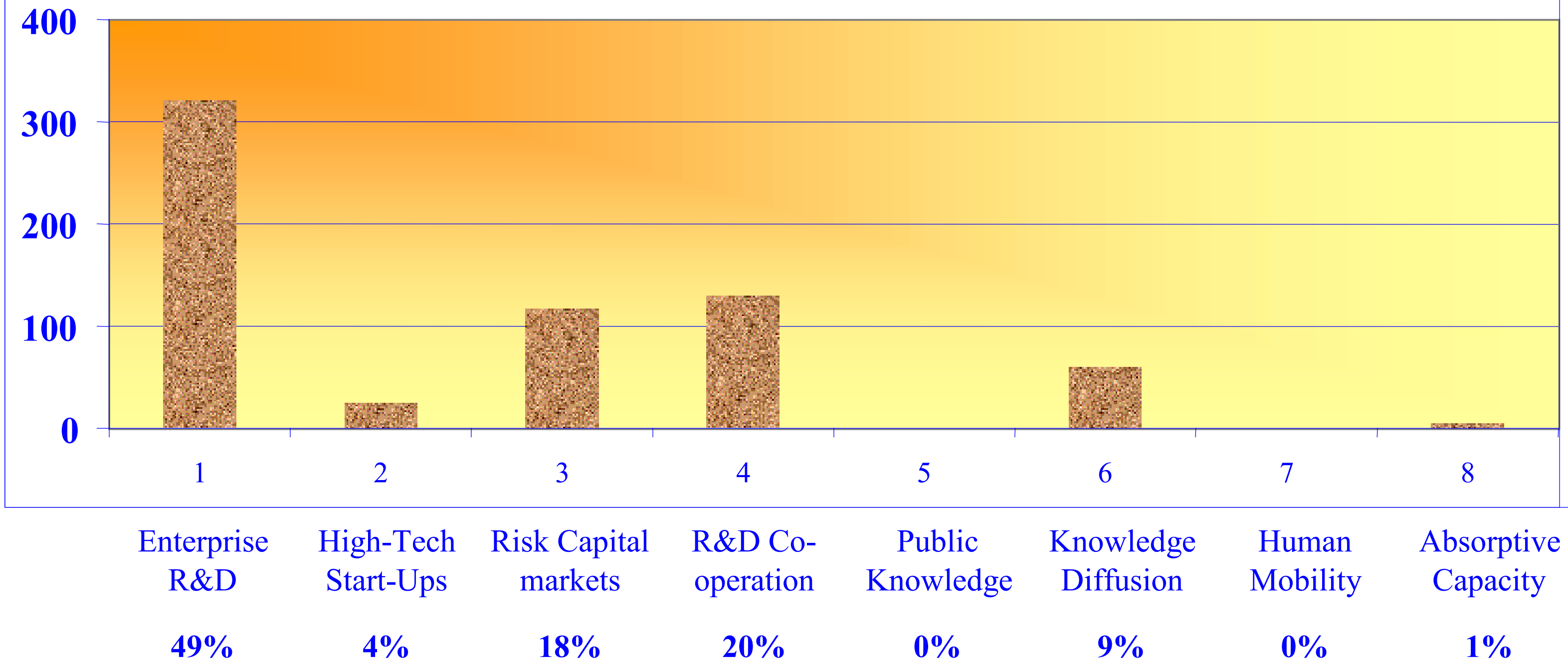


Figure 6.3 IRL: Annual Public Expenditure by Objective €m

National Development Programme 2000- 2006

(Average €132m per year ~ 0.127% % GDP)

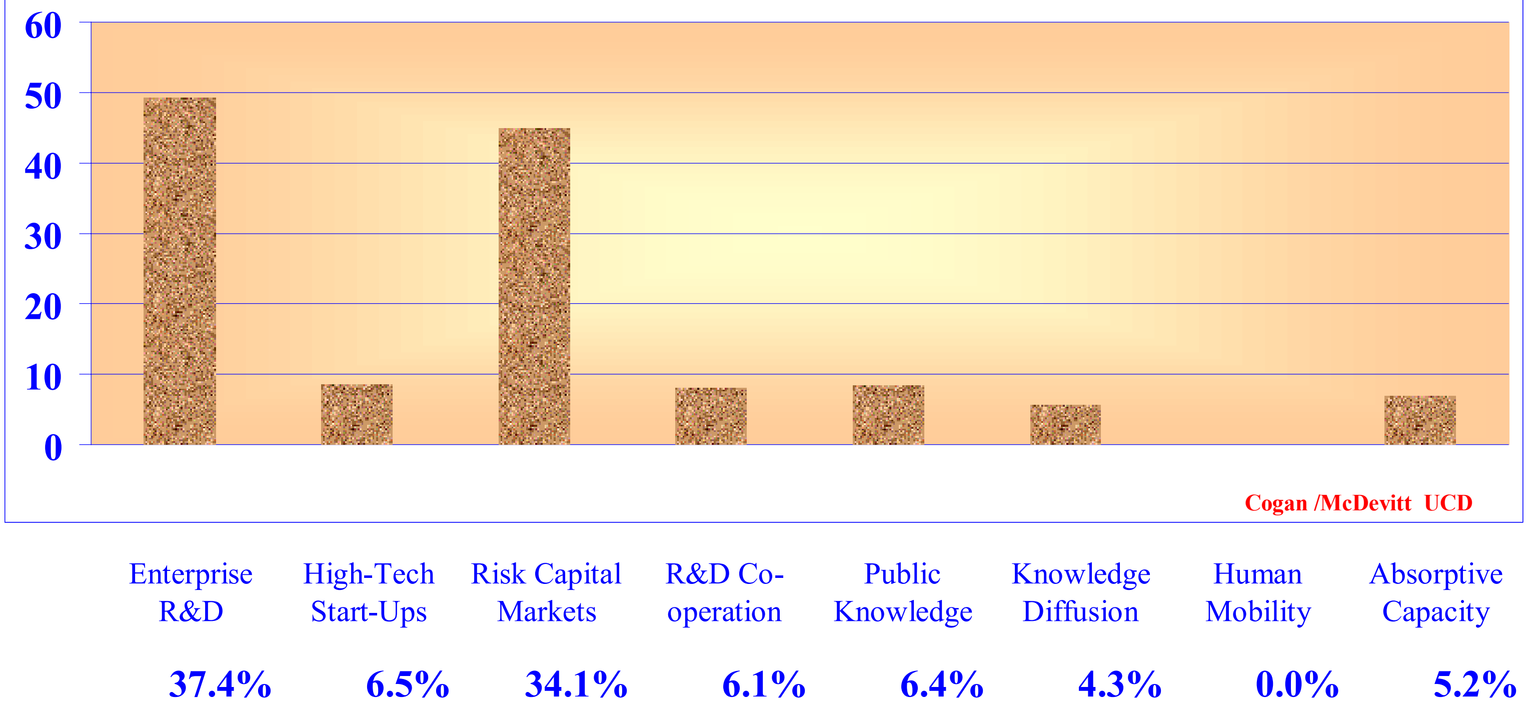


Figure 6.4 Greece : Expenditures (€m) by Objective 1996- 2002
Total for 7 years: 1,389 €m

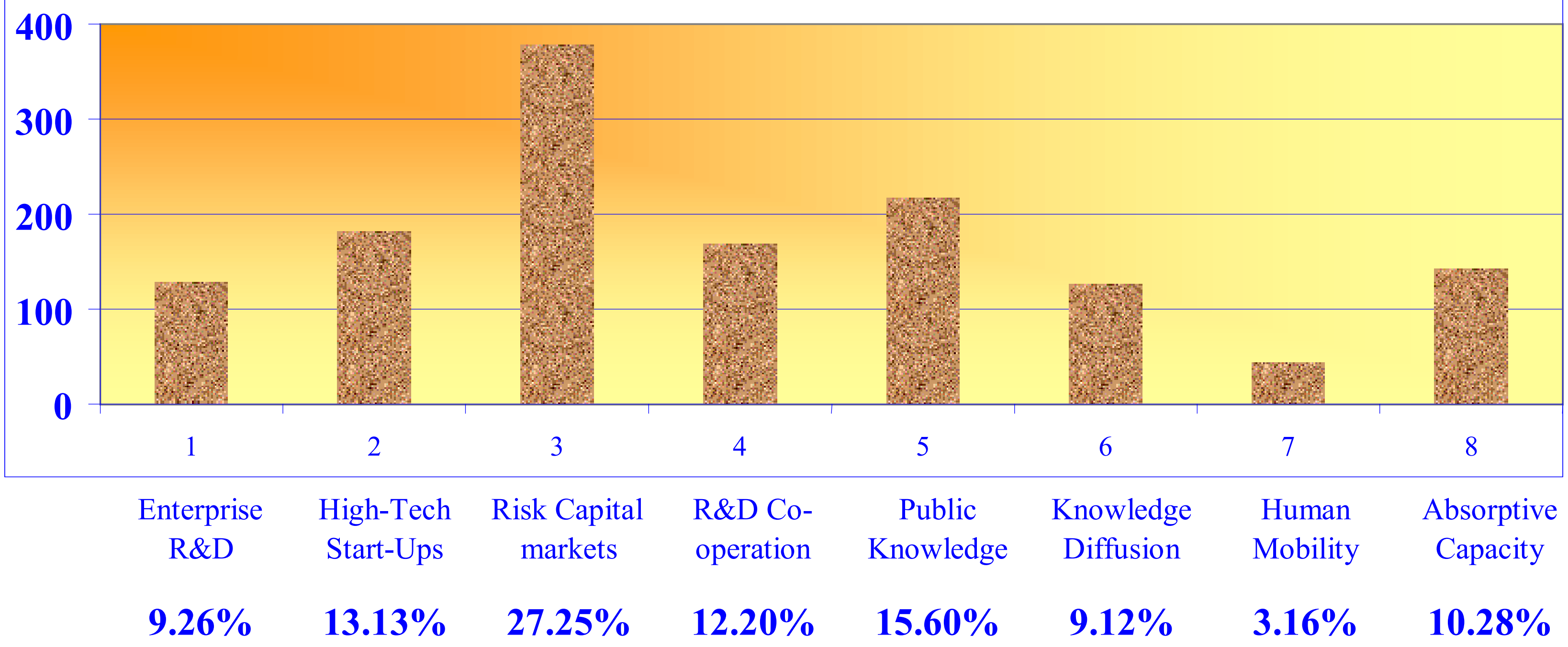
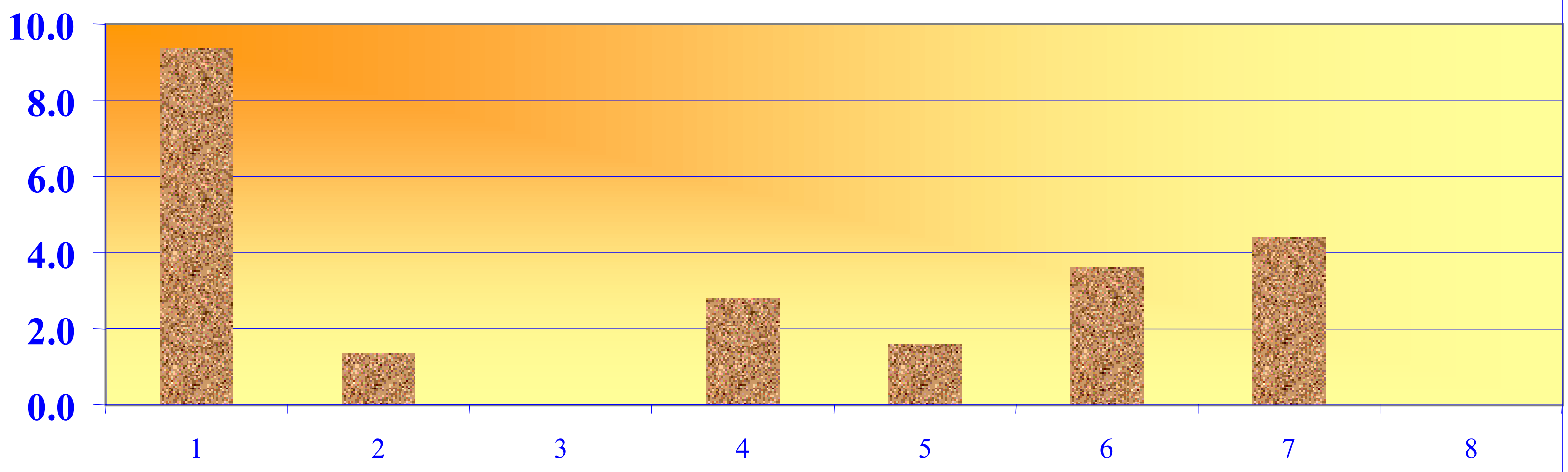


Figure 6.5 Slovenia : Annual Expenditures by Objective 2001 (€m)
Total 21.0 €m ~ 0.11% GDP



Enterprise R&D	High-Tech Start-Ups	Risk Capital markets	R&D Co-operation	Public Knowledge	Knowledge Diffusion	Human Mobility	Absorptive Capacity
40.48%	**5.84%**	**0.00%**	**12.12%**	**6.93%**	**15.58%**	**19.05%**	**0.00%**

7 Evaluation of Industry-oriented Innovation Policies

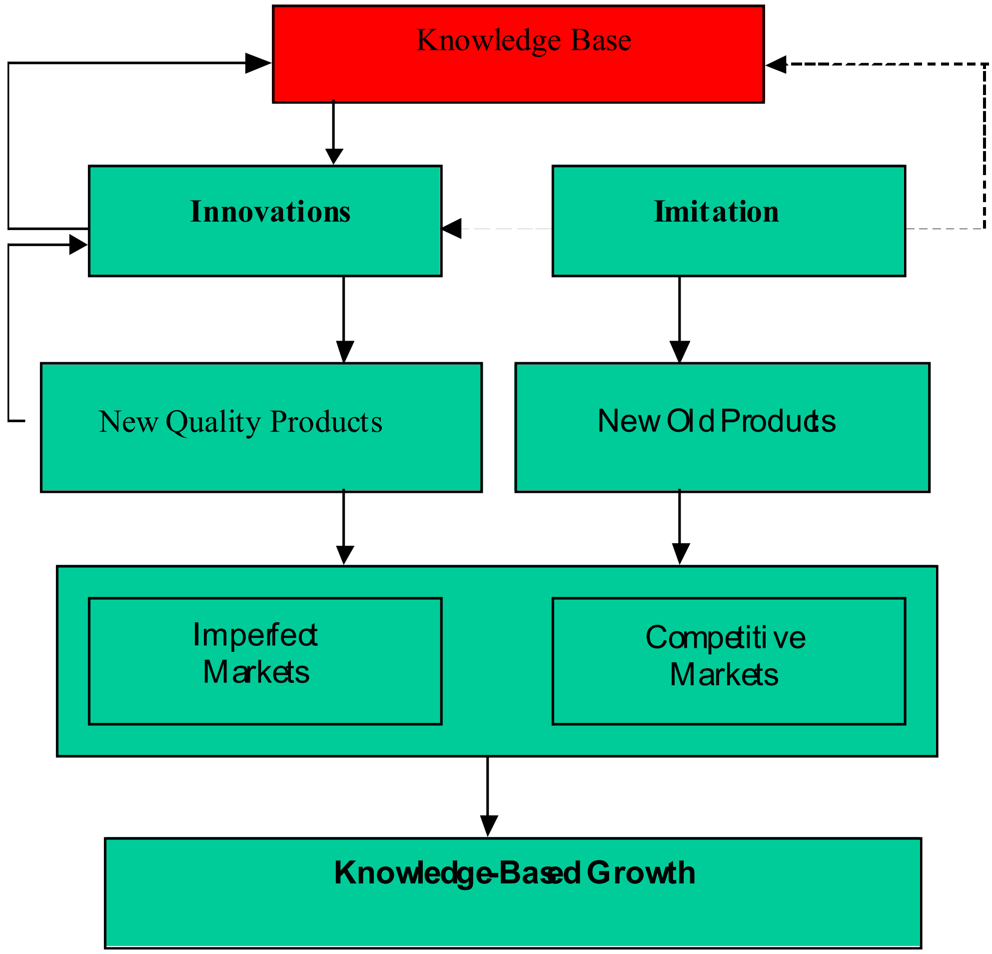
The previous section of this workpackage was an attempt to abstract from the complexity of the innovation systems of the six participating countries those innovation support measures that are narrowly focussed on the capacity to produce new and improved products and processes at the level of the firm. The total industry-oriented innovation support budget for each country, when expressed as a percentage of GDP, shows that, with respect to this particular metric, all six countries fall within the range 0.10% to 0.22% of GDP. This conceals deep underlying differences between the partner countries with respect to the scale of their RTD resources, their state of economic development and the sophistication of their systems of innovation. All six countries are classified as small but, as was demonstrated in Tables 1 and 2 of the first KNOGG workpackage, the range in both absolute level of GDP and GDP per capita is very great. The World Economics Forum Report 2001 places Finland first out of 75 countries in both the Current Competitiveness Index (CGI) and the 5-year Growth Competitiveness Index. Other rankings are the Netherlands 6, Ireland 11, Hungary 28, Slovenia 31, and Greece 36.

In this section we will identify the essential characteristics of the industry-oriented innovation policies of the KNOGG partners and assess their strengths and weaknesses with respect to the innovation capability of their firms. Particular attention will be given to the balance between knowledge creation by the firm and knowledge acquisition and diffusion, and the interaction between these two dimensions of the innovation process. This distinction between knowledge creation and knowledge diffusion/acquisition is central to the conceptual framework for knowledge-based economic growth, that was presented as the KNOGG Framework model in the first workpackage of this project

7.1 KNOGG Framework for Economic Growth

The KNOGG model (Figure 7.1) postulates two separate growth paths, depending on whether a country has the capacity for self-sustaining innovation, or alternatively, is constrained to catching up through imitation. The innovation growth path is predicated upon a formidable base of technological knowledge, derived from basic research, and a commensurate stock of human capital. The alternative 'imitation' growth path, for economies without an adequate knowledge base, is not self-sustaining and requires external policy intervention to close the technology gap.

Figure 7.1 KNOGG Framework Model



Arising out of the quantification of country resource allocation, across a range of industry-oriented innovation policy objectives, in Section 6 of this workpackage, it is possible to identify what proportion of its industry-related budget each country allocates to knowledge creation as opposed to knowledge diffusion. These data are summarised in Table 7.1 and would appear to indicate that the stronger economies spend about three-quarters and the weaker economies about half of their industry innovation budgets on knowledge creation.

Table 7.1 Proportion of Industry-oriented Innovation Budget Spent on Knowledge Creation/ Knowledge Diffusion (most recent year)

	Budget, % of GDP	Knowledge Creation	Knowledge Diffusion
Finland	0.218	73.5%	26.5%
The Netherlands	0.094	71.0%	29%
Ireland	0.127	78.0%	22%
Greece	n.a.	49.6%	50.4%
Hungary	n.a.	n.a.	n.a.
Slovenia	0.11	46.3%	53.7%

Table 7.1 suggests that Finland, the Netherlands and Ireland, all of whom allocate about three-quarters of their industry innovation budget to knowledge creation, may be pursuing the innovation growth path. But the overall intensity of knowledge creation in the Netherlands (2.0% of GDP) and Ireland (1.4% of GDP) does not justify that conclusion. The low R&D performance of a substantial number of MNEs in the host country contributes to the relatively low rate of knowledge creation in Ireland and the Netherlands.

The KNOGG model clearly points to the alternative 'imitation' growth path for Hungary, Slovenia, Greece, Ireland and, to a more limited extent for the Netherlands. These economies must leverage the potential of their STI policies to make the transition to the higher path of 'innovation' growth. Explicit policies must be put in place to acquire and absorb technology from external as well as internal sources. The role of bridging institutions and intermediaries is critical. A relatively high proportion of the industry-oriented segment of the national S&T budget should be allocated to knowledge diffusion measures. The rest of this section contains a critique of the industry-oriented policies that individual countries are pursuing in their search for knowledge-based growth.

7.2 Finland

Finland is currently the role model for countries trying to close the technology gap with advanced economies. It is a small country that had few large companies with R&D capability, a limited number of medium-sized companies and many small companies with low innovation capability. Finland is a more interesting case-study in many respects than countries like Ireland that have achieved economic convergence through the medium of FDI. Finland set itself clear and demanding development targets at the start of the 1980s and pursued them with vision and considerable success even through the recession period in the early 1990s.

Ambitious public expenditure targets for Science and Technology were set. Incentives were offered to the private sector to upgrade its technological capability. Tekes devised its Technology Programmes, not as a subsidy for individual firms, but as an instrument to develop networks and promote linkages between SMEs and large firms. They have proved to be a very effective package of measures for boosting private R&D. They account for nearly half the Finnish industry-oriented innovation support budget and are probably the most successful programme of their kind. They appear in the barchart (Fig. 6.1) in the category of R&D support for individual firms, but they also qualify for inclusion under two other headings, namely R&D Co-operation and Knowledge Diffusion. Technology Programmes promote development in specific sectors of technology or industry and provide a conduit for the flow of research results to business. The Tekes Technology Programmes have also become an instrument for co-operation, for networking, and for promoting private sector R&D.

Finland was an early adopter and a enthusiastic exponent of the National System of Innovation doctrine. A well-funded Cluster programme has been a cornerstone of industrial policy since the mid-1990s. Cluster programmes are extensive R&D supports that involve several sectors of the Finnish economy. The aim of these clusters is to accumulate and transfer knowledge, in chosen fields, by promoting co-operation among various actors including both the producers and users of knowledge. They also aim to break boundaries between different sciences and fields of expertise and hence to stimulate innovation. Thus the focus is on strengthening the general business environment for enterprise. Successful clusters have developed in ICT, the forest industry, metals and engineering and in knowledge-based services. Cluster programmes are shown in the Barchart as instruments of technology diffusion but they also qualify as R&D co-operation measures. The Centres of Expertise are part of a complementary programme that enhances competitiveness by addressing weaknesses in the structure of production in the regions.

All these programmes have a core R&D dimension but they are also instruments for diffusion and for co-operation and thus serve to enhance the Finnish system of innovation . Direct R&D support to companies is delivered through credits and loans (CLOAN and SLOAN) and through Tekes R&D grants.

Another cornerstone of Finnish technology policy is a commitment to putting technology at the core of SME business strategy. This goal was pursued with the same energy and enthusiasm as a belief in the imperative of a dynamic system of innovation. Finland was an early convert to the BUNT philosophy, that was launched in Norway in 1989 and incorporated into the EU SPRINT programme under the rubric Managing the Integration of New Technologies (MINT). Finland also adopted a further development of MINT embodied in a subsequent EU initiative, namely Innovation Management Techniques (IMT). These measures are delivered in Finland under the umbrella of the Technology Consulting Services programme.

Special steps were taken in Finland to address what has proved to be an intractable problem for many countries, that is, how to enable SMEs to absorb technology from external sources. Tekes recognised that it had to tackle a capability deficit in both the technology service providers and in the technology service users. The Technology Clinics are an innovative and very successful initiative which is focussed, not on firms but on technologies and these technologies must be new to the Finnish SME sector. The clinics are delivered to clusters of SMEs and this contributes to the learning experience as well as to the cost-effectiveness of the programme.

Technology diffusion measures are demand-driven and much more difficult to implement than supply-driven measures such as R&D subsidies or venture capital supports. Government agencies do not have a good record of success in this area. The services of intermediaries as well service suppliers are normally needed. Finland's record in designing and implementing successful technology diffusion mechanisms is unequalled. In addition to the technology Clinics it operates a sophisticated technology transfer programme (TTRANS) that provides intermediary and brokerage services to firms.

The distinctive feature of the Finland's portfolio of industry-oriented innovation supports is that they form an integrated package addressing all aspects of the innovation process: knowledge-creation, knowledge distribution, knowledge acquisition and finishing with knowledge application. Many of the initiatives, through their design and delivery mechanism, have a pervasive impact across the innovation spectrum. This is a sphere of activity in which Finland has been uniquely successful.

7.3 The Netherlands

A distinctive feature of the Dutch industrial landscape is the existence of a number of world-class MNEs. The MNE sector in the Netherlands is different from the foreign-owned sector in catch-up and late industrialising countries in so far asit has six large home-based multinations. These Dutch MNEs are not manufacturing branch plants but fully integrated businesses with a full range of business functions including R&D and marketing. They are thus dynamically linked into the Dutch innovation system and contribute over 40% of BERD.

The Netherlands, like Finland, is a world class economy, clearly confirmed by its 3rd place in the Current Competitiveness index of the World Economics Forum 2001. In the 5-year Growth Competitiveness index, however, it has fallen to number 7, largely because of a 14th place in the technology component of that index. The Netherlands also performs strongly in the attached Innovation Scoreboard 2001. A strong overall performance in knowledge creation and knowledge application is somewhat marred by a relatively weak international position in Business R&D (BERD). The Netherlands fell below the EU average for BERD but is a clear leader in the provision of early-phase and growth-phase venture capital to business.

The Netherland's barchart (Figure 6.2) is rather similar to that of Finland in so far as more than 70% of the country's industry-oriented innovation support appears to be directed towards knowledge creation. It is surprising therefore to discover that the value of the BERD indicator, at 1.05% of GDP,is below the EU average. The knowledge-creation capability of Dutch industry is depressed because the host MNEs in the Netherlands, as is the case generally, locate their R&D function at their home base

The proportionately high level of support for knowledge creation cannot be interpreted as evidence of a technology-push strategy because many of the R&D measures satisfy a technology diffusion policy objective. There is a trend away from single company support and a move towards forming centres of excellence as a focal point for funding. This is linked to a policy of improving the interaction between industry and public sector research organisations. As a result the R&D supports contribute to inter-firm and firm-to-research base co-operation and to the diffusion objective of industry-oriented innovation policy.

The range and richness of non-R&D innovation supports is a feature of the Dutch barchart. Overall there are nine diffusion-oriented programmes, many well established and most tailored to meet specific Dutch needs. Syntens (formerly Innovation Centres) is best known outside the Netherlands as one the earliest SME support measures in Europe. It is an integrated technology strategy initiative designed to improve the innovative capacity of SMEs. The programme is based on a network of 18 regional centres and has been through many evolutions in its 20 year history. On the other hand, the Technology Top institutes are new and their focus is on particular areas of technology. They are well-funded, industry-driven initiatives that co-ordinate and exploit existing sources of expertise. Furthermore, in selected areas of national importance, such as Maritime Research and Environmental Technology, there are specific programmes for stimulating knowledge transfer from research institutes to firms.

Research co-operation is a priority funding area in the Netherlands. The two most extensive measures are the Technology Co-operation initiative and a programme, aimed specifically at SMEs, to promote the introduction of new technologies. These two programmes share over Euro100 m per annum. In general, the Netherlands has adopted a bottom-up approach to industry innovation funding: clustering and networking of SMEs are seen as the best avenues to improved competitiveness.

The headings Human Mobility and Improving Technology Absorption register only one entry on the Dutch barchart but the policy objectives of these two categories are, to a considerable extent, met by initiatives appearing under other headings. The intermediary role of Syntens enhances the innovation capability of firms, as does the overall priority given to stimulating the networking of firms. There is a human placement programme (Knowledge Carriers) to transfer tacit and codified knowledge to SMEs, using graduates and post-doctoral personnel from technical colleges and universities.

In conclusion, this analysis found that the Netherlands has a comprehensive portfolio of innovation supports, substantially covering all activities of the innovation policy spectrum. The success of Dutch innovation policy is reflected in the EU Innovation Scoreboard and in the World Economics Forum indicators. The emphasis on industry clusters and on the system of innovation philosophy is not as overt as was the case for Finland. But the delivery mechanisms for the industry programmes are oriented towards the support for consortia rather than for single firms, for centres of excellence rather than stand alone projects. There is evidence that a lack of innovation culture may be impeding entrepreneurial high-tech start-ups and that business expenditure on R&D is rather weak in international terms. The latter problem may be related to the dual industry structure, with separate foreign-owned and indigenous segments. Innovation culture on the other hand may be a function of social learning and capability building and is unlikely to have any short-term solution.

7.4 Ireland

Ireland performs well on most indices of innovation and competitiveness. Its position, at number 11 out of 75 countries in the World Economics Forum 2001 ranking, is creditable and would have been much better but for a lowly 28th place in the technology component of that index. Ireland also performs quite well on the Innovation Scoreboard 2001, although not at the same level as Finland and the Netherlands. Its performance is above average in the technical quality of its human resources and in the transmission and application of knowledge but weak in knowledge creation. Public expenditure on R&D is particularly weak and BERD is at the same relatively low level as the Netherlands.

The Irish barchart is unexceptional in so far as it shows that, as was the case for Finland and the Netherlands, Ireland spends more than 70% of its industry-oriented innovation budget on knowledge creation. It could be argued, however, that in Ireland's case, a higher allocation of resources to technology acquisition and diffusion would be appropriate. In other words Ireland should hold an intermediate position between the strong and the weak countries in Table 7.1. Ireland has experienced great difficulty in expanding its base of R&D performing SMEs and this has been attributed to an inherent lack of technology absorption capacity and innovation capability.

Ireland did have a number of well-funded, non-R&D, innovation support initiatives in place during the 1990s. These included a Technology Acquisition (Licensing) Programme, a Technology Partnership Programme and a Programme in Advanced Technologies (PATs) attached to the HE sector. The PATs engaged in industry-oriented research but they were also mandated to assist SMEs with technology transfer services such as consultancy, demonstration and specialised training. A National Technology Audit Programme was launched in parallel with the MINT and IMT initiatives elsewhere in Europe. This was intended to be an integrated technology strategy programme but it had serious limitations in design and implementation. All the programmes mentioned in this paragraph were either discontinued or scaled down at the end of the decade

There have been many industry policy recommendations for Ireland to pursue a more focussed industry cluster strategy. But because of the critical role of Ireland's foreign-owned sector and the propensity of that sector not to engage in any dynamic way with the indigenous system of innovation these recommendations have not been proceeded with. A Pilot Inter-firm Co-operation Networks programme was introduced in 1996 and ran for a number of years.

Two human mobility programmes also operated during the 1990s. The Techstart Programme placed young technical graduates in SMEs for a year, with a view to giving low capability firms a window on the world of science and technology. The Techman programme place experienced technologists in SMEs for a 3-year term to undertake significant product development /innovation projects. Both these programmes achieved a considerable amount but they had serious shortcomings and were discontinued in 1999. The main deficiency was that they tended to isolate the placements and leave them without technical supervision or the support of technical colleagues in low-innovating SMEs. The Irish programmes contrast unfavourably with better designed human placement programmes, such as the UK Teaching Company initiative.

Table 7.2 shows how the balance between knowledge creation and knowledge diffusion resource allocation changed for Ireland after 1999.

Table 7.2 Ireland's Industry-oriented Budget Resources to R&D and Non R&D Measures in Successive Periods

	Knowledge Creation % of Budget	Knowledge Diffusion % of Budget
Average p.a. (1994-1999)	49.6%	50.4%
Average p.a. (2000-2006)	78.0%	22.0%

Ireland is currently pursuing a dedicated policy of revolutionising its commitment to research. R&D as a percent of GDP currently stands at a lowly

1.5%: the target is to increase this to 3% of GDP by the end of the decade. There are serious dangers in trying to achieve this goal without a parallel improvement in the technological capability of the industry base. Otherwise the fruits of the enhanced research output are likely to flow out of Ireland, probably to the US and Japan.

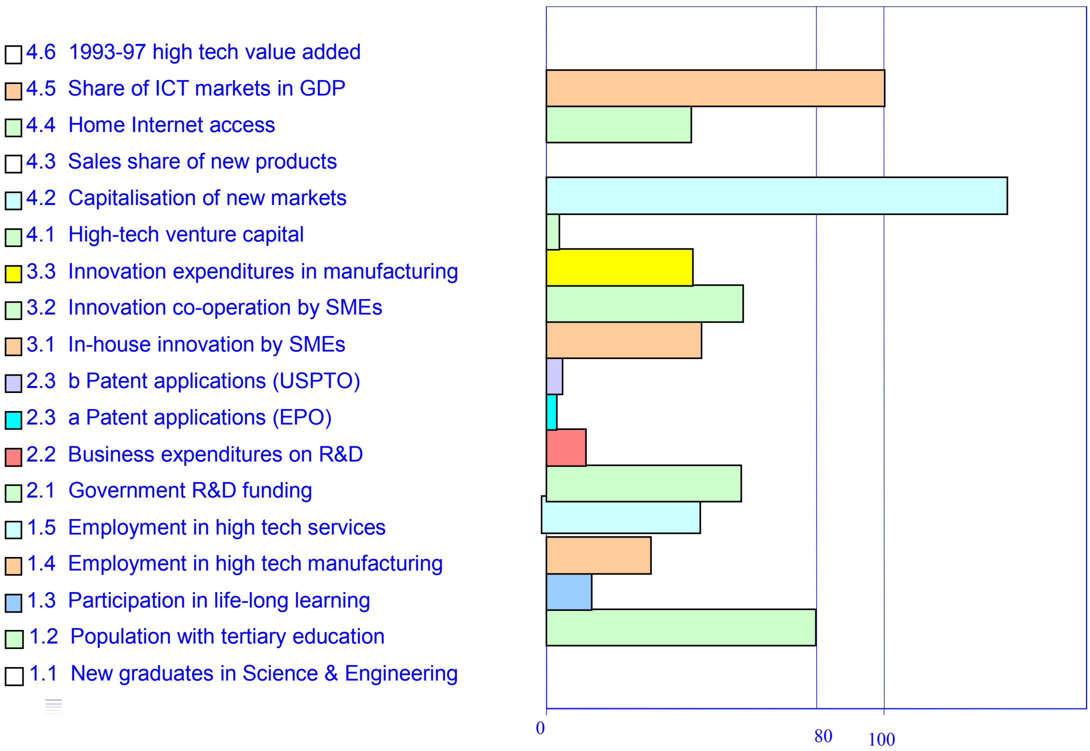
7.5 Greece

The Greek barchart indicated an average annual public expenditure on industry-oriented support measures of 0.2% of GDP. This level of expenditure is in line with the spend by high-performing KNOGG member states in relative terms but falls well behind in absolute terms. Greek public expenditure includes, in addition to exchequer funding, considerable transfers from EU Structural Funds. About 50% of industry-oriented innovation supports are allocated to knowledge diffusion/application and this is in line with expectations for technologically weak economy.

The WEF Global Competitiveness Report 2001 ranked Greece 36 out of 75 countries by its Growth Competitiveness Index, the lowest of the KNOGG member countries. Greece was positioned in 38th place for the Technology component of this Index. The DG Enterprise's Innovation Scoreboard 2001[20] indicated a poor Greek performance, falling more than 20% below the EU average in 13 of the 15 indicators entered for Greece, as can be seen in figure 7.2.

[20] Results for all KNOGG countries are shown in Annex A.

Figure 7.2 Greece Innovation Scoreboard 2001 (EU=100)



The Scoreboard's Summary Innovation Index (SII) ranked Greece second from bottom of the EU league, but there was some redemption in the fact that the Greek SII trend over the period 1995/1997 to 1999/2000 proved the strongest in the EU, suggesting 'catch-up' potential.[21]

The Innovation Scoreboard listed Greek's four major 'relative weaknesses' as :

- public (i.e. GOVERD & HERD) & Business R&D (BERD)
- high-tech patenting
- innovative SMEs
- internet access

The Greek BERD was particularly low at 0.13% GDP[22], and its trend was negative. Increasing the BERD level is clearly a major challenge for Greek STI policy makers. Improving public expenditure on R&D is relatively straightforward but it is more difficult to induce an appreciable increase in company spend on R&D.

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[21] Roughly half of the leading slots for the trend results are occupied by countries that are below the EU average in many indicators.

[22] This makes BERD only 25% of GERD.

The low BERD for Greece goes hand in hand with the low Greek score of 0.3 researchers in business per 1,000 Labour Force compared with the EU average of 2.3. Patent scores are also low, as are the values of the SME innovation indicators.

Greek STI policy has, in its PAVE Programme, an established instrument for the direct promotion of research in enterprise. This has been systematically reviewed each year since 1986 and, uniquely among STI programmes, it has been evaluated twice. It was re-launched as PAVET (depicting a new emphasis on Technology) and a specific PAVET-NE has been introduced to target new enterprises in 2001.

For weaker firms, lacking in-house research capabilities, the only option appears to be co-operative or contract research with public (or private) research organisations and this is unlikely to prove a realistic alternative path.

The culture gap between SMEs and the Higher Education sector places an unfair onus on academics to be proactive in HE-Industry liaison. This is very much the case in Greece where universities are still firmly set in the traditional mode. The recent transfiguration of the Technical Educational Institutions[23] into Higher Education Institutes suggests that they, too, may be distancing themselves from the grind of industry.

Only prestige flagship programmes such as EKVAN are guaranteed to engage the academic community. EKVAN promotes substantial, long-term, collaborative projects in cutting edge research. Complementary programmes to encourage academic entrepreneurship include PRAXE and TANEO introduced to support high-tech, HE spin-outs and access to venture capital. A new scheme entitled ELEFTHO was introduced in 2001 to support the development of incubators and S&T parks.

Greece has a number of established public applied-research institutes but they operate in low-tech sectors such as metallurgy, textiles, ceramics, marine and agriculture. The technological infrastructure does include high-tech research institutions such as the research organisations of FORTH (Foundation of Research and Technology Hellas)[24] but these specialise in basic research in Biotechnology, Informatics, Transportation and Chemistry.[25] Greece lacks applied research organisations of a stature capable of bridging the divide with basic research and spawning new sectors in the Greek economy. Initiatives such as YPER (Targeted Research Scholarships Programme) and PENED (programme

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[23] These are the equivalent of the Polytechnical Colleges of other countries.

[24] FORTH was split into two organisations in 2000 with the partner CERTH (Centre for Research and Technology Hellas) operating in Thessaloniki in Northern Greece.

[25] Forth develops Science and Technology Parks in collaboration with the University sector.

for the enhancement of scientific manpower) have been launched to increase the pool of doctoral talent in industrial research and there is an interesting programme called ENTER that targets researchers in the Greek diaspora. But such endeavours are in danger of being top-down.

The disappointing BERD performance suggests that many firms may not possess the competence to exploit research co-operation opportunities. In this case policy measures on the diffusion/application side of the barchart must be brought into play. In particular, firms operating at low capability levels require 'hands-on' support measures. At the most basic level is a requirement for a continuous commitment to enterprise training. The recently published Enterprise 2002 scoreboard highlighted this as a weak area of the Greek NIS.[26]

More specifically, firms need help in enhancing their absorptive capacity – the 'imitative' ability to adopt and modify already commercialised external technology (TT) and the more creative ability to commercialise external research results from HE and public research institutions. Greece has brought forward several measures to enhance absorptive capacity. The PAPHOS initiative encourages benchmarking and the assimilation of best practice and world-class technologies. PEPER promotes the participation of Greek firms in large-scale demonstration and TT programmes. Efforts to establish full-time, private intermediaries and technology brokers have not proved successful but the government continues to experiment. A new scheme called AKMON (Research Centres Development and Services Supply Projects with User Participation) was launched by the GSRT in Jan 2001 aimed at encouraging public sector research institutions (PRIs) to provide technical, research and advisory services. Thirteen regional Centres of Entrepreneurial and Technological Development (KETA) were opened in 2001 to provide information and consulting services to companies. An emphasis on the information society and the 'new economy' is reflected in the new CSF (EPET III) which contains initiatives such as the 'Network Yourself' programme, encouraging the uptake of e-business ICT s by SMEs. There is also a placement programme, IRON, which introduces research graduates into enterprise.

Clustering is another important policy instrument to facilitate learning in enterprises. EKVAN's support for R&D in "high economic interest areas" is felt to be the programme closest to this objective. Co-operation among HE, RTO and Enterprise was envisaged, but, to date, there has been little evidence of cluster formation. The Technology Brokers initiative includes an incentive for the networking of technology providers.

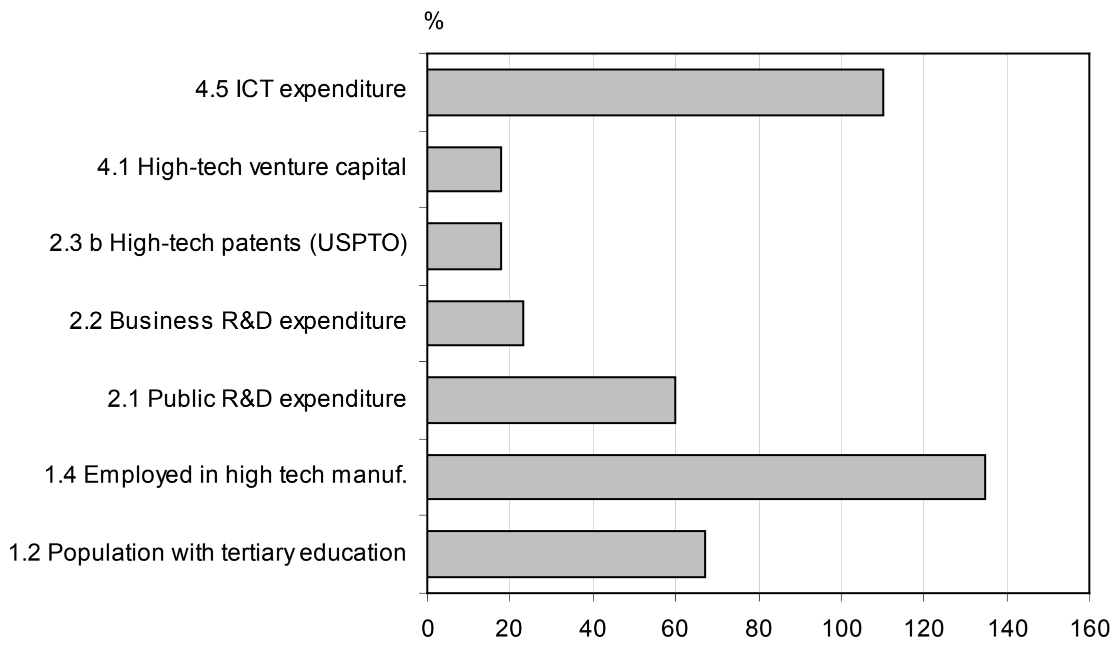
[26] Training is a Greek example of where lack of policy co-ordination has impeded a measure: enterprise training suffered because it was, until recently, split between the two Ministries, Labour and Education. A new co-ordination body has recently been agreed with the social partners.

To summarise, the Greek NIS would appear to have most of the standard innovation policy instruments in place, but the disappointing Scoreboard indicators show that they are not achieving the desired objectives. Commentators have criticised the lack of clear policy vision and focus from the top. This is compounded by the absence of a strong executive STI agency that can interact directly with firms and encourage them to take up the supports on offer. The absence of such an agency leaves a vacuum with respect to monitoring the impact of policy initiatives and inhibits the prospects of getting accurate and swift feedback.

7.6 Hungary

The WEF Growth Competitiveness Index ranked Hungary 28th out of 75 countries with a 21st position ranking on the Technology component. Hungary has seven entries in the 'Simulated Innovation Scoreboard'[27] as shown in figure 7.3

Figure 7.3 Innovation Scoreboard Indicators: Hungary (EU=100)[28]



[27] See DG Enterprise (2001), Innovation Policy in Six Candidate Countries. Results for Slovenia and Hungary are presented in table A1 in Annex A.

[28] In this Simulated Scoreboard values for EU are simple averages, rather than weighted averages that take the relative size of country economies into account.

Source: DG Enterprise (2001), Innovation Policy in Six Candidate Countries [all data relates to 1999 except for 1998 USPTO data].

Two indicators are above the EU average – employment in high tech manufacturing and the percentage of GDP accounted for by ICTs.

Most high tech industries in Candidate Countries (CCs) specialise in low value-added industry segments. Hungary's 1999 BERD as a percentage of GDP (0.26%) is only one third of the Slovenian level, lending credence to the 'hollow high tech' conjecture. Hungary has a considerably greater share than Slovenia of high tech products in manufacturing exports (21%) but this derives from its sizeable FDI stock[29] which is known to conduct very little of its research in Hungary.[30] A more revealing measure would be the percentage of high tech products in the exports of indigenous Hungarian firms.

The collapsed BERD performance comes after a proud record of investment in Science & Technology spanning several decades. 1989 marked not only a year of important political changes in Hungary, but also the first year that GERD dipped below 2% of GDP. In the early transition years both public and business expenditure on R&D fell away sharply and remained at a low level through the later 1990s.[31] BERD was particularly badly affected as collapsing markets and shrinking profits forced companies to concentrate on short-term survival. The shrinking BERD resulted in the Government's share of GERD reaching 65% by 1993. In 2000, when GERD had recovered to 1% of GDP, government funding still accounted for over 60%.

The political transition saw the total number of researchers plummet to 60% of 1988 levels. The enterprise sector took the brunt of the casualties. In 1988 40% of researchers were employed in Business; today the figure has only recovered to 30% of researchers.

The main R&D funding for firms is allocated by the Ministry of Education (OM) through the Central Technological Development Fund (KMUFA).[32] Raising the level of BERD has proved a daunting challenge. Most companies are focused on upgrading their production operations in terms of efficiency and quality and are more interested in consultancy services than in R&D. Tightened profit margins

[29] Hungary is an active FDI destination, achieving over three times the FDI inflow rate of Slovenia in the late 1990s [World Development Indicators 2000].

[30] Data for 1997 indicate that, in Hungary, FDI's share of turnover was 66%, and share of BERD was 77%; hence the research intensity of FDI is only marginally greater than that of indigenous industry.

[31] GERD reached its nadir in 1996, slumping to 0.67% of GDP.

[32] A Technological Development Fund was originally set up in 1959. This attracted matching funds from industry eager to use the research results. A National Committee of Technological Development (OMFB) was set up in 1961 to manage the Fund. In 2000 this Committee was downgraded to a technology policy advisory body, the R&D Division of the Ministry of Education.

constrain their options and an under-developed capital market makes it difficult to access external funds for R&D projects. Of the large state companies, traditionally prime customers of research institutes, many have disappeared[33] and others have switched to sub-contract work for MNEs in which case research ceases to be an imperative.[34]

The government offered tax concessions to the MNEs to encourage them to perform more R&D in Hungary. Since 1997 a number of MNEs have increased their R&D spend or established new research units. Most research is connected with production in the local affiliate, some is performed for corporate consumption.

The government is trying to encourage more R&D operations by offering favourable loans worth up to € 2m for R&D projects that guarantee employment for 30 researchers for a minimum of 3 years. A ray of light in the enterprise R&D story is the fact that the overall number of company research units began to increase again from 1996, and, by 2000, had recovered to 1988 levels.[35]

Policy measures to promote the development of positive framework conditions for new technology-based firms (NTBFs) include financial support for industrial parks.[36] The leading industrial park, operated by an Austrian-Hungarian joint venture, is situated in Györ near the Austrian border and offers a high quality industrial environment with dynamic educational institutions for its current complement of 32 enterprises. In 1999 The National Committee for Technological Development (OMFB) instituted the TECH-START scheme to promote the creation of NTBFs in new growth areas. It is planned to extend this scheme as part of a broader regional innovation programme promoting spin-off companies and cluster development.

Economic conditions in Hungary (low inflation, dynamic economic growth, developed financial institutions) are becoming favourable for the development of a risk capital market and the establishment of venture capital companies. To date, the scarcity of capital has constrained this development. Another problem for innovation policy makers is that present regulations governing venture capital orient the flow towards lower risk, large company projects.

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[33] A very few (notably, large Pharmaceutical companies) had sufficient strengths in depth to survive by relying on in-house research capabilities.

[34] Both the companies and government are aware that such a strategy can lead to entrapment in non-innovative activity if not properly managed

[35] The culling of inefficient industry research units in the early transition period in parallel with the decline of traditional business activities was followed by the development of new independent R&D facilities in other sectors.

[36] Technology Parks in the original strict sense of this concept (ie joint ventures between government and private enterprise) do not exist in Hungary.

In the pre-1989 era there was a high degree of openness between the worlds of research and industry as the original matched funding of the Technological Development Fund testifies. The build up of FDI has been adduced as one reason for the marked diminution in this open relationship in the post transition period. The reduced state of both public research and industry demand has undoubtedly been a much greater factor in the current limited interaction. Research institutes under the aegis of the Hungarian Academy of Sciences (MTA)[37] and university research laboratories suffered heavily from the large budgetary cuts and the huge drop in industry demand, but the sectoral industrial research institutes were decimated. Today, apart from the Agriculture, Food & Forestry sector, companies have sporadic contracts but few systematic relationships with public research institutes. The universities sought to maintain their former strong relations with surviving large enterprises which now represent an important alternative source of research finance.[38] In an effort to broaden this academia-industry collaboration the R&D Division of the Ministry of Education has redesigned its R&D schemes to promote linkage and most HEIs now claim relations with industry.

The major government initiative to promote research co-operation is the Co-operative Research Centres (CRCs) programme, launched in 1999. This was based on a similar US policy instrument. Its major aim is to foster strategic, long-term co-operation between higher education institutions, other non-profit R&D units and businesses. Five consortia have been approved to benefit from a subsidy pool of HUF 1083m to undertake projects of 3 to 4 years duration.

While hard times help to focus research institutions on market needs there is a danger that excessive curtailment of public funding may force them to deploy all their resources in the delivery of low level, routine technical services. The Zoltan Bay Foundation for Applied Research has sponsored new applied research institutes based on the German Fraunhofer model which is guaranteed a substantial level of public funds[39] and the latitude to pursue high level applied research to renew its knowledge capital.

The EU RTD Framework Programmes IV & V have provided another opportunity for Hungarian public research institutions to renew their knowledge assets. These Framework Programmes have also been an important collaboration resource for Hungarian firms wishing to upgrade their production quality or develop new products. Hungary also participates in other international

[37] These institutes traditionally focused on basic research.

[38] From the innovation policy maker's perspective, one benign result of the straitened transition experience has been that both universities and MTA institutes were forced to adopt a more market-driven approach to research.

[39] The anecdotal figure is 2/3 of its costs (ie from federal and lander sources combined).

technology fora including EUREKA, COST, CERN and the scientific programmes of NATO.

Mobility of senior staff between research institutions and industry has not been a feature of HE-industry relations in Hungary. The predominant mobility has been within these two sectors.[40] There are no specific placement schemes in operation based on the UK teaching company model.

Research co-operation between MNEs and the research infrastructure has been minimal. The ICT sector is an exception where firms such as Ericcson, Nokia, Sony and Knorr-Bremse have located their R&D labs in universities like the Budapest Technical and Economic Sciences University. Some of the large scale M&As, notably General Electric's acquisition of Tungsram, were patently research based. However, the general run of greenfield MNE projects are more interested in recruiting researchers than in accessing indigenous research results. For these MNES, the extent of their co-operation has been a contribution to the design of college curricula to fast-track graduates in sectors where skills are in short supply.

Capability-building in firms is supported by government on a number of fronts. The education system has boosted the output of third level graduates, up from 76K full time graduates in 1990 to 172K in 2000. Efforts are in hand to dismantle the rigid 'Prussian' education bureaucracy to achieve a more flexible delivery system and a curriculum that develops the skills required in a global, knowledge-driven economy.[41] EU Phare funding is being used to introduce new third level courses in Innovation and Technology Management and overcome the difficulty in securing qualified teaching staff.

Intermediary organisations such as the Hungarian Innovation Association, the Hungarian Centre of Technology Transfer, and the National Business and Innovation Center have been established to provide information and consultancy services to firms seeking to upgrade their capabilities. The Széchenyi plan[42] included a proposal for the development of a BUNT-like programme to teach the specific consultancy skills and innovation management techniques (IMTs) that business firms require to integrate their technology and business strategies

Increasing linkages between indigenous sub-suppliers and the burgeoning MNE population has been high on the policy agenda. The INTEGRATOR scheme was launched in 1999 to build up the capabilities of the sub-contracting firms. An MNE (the 'integrator') and its potential suppliers (a minimum of two SMEs)

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[40] A worrying statistic is that 60% of researchers who go abroad to complete their studies do not return.

[41] MNEs have complained that they had to spend months acquainting recruits with modern production practices.

[42] Széchenyi Green Paper (National Development Plan 2001-2002).

apply jointly as a consortium to undertake a joint technological development project of 1 to 2 years duration. To date 26 consortia have been funded at an average rate of HUF 20 m.

This policy review has addressed the main initiatives contained in the S&T policy 2000 document, launched by the Ministry of Education and TMA in 2001 as an integral part of the Széchenyi Plan. A change of government took place in mid-2002 and new STI measures are expected. It is anticipated that one of the major commitments of the new administration will be an increased effort to enhance the STI capability of MNEs in Hungary.

7.7 Slovenia

The Slovenian barchart indicated an average annual public expenditure of 0.11% of GDP on industry-oriented support measures. This level of expenditure places Slovenia towards the lower end of the KNOGG member table. About 46% of industry-oriented innovation supports are allocated to knowledge creation but, unlike other KNOGG members, this is predominantly allocated to enterprise R&D and none toward the promotion of risk capital markets.[43]

The WEF Global Competitiveness Report 2001 ranked Slovenia 31st out of 75 countries by its Growth Competitiveness Index, with a 30th position ranking on the Technology component of this Index. The overall ranking was just slightly in the wake of Hungary (28) but the technology rating lagged that of Hungary (21) by a greater margin.

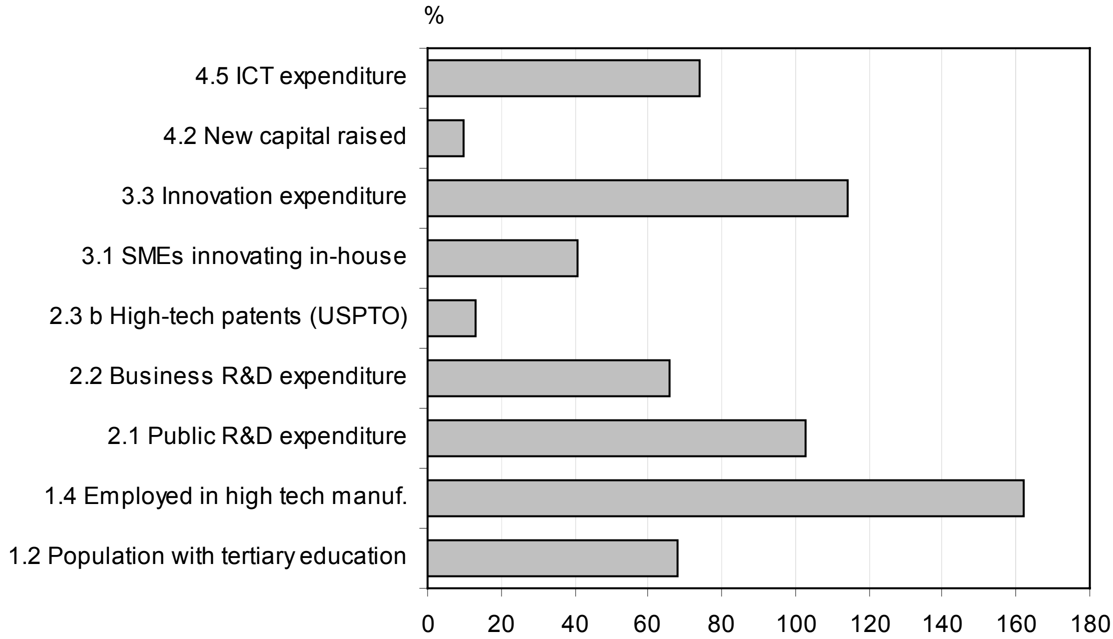
Slovenia has nine entries in the 'simulated Innovation Scoreboard'[44] compiled by the DG Enterprise (2001). Slovenia and Poland were the only two Candidate Countries (CCs) with innovation performance statistics available.[45]

[43] The DG Enterprise (2001) study Innovation Policy in Six Candidate Countries [commissioned for the FP5 Innovation/SMEs Programme] found that, with the exception of Poland, the capital market, and venture capital in particular, remained heavily underdeveloped in candidate countries.

[44] See results for Slovenia and Hungary in table A1 in Annex A.

[45] The general absence of data in this 'transmission and application of knowledge' section of the Scoreboard is indicative of the former lack of emphasis on enterprise innovation in the CCs.

Figure 7.4 Innovation Scoreboard Indicators: Slovenia (EU=100)[46]



Source: DG Enterprise (2001), Innovation Policy in Six Candidate Countries. [all data relates to 1999 except for 1998 USPTO patent data].

In terms of indicators above the EU average, Slovenia, with three leading indicators, was best placed of the six Candidate Countries in the study. The Scoreboard shows a high relative percentage of employment in high tech manufacturing, a high innovation intensity (spend on innovation as a % of sales), and a solid public sector R&D performance.

These results need to be more closely scrutinised in the light of specific country circumstances. In CCs 'high tech' industries tend to be specialised in low value-added segments, a fact borne out, in the case of Slovenia, by the low BERD and patenting scores. IMD data shows that value-added per employee in Slovenian manufacturing and service industries was only a third of the EU level in the period 1999-2001. World Bank data for 1998 show that the percentage of high tech products in Slovenian exports was only 4% compared with 21% for Hungary.[47]

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[46] In this Simulated Scoreboard values for EU are simple averages, rather than weighted averages taking the relative size of country economies into account.

[47] World Development Indicators 2000.

The strong Slovenian innovation intensity indicator is driven by a small number of highly innovative small firms and a few innovative large firms, and masks the gulf between this dynamic group and the majority of non-innovating SMEs. The Slovenian innovation survey found that over 60% of manufacturing firms performed no product innovation in the period 1997-1998 and 84% performed no process innovation. Another caveat attaching to the innovation score is the low share performed in co-operation with external firms or research institutions. Anecdotal evidence suggests a low incidence of co-operation in Slovenia.[48] This can mean that the quality of the innovation is impaired.

A public dominated R&D system has been a characteristic of the candidate countries who traditionally relied on large state-owned research institutions while firms concentrated on production. Transition to a market economy posed an enormous challenge for these large research institutions when privatised and forced to survive in the market. The sudden withdrawal of public financial support resulted in many closures, leaving their industrial clients to find other immediate sources of research services while they endeavoured to build up in-house capability for the longer term.

Slovenia is somewhat unique among Candidate Countries in that it maintained a fairly robust public R&D system throughout the transition. The major casualties of the transition occurred in the privatised business sector. Large vertically integrated conglomerates were broken up and the dismantling of their R&D units led to a mass brain-drain of some 3,000 industrial researchers in the early 1990s.

The Slovenian barchart indicates that 40% of the industry-oriented innovation budget is allocated to direct support for R&D in enterprise.[49] There are two principal support measures operating under this objective. The first measure is a direct project-based R&D subsidy which encourages firms to set up internal R&D units. The second measure is the Research Group Programme financing scheme that guarantees a five-year budget (2000-2004) to 300 research groups to carry out rigorously vetted projects. While the bulk of this research is of a basic or strategic orientation it was estimated that 10% of the budget reaches enterprises for industrial research projects.

Clearly, the public financial support for enterprise R&D has not yet succeeded in leveraging enterprise performance. The Scoreboard indicates a low Slovenian BERD level (approximately 66% of the EU average) and a very modest patent performance (20% of the EU average). The number of researchers in the business sector per 1,000 Labour Force is 0.7 compared with an EU average of 2.3.

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[48] Neither slovenia nor Poland measured this co-operation aspect in their surveys.

[49] In a wider context public funding of GERD has been dropping; its share was 48% in 1993 and 37% in 1999. [The government objective for GERD is 3% GDP by 2010 with government funding 1/3].

One key area of the innovation system where Slovenia is on a steep learning curve is the ability to generate ‘new capital’[50] to support the cohort of new innovative firms needed to spearhead the restructuring of their enterprise sector. The Scoreboard shows that Slovenia lags well behind European countries in the availability of capital for new innovative firms. Banks remain the major source of long-term financing.

The 1997 OECD Economic Survey for Slovenia pointed to light, high-tech industries as a potential area of competitive advantage. Industry has traditionally been concentrated in medium-technology transport and chemicals sectors. One initiative in the government’s effort to upgrade its industrial structure is the sponsoring of Technology Parks to assist new technology-based firms (NTBFs) in their early years. Ljubljana and Maribor parks are the flagship projects. A further initiative is financial support for incubator centres attached to universities and research institutes.

Co-operation between actors is a central tenet of the NIS approach. To galvanise co-operation in the Slovenian NIS the government has established a scheme to promote joint projects involving at least three companies and a knowledge institution. Projects can relate to international markets, joint development of new products, processes or services, or programmes to assist firms develop niches in production chains. In a second initiative the government has followed up a pilot study on industrial clusters with a two year subsidy programme to promote ongoing development of clusters. These clusters will embrace large firms, SMEs and research institutes.

The Candidate Countries have a tradition of strong investment in education but they placed the emphasis on participation rates at second level and on vocational skills. The innovation scoreboard shows that Slovenia lags Europe[51] by some distance in the percentage achieving tertiary qualifications, a vital cadre to fill the management and technologist positions in the new economy. The 2002 Enterprise Policy Scoreboard casts further light on the trends in tertiary level stocks, showing a healthy output rate for the third level ‘engineering, manufacturing and construction’ grouping in Slovenia, but a relatively low flow of graduates in the ‘science, mathematics and computing’ stream.[52]

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[50] The Innovation Scoreboard refers to ‘new capital raised by domestic firms on domestic stock markets’. Two types are included: capital raised on ‘parallel markets’ plus capital raised by new firms on the main stock exchange.

[51] And the average figure for Europe is less than 50% of the US average [Tertiary graduates: 12 % of the 25-to-64 years old population in the EU versus 27 % in the US (1999)].

[52] Some data for the thirteen CCs is included in this third edition of the Enterprise Policy Scoreboard and this augments the Innovation Scoreboard picture in several areas: venture capital, entrepreneurship, human resources, and innovation & knowledge diffusion.

A Young Researchers Programme was established in the mid-1980s to encourage graduates to proceed to postgraduate research. Today some 300 to 350 fellowships are awarded annually. The mix among MSc degree and PhD holders has shifted. In 1985, of the fellowships awarded, 60% went to PhDs, while today's proportion approaches 90%. In the early 1990s the overwhelming majority of participants went on to fill vacancies at universities or research institutes where working conditions were more attractive than in industry. This poor mobility tradition is beginning to change as new industry sectors offer more attractive careers for qualified research personnel.

Knowledge diffusion from research to industry is a central challenge for Slovenia. Science and Technology are split between two ministries, Education and Economy, and the interface is not entirely satisfactory. R&D efforts, administered by the Department of Education, are heavily focused on academic and human capital objectives to the detriment of applied research and industrial production. Technology policy in the Ministry of the Economy seems to opt for technology importation rather than face the challenge of commercialising locally produced research results. A recent restructuring of the Department for the Development of the Entrepreneurial Sector and Competitiveness at the Ministry of Economy has given hope that this policy stance may be reviewed.

The overall Slovenian STI performance reflects an underdeveloped national innovation system. A rigid policy and research infrastructure has failed to keep pace with the restructuring and institutional reforms in other parts of the economy.[53] There has been a sequence of well-informed plans and parliamentary bills to overhaul the innovation system. These have been repeatedly thwarted, however, by political problems and difficulties in securing the necessary public funds. Resistance is being lead by entrenched interests in the research community, anxious to preserve the current funding bias in favour of 'pure' science. This is happening at a time when the enterprise sector is severely weakened by the post-1990 exigencies.

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[53] Innovation is not included in the chapters of the accession negotiations.

Annex A *Innovation Scoreboard 2001*

No	Indicator	Yr[1]	So.[2]	US	JP	EUtotal	FIN	NL	IRL	GR	Hun	Slov	EU av
1. Human resources													
1.1	‰ S&E grads/ 20-29 pop	99	1	*8.1*	11.2	10.4	10.4	*5.8*	**15.6**				9.32
1.2	% pop with 3rd education	00	1,2	**34.9**	**30.4**	21.2	**32.4**	25.0	22.2	*16.9*	*15.6*	*15.9*	23.25
1.3	Life-long learning	00	1			8.4	**19.6**	**15.6**	*5.2*	*1.1*			9.65
1.4	% empl. h-tech manuf	99	1			7.8	7.2	*4.7*	7.3	*2.4*	8.49	**10.18**	6.29
1.5	% empl. h-tech services	99	1			3.2	**4.3**	3.6	**4.0**	*1.5*			3.27
2. Knowledge creation													
2.1	Public exp. R&D / GDP	99	1	0.56	0.70	0.66	**0.95**	**0.87**	*0.35*	*0.38*	*0.37*	0.64	0.62
2.2	BERD / GDP	99	1	**1.98**	**2.18**	1.19	**2.14**	1.05	1.03	*0.13*	*0.26*	*0.75*	1.14
2.3a	EPO h-tech pats /pop	99	1,3	**29.5**	**27.4**	17.9	**80.4**	**35.8**	*13.3*	*0.5*			19.14
2.3b	USPTO h-tech pats /pop	98	1,4	**84.3**	**80.2**	11.1	**35.9**	**19.6**	*3.8*	*0.5*	*2.08*	*1.52*	11.65
3. Transmission and application of knowledge													
3.1	% SMEs innov in-house	96	10			44.0	*27.4*	51.0	**62.2**	*20.1*		*16.9*	41.01
3.2	% SMEs innov co-op	96	10			11.2	**19.9**	**13.8**	**23.2**	*6.5*			15.42
3.3	% innov exp /total sales	96	10			3.7	4.3	3.8	3.3	*1.6*		3.9	3.41
4. Innovation finance, output and markets													
4.1	‰ vent capital / GDP	00	1,5			1.08	**1.38**	**1.62**	*0.65*	*0.04*	*0.016*		0.09
4.2	% new capital / GDP	99	1,6	**1.9**		1.1	*0.3*	**5.6**	0.9	**1.5**		*0.15*	1.53
4.3	% new-to-markt products	96	10			6.5	7.3	6.9	**8.4**				5.40
4.4	% home internet access	00	7, 8	**47**	28	28.0	**44**	**55**	**36**	*12*			33.40
4.5	% ICT markets / GDP	00	9	5.9	*4.3*	6.0	6.0	6.6	*4.8*	6.0	6.42	*4.31*	5.86
4.6	% h-tech value added	97	1	**25.8**	**13.8**	8.2	**12.5**	7.5	**20.5**				9.50
	Summary Index			*5.6*	*3.8*		*4.7*	*2.9*	*1.2*	-7.9			

1: Most recent data available.

2: So. = Sources of Data:
1 = Eurostat, 2 = OECD Education at a Glance, 3 = EPO, 4 = USPTO, 5 = EVCA, 6 = FIBV, 7 = Eurobarometer, 8 = US National Telecoms and Information Administration, 9 = EITO, 10 = Community Innovation Survey.

3: Indicators (except for the final summary index) that are more than 20 % above or below the EU average are highlighted in bold Roman or in italics respectively.

Note:
The Innovation Scoreboard uses weighted averages shown as EU Total above.
The 'Simulated Scoreboard' for Candidate Countries used simple averages for EU figures as shown in the rightmost column above.

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Glossary

The following abbreviations appear in this publication

ATRP	Advanced Technology Research Programme (Ireland)
AWT	Advisory Council for Science and Technology to the MOCW (Netherlands)
BERD	Business Expenditure on R&D
BUNT	Business Development Using New Technology – launched in Norway in 1989
CBS	Central Bureau of Statistics (Netherlands)
CC	Candidate Country
CIMO	Centre for International Mobility (Finland)
CIS	Community Innovation Survey
CPB	Bureau for Economic Policy Analysis (Netherlands)
CRC	Co-operative Research Centre (Hungary)
CSP	Social and Cultural Planning Office (Netherlands)
DLO	Department of Agriculture Research Institute (Netherlands)
EI	Enterprise Ireland – Development Agency for Indigenous Industry (Ireland)
EITO	European Information Technology Organisation
EPET III	Community Support Framework 2000 – 2006 (Greece)
EPO	European Patent Office
ETLA	Research Institute of the Finnish Economy (Finland)
EVCA	European Venture Capital Association
FDI	Foreign Direct Investment
Finnvera Oyj	Regional Development Fund (Finland)

FORFAS	Policy Advisory and Co-ordination Board for Industrial Development and Science and Technology (Ireland)
FORTH	Foundation of Research and Technology HELLAS (Greece)
FP5	European Union Fifth RTD Framework Programme
GERD	Gross intramural Expenditure on Research and Development
GOVERD	Government Expenditure on R&D
GSI	General Secretariat for Industry, Ministry for Development (Greece)
GTI	Large Technology Institution (Netherlands)
HAS/MTA	Hungarian Academy of Sciences (Hungary)
HE	Higher Education
HEI	Higher Education Institution
HERD	Higher Education Expenditure on R&D
ICI	Inter-departmental Commission for Information Policy (Netherlands)
ICSTI	Irish Council for Science, Technology and Innovation (Ireland)
ICT	Information and Communications Technologies
IDA	Industrial Development Authority – Development Agency for Foreign-owned Industry (Ireland)
IMD	International Institute of Management Development
IMT	Innovation Management Techniques
INNOTECH	Technical University Innovation Park (Hungary)
IOT	Inter-departmental Commission for Technology Policy (Netherlands)
IOW	Inter-departmental Commission for Scientific Policy (Netherlands)
IPR	Intellectual Property Rights
IRC	Innovation Relay Centre
KETA	Centre of Entrepreneurial and Technological Development (Greece)

KNAW	Royal Netherlands Academy of Arts and Science (Netherlands)
KTM	Ministry of Trade and Industry (Finland)
LIFIM	Finnish Institute of Management (Finland)
MEZ	Ministry of Economic Affairs (Netherlands)
MINT	Managing the Integration of New Technology
MNE	Multinational Enterprise
MOCW	Ministry of Education, Culture and Science (Netherlands)
NCRT	National Council for Research and Technology (Greece)
NCTD	National Council for Technological Development (Hungary)
NDP	National Development Plan
NIS	National Innovation System
NITM	National Institute of Technology Management (Ireland)
NOWT	Netherlands Observatory of Science and Technology (Netherlands)
NRDP	National R&D Programme (Hungary)
NTBF	New Technology-based Firm
NWO	Institute for Scientific Research (Netherlands)
OMFB	National Committee for Technological Development (Hungary)
OST	Office of Science and Technology (Ireland)
PAT	Programme in Advanced Technology (Ireland)
PGB	Programme Governing Body (Hungary)
PMT	Participation Companies for New Technology-based firms (Netherlands)
RIVM	National Institute of Public Health and the Environment (Netherlands)
ROC	Regional Education Centre (Netherlands)
RTD	Research and Technological Development

RTDI	Research, Technological Development and Innovation
RWTI	Council for Science, Technology and Information Policy (Netherlands)
SAB	Scientific Advisory Board (Hungary)
SDC	Small Business Development Centre (Slovenia)
SENTER	Executive Research and Innovation Agency (Netherlands)
SII	Summary Innovation Index – EC DG Enterprise Innovation Scoreboard
SITRA	National Fund for Research and Development (Finland)
SME	Small and Medium Enterprises
SMI	Strategic Management Initiative (Ireland)
STC/STPC	Science and Technology Policy Collegium (Hungary)
STI	Science, Technology and Innovation
STPC	Science and Technology Policy Council (Finland)
SYNTENS	SME Support Measure - formerly Innovation Centres (Netherlands)
TDQM	Technological Development and Quality Management Programme – EU PHARE
TE	Regional Employment and Economic Development Centres (Finland)
TEKES	National Technology Agency (Finland)
TNO	Contract Industrial Research Institute (Netherlands)
TRIPS	Agreement on Trade-Related Aspects of Intellectual Property Rights
TT	Technology Transfer
TTI	Technological Top Institute – Centre of Excellence (Netherlands)
USPTO	US Patent & Trademark Office
VTT	Technical Research Centre (Finland)
WEF	World Economic Forum

WIPO	World Intellectual Property Organisation
WP	Work Package (KNOGG Project)
WRR	Scientific Council for Government Policy (Netherlands)

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