RIP-WATCH

ANALYSIS OF THE REGIONAL DIMENSIONS OF INVESTMENT IN RESEARCH

CASE STUDY REGIONAL REPORT: SCOTLAND (UK)

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Case Study Regional Report on the Regional Dimensions of Investment in Research

OBJECTIVE

The main objective of this regional case study report is to provide a better understanding of the structural and techno-economic characteristics of the European region analysed, to present the key factors conducive to increased investment in R&D and to identify the key R&D policy challenges the region is facing.

BACKGROUND

In partnership with DG Research, the Institute of Prospective Technological Studies of the Joint Research Centre (JRC-IPTS) has been conducting a watching brief on policy developments aimed at promoting both private and public investment in R&D (RIP-WATCH). A stated aim of this policy watch activity is to take stock of developments aimed at increasing investments in R&D in the European regions.

In the design phase of the activity, a typology of the European regions was produced. A balanced mix of regions was selected from each of the nine regional types identified, representing fifteen member states of the European Union.

REGIONS COVERED

Phase 1		Phase 2	
1. Andalusia (ES)	2. Catalonia (ES)	11. Bavaria (DE)	12. Corsica (FR)
3. Carinthia (AT)	4. Crete (EL)	13. Emilia-Romagna (IT)	14. Etelä-Suomi (FI)
5. Dél-Dunántúl (HU)	6. Jihozápad (CZ)	15. Lorraine (FR)	16. Midi-Pyrénées (FR)
7. Norte (PT)	8. Sicily (IT)	17. Saxony (DE)	18. Scotland (UK)
9. Styria (AT)	10. Wielkopolskie (PL)	19. Västsverige (SE)	

THE REPORTS

The regional reports are structured according to the following two interrelated dimensions of regional techno-economic systems:

- **Regional knowledge base**, including the research, technological development and innovation (RTDI) infrastructure, human resources, RTDI efforts and outcomes and knowledge-transmission mechanisms in the region.

- **Regional economic structure**, including the productive structure, regional clusters and networks, international position and financial capacities and instruments.

Each report examines these dimensions from two points of view: their current state, as reflected in a selected set of regional indicators, and their policy context (i.e. policy framework, actors, objectives and instruments).

In addition to the regional case study reports, a **synthesis report** will be produced that combines and interprets the information contained in the case study reports. This will present the strengths and weaknesses of the regions covered and the factors that determined the trajectories of development of their R&D and innovation capacities. It will also discuss the main R&D and innovation challenges identified.

The JRC-IPTS launched the second phase of the activity in December 2006 with the contribution of the ERAWATCH Network. The work was undertaken between December 2006 and May 2007 by a project team led by LOGOTECH S.A. (EL) with the participation of Advansis Ltd, (FI), Faugert & Co Utvärdering AB (SE), Fraunhofer Institute for Systems and Innovation Research (ISI) (DE), Institute for Policy and Practice of Centre on Knowledge, Innovation, Technology and Enterprise (KITE) of University of Newcastle (UK), PREST – Manchester Institute of Innovation Research (UK), and Technopolis France (FR).

The regional case study reports produced in the study are now available on the ERAWATCH web-site at http://cordis.europa.eu/erawatch/index.cfm?fuseaction=intService.home

The synthesis report will also be available on the ERAWATCH web-site.

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Abbreviations

MC	Management Committee
PM	Project Management
ToR	Terms of Reference
ANBERD	Analytical Business Enterprise Research and Development Database
BERD	Expenditure on R&D in the business enterprise sector
CASE	Collaborative Award in Science and Engineering
CBI	Confederation of British Industry
DTI	Department of Trade and Industry
EPO	European Patent Office
GBAORD	Government budget appropriations or outlays for R&D
GDP	Gross domestic product
GERD	Gross Domestic Expenditure on R&D
GUF	General university funds
GVA	Gross Value Added
HEI/HE	Higher Education Institution/Higher Education
HERD	Expenditure on R&D in the higher education sector
HESA	Higher Education Statistics Agency
ISIC	International standard industrial classification
IPTS	Institute of prospective Studies, Seville, Spain
ITI	Intermediary Technology Institute
NACE	Nomenclature générale des Activités economiques dans les Communautés Européenes
N.E.C	Not elsewhere classified
OSI	Office of Science and Innovation
PPP	Purchasing Power Parity
SHEFC/SFC	Scottish (Higher Education) Funding Council
SME	Small or medium sized enterprise
STEM	Science, Technology Engineering and Medicine
UK	United Kingdom

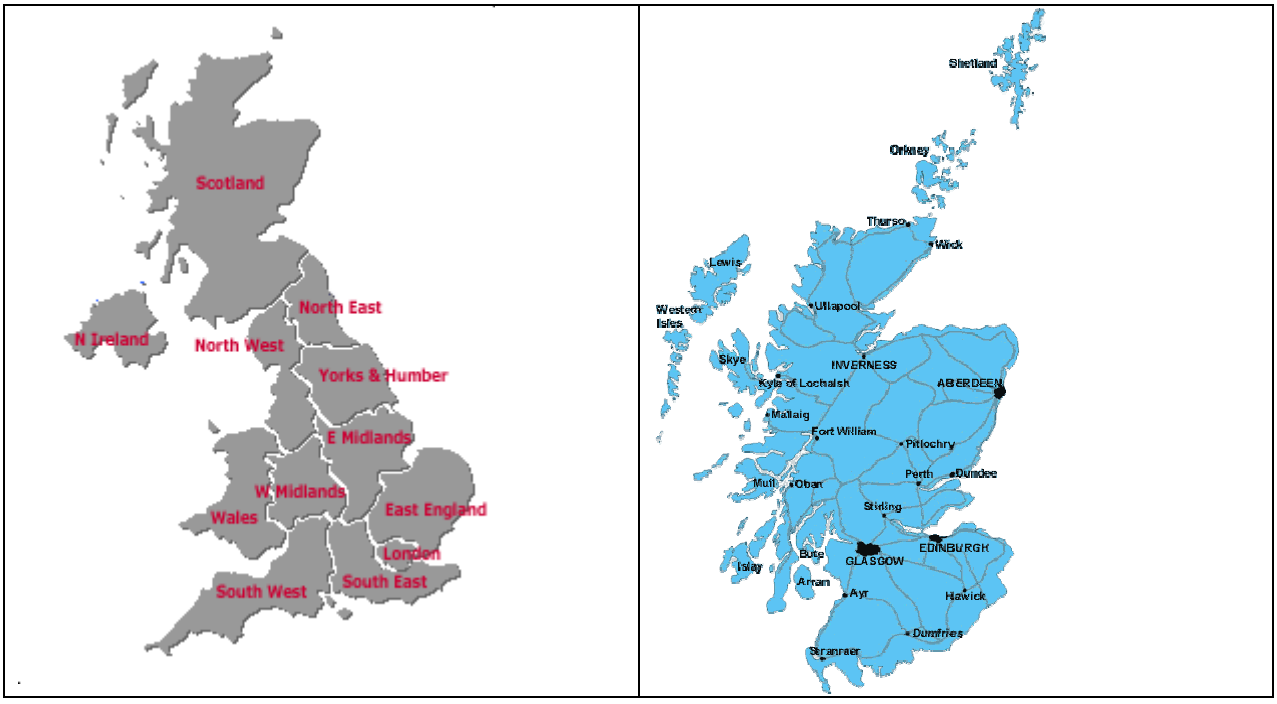
1 Introduction

Scotland is in the north of the United Kingdom and forms one of the four 'nations' of the UK and one of 12 official regions. It has a special status as a devolved territory with its own parliament, the Scottish Assembly, and distinct powers that have not been given to other regions or devolved bodies. With a population of just over 5 million, Scotland makes up around 8.5% of the UK, and is a typical sized region in population terms, although its land area of 78,807 sq km makes up 32% of the UK. Consequently its population density is much lower than the rest of the UK at only 64 people per km^2 compared with 243 per km^2 for the UK. Its population is concentrated in the central belt in the cities of Edinburgh and Glasgow with over 1.5 million in the two conurbations not including all of the settlements between them, so the contrast between a dense urban core and extremely sparsely populated periphery is marked. In recent decades population has been declining slightly relative to the UK total.

Scotland has been facing significant economic problems over many decades as a result of the decline of traditional industries in the central belt and in other cities such as Dundee. The loss of industries such as coal and heavy engineering was partly addressed through an active programme of foreign direct investment with notable success in electronics and amore recent focus on other high tech sectors. Scotland's extensive areas of sparsely populated uplands and islands have severe problems of peripherality, accessibility and marginal conditions for agriculture. As a result regional GDP and GVA are below the UK average. In 2005 GVA was £86.3 billion, and GVA per head £16,900, but with a strong positive shift, up 4.1% on the previous year. In recent years Scotland has been catching up on the UK average and is now at 96% of that figure, but lags significantly behind the figure of £24,100 per head for London.

Employment in Scotland is 2,421,000 out of a working age population of 3,191,000 with an employment rate of 5.5% and an inactivity level of 20.5%. Employment levels have grown since the low point of the 1980s, with a commensurate decline in the level of unemployment, especially over the last decade.

Figure 1: Map of Scotland



2 Regional Knowledge Base

2.1 Description of the regional knowledge base

2.1.1 Knowledge creation capacity

Scotland has 20 higher education institutes of which 14 are currently designated as universities. The remainder comprise specialist colleges (such as art colleges) one general college, and a network of institutions across the Highlands and Islands[1]. The universities are of varying ages from mediaeval foundations to some which have only been universities for a few years, and with considerable variation in research intensity. In total around 210,600 students were enrolled on higher education courses in 2004/5, around 9.2% of the UK total (HESA, 2006). Around 49900 or 23.7% were postgraduate students (masters and doctoral) and around 23.5% of these were from outside of the EU. The universities employ 15,310 academic and research staff (2004/5) of which 3045 are full-time research only working on externally funded projects. The universities receive two forms of research income, a block grant from the Scottish Funding Council[2] which is allocated according to the Research Assessment Exercise and came to £168m in 2004/5, and grants and contracts from public and private sources which was £365m in the same year. These two sources accounted for 27.5% of total HE income in Scotland. Higher Education in Scotland has seen considerable growth in real terms recent years both in terms of numbers of students as well as in research expenditure.

Research quality is assessed by the Research Assessment Exercise. The last such assessment was in 2001 with the next scheduled for later this year. In 2001 Scottish universities performed strongly in biological sciences, veterinary science, computer science, history, applied mathematics and Middle Eastern and African studies. In biological sciences in particular Scottish submissions accounted for 16.2% of the UK total showing an absolute concentration of numbers as well as above average quality. Subject areas where Scotland performed below the UK average included food science and technology, chemical engineering, business and management and environmental sciences.

Scotland has a strong public sector research base in a UK context, although largely funded at the Scottish scale rather than by national UK government. Public research institutions in Scotland include a set of agricultural and biological establishments funded by the Scottish Executive Environment and Rural Affairs Department (SEERAD), and some establishments funded by UK national bodies. The former includes five research institutes and the Scottish Agricultural College (included in the HE list also).

- The Fisheries Research Agency incorporates two main laboratories, a marine research lab in Aberdeen and a freshwater lab in Pitlochry, plus additional outstations. It employs a total of 300 staff.
- The Scottish Agricultural Science Agency is based in Edinburgh and employs 100 staff mainly focused on the quality and safety of the food supply.
- The Macaulay Institute is the premier land use research institute in the UK, employing two hundred and seventy staff in Aberdeen. The Macaulay Institute aims to be an international leader in research on the use of rural land resources for the benefit of people and the environment and is involved in research across the globe; from Scotland to Chile and China.

[1] Colleges are differentiated from universities in that their degrees have to be externally validated by a university, so Bell College's degrees are offered in conjunction with three universities. Several universities have been redesignated as such in recent years, but colleges must meet a set of basic criteria regarding size and quality before being given the right to confer their own degrees and call themselves universities. Queen Margaret University is the latest of these.

[2] Formerly called the Scottish Higher Education Funding Council

- The Scottish Crop Research Institute (SCRI) is the leading institute in the UK for research on plants and their interactions with the environment particularly in managed ecosystems. SCRI employs around 400 people at its site in Invergowrie.

The nationally funded public research institutes include some funded by the Natural Environment Research Council, such as the Scottish Association for Marine Science and branches of the British Geological Survey and the Centre for Ecology and Hydrology.

Previously Scotland was also the base for the National Engineering Laboratory which undertook engineering research on behalf of UK industry, but this was privatised during the early 1990s and in 1995 became a fully private subsidiary of the TUV group. It still employs 150 staff. Similarly one of the largest research facilities in the UK used to be the Dounreay experimental nuclear reactor site on the north coast of Scotland, once employing around 2500 people but since the reactors have been taken off-line in 1994 the site has been re-assigned to decommissioning and whilst employment is back up to over 2000, most are involved in decommissioning work on site. Although no longer a centre for R&D, the site does still have significant knowledge production potential[3].

Overall **GERD** in Scotland is £1367m, only 6.8% of the UK figure, and amounting to 1.53% of GDP. This places Scotland below the UK aggregate figure of 1.81% and sixth out of twelve standard regions within the UK in both relative levels of GERD, and absolute scale of effort. In recent years this performance has been variable and fell from 2002 when it was £1459m. As a proportion of the UK figure the Scottish share rose from 6.2% in 2000 to 7.6% in 2002 and then fell back to 6.8% in 2003.

R&D expenditure by sector of activity varies greatly between the major sectors though. Business R&D (BERD) at £521m is low at only 0.58% of GDP, and Scotland accounts for only 3.8% of UK BERD, whereas government expenditure is £271m and is 13.5% of the UK total GOVERD. Higher Education R&D is also strong at £575 or 12.9% of UK HERD. If Scotland's BERD performance was equivalent to that of its performance in GOVERD or HERD then Scotland would have a GERD approaching 3% of GDP and would be among the three top performing regions. There is clearly then a strong public sector lead in R&D, but one which the private sector has not yet been able to match.

R&D personnel numbers in Scotland follow the same pattern with strong performance in the public sector and relatively poor performance in the business sector. 2002 data suggest that the public sector employs 2900 in R&D (excluding HE) at 0.12% of the workforce, which compares favourably with a UK figure of 0.07% and is third in the UK behind the South East and Eastern regions, but only by a small margin. The business figure however is much less impressive with a total employment of 10800 or 0.45% of the regional workforce, compared with a UK average of 0.59%. Here Scotland lies in the middle of the regional rankings with 6 regions having higher levels, in some cases much higher at 1.21% and 0.98%. The only regions scoring lower than Scotland have very low levels of business R&D and are all the other peripheral old industrial regions plus London[4].

R&D expenditure in business is highly concentrated in just three sectors, pharmaceuticals (37%), precision instruments (12%) and electronics (9%). Only one significant sector, precision

[3] UKAEA (2004) Skills, Enterprise and Opportunity: Dounreay's decommissioning legacy, UKAEA, Dounreay.

[4] London has relatively low R&D in both business and the public sector as much of this activity has been decentralised to the surrounding regions of South East and East, and hence the London economy is heavily specialised on services and especially financial services. Whilst formal R&D may be relatively low, there is nonetheless considerable innovation investment in services and in creative industries. The size of London therefore has a significant effect on the UK averages but in varied ways, reducing some of the R&D measures but increasing some labour measures.

instruments, has a higher level of expenditure measured in terms of expenditure per employee than the UK average, and this sector saw significant growth in 2001, although with a downturn again in 2002. Even though electronics is an important sector in Scotland, R&D expenditure per employee is less than half the UK average for the sector, and expenditure has been relatively flat since the mid 1990s. Pharmaceutical R&D has however increased markedly since the mid 1990s, growing nine fold in real terms between 1997 and 2002, and making a considerable impact on overall BERD (Roper et al 2003). Across all other industries though R&D levels remain low including for example computer services where Scotland accounts for just 2.3% of UK expenditure and only 42% of the UK average spend per employee.

BERD has to be seen in a context of a high emphasis on inward investment over many years with the successful Scottish electronics industry largely being built on foreign direct investment, much of this being in routine production plants receiving product designs from elsewhere. During the 1980s there was some growth in R&D attached to these plants and some more innovation oriented investments, but also the decline in Ferranti a UK owned defence firm which undertook extensive R&D in its Scottish plants. Since the 1990s electronics investment has declined despite continued efforts to encourage cluster-based development.

Outputs – During 2006 there were 1131 patents filed from within Scotland at the UK Patents Office, out of 17484 nationally, so Scotland accounted for 6.5% of the UK total, and again this is much less than Scotland's share of the UK population. 138 patents were granted, at a lower rate still of only 4.6% of the national total. The figure for patents granted was lower in 2006 than in 2005, although this reflected a national trend also.

2.1.2 Knowledge diffusion capacity of the region

There is a complex set of knowledge transfer activities around the universities in the region as a result of many years of investment by the universities and by various government agencies. So overall the system for the diffusion of knowledge is well developed relative to the capacity to absorb within the region. Roper et al (2006) make the point that Scottish universities place a strong emphasis on technology transfer but much less emphasis on supporting local SMEs, and they attribute this to the weakness of local demand, but a consequence of the weak local context has been considerable investment in new infrastructure.

All of the full-range universities in the region have extensive support structures for knowledge transfer, with only some of the smaller specialised colleges having limited facilities. So 15 of the HEIs have in-house facilities for seeking technology licensing opportunities, 15 have an enquiry point for SMEs and 14 help SMEs to specify their needs.

In recent years the capacity of universities to support technology transfer has been aided by the knowledge transfer grants from the Scottish Higher Education Funding Council, in which HEIs have been supported with a core grant for KT, allocated according to metrics of past performance. In 2004-05 SHEFC allocated £9.5 million to HEIs through these metrics, £12 million in 2005-06 and around £16 million in 2006-07. This funding has been to support the creation of capacity within specialist units in universities for engagement with industry.

In addition Scottish universities access national/research council schemes such as LINK, CASE Studentships, Knowledge Transfer Partnerships, as well as specific Scottish schemes such as Enterprise Fellowships, and the Proof of Concept Fund.

Scotland has 16 science parks listed as members of the UK Science Park Association, of which 5 have direct inputs from universities, 4 more have links with local universities and 3 are based around major research organisations. The five parks with direct university engagement, involving the use of university-owned land or university investment are connected to the universities

of Edinburgh, Heriot-Watt, Glasgow and Strathclyde, Dundee and Stirling. The Edinburgh cluster of parks includes Edinburgh University's Technopole, Heriot-Watt Research Park, BioCampus, Roslin BioCentre and Pentland Science Park and these brand themselves as the Edinburgh Science Triangle, and this group has a total of 83 tenants with 4,100 employees on 252k m^2 of build, putting it among the top 20 largest science parks in the world

Scotland has an excellent record on university spin off firms. Analysis of the numbers of spin offs since 1996 show that relative to the scale of research investment Scotland performs at least as well as the USA's leading universities in starting up new businesses. Smailes (2005) points out that in 2002/3 Harvard and Penn State universities evaluated 275 disclosures, filed 165 patents, licensed 89 technologies, generated $19.4m in royalties and created 6 spin outs. In the same year the Scottish universities evaluated 261 disclosures, filed 197 patents, licensed 85 technologies, generated $12.7m in royalties and created 13 companies, but from half the level of research income. Taking figures of spin outs per million population (figure X) Scotland performs consistently better than the UK, USA or Canada, despite a recent downturn as a result of less favourable tax treatment (now reversed).

In addition to the university activities Scottish Enterprise and Highlands & Islands Enterprise have jointly established new 'Intermediary Technology Institutes' (ITIs) in three key areas of market opportunity for Scotland – Life Sciences, Energy, and Communications Technologies & Digital Media. 'The ITIs' goal is to help increase the number and strength of High Growth Technology Companies in Scotland – the foundation of economic growth. They will do this by commissioning and then diffusing market-focused pre-competitive technology, into new and existing high growth companies' (Scottish Enterprise[5]).
The ITIs are intended to

- Create and expand the number of high growth, high value technology companies
- Attract and expand foreign direct investment that is linked to knowledge and retained skills
- Nurture strong technical, entrepreneurial and flexible skills to create a fertile environment for growth
- Increase both the technology research and commercial reputation of Scotland
- Build significant, sustainable economic impact for Scotland in these key global market areas

The ITIs or 'hubs' are located in Dundee (Life Sciences), Aberdeen (Energy) and Glasgow (TechMedia). Each ITI will have a core staff of approximately 15 people who will co-ordinate with the market and undertake programme management. Research activity will be commissioned through existing research organisations in Scotland and, where necessary, elsewhere.

2.1.3 Knowledge absorption capacity of the region

In terms of the level of qualifications in the workforce, Scotland is well placed to absorb knowledge. The proportion of the workforce with graduate level qualifications has risen from 28% in 1999 to 34% in 2005, well above the UK average figure in 2005 of 29.8% and second in regional terms only to London which has 38.9%. Only three regions are above the UK average, London, Scotland and the South East.

Scotland has for a long time had an exceptionally high level of participation in HE relative to the rest of the UK, partly a consequence of different higher education system. The Scottish Executive uses the Age participation index which measures the proportion of young Scots under 21 entering higher education in a particular year. From a figure of under 20% until the mid 1980s, this figure has climbed to over 50% between 2000 and 2002, but dropped back to 48.9% in 2004.

[5] Scottish Enterprise (no date) ITI Scotland: Realising Scotland's Potential

Scotland also has a high share of human resources in S&T. Taking Human resources in S&T as a proportion of the active population, Scotland has a level of 43.4% compared to 40.8% at a national level. Again only London and the South East have higher levels than Scotland, and only these three regions are above the UK average. So Scotland is in an anomalous position of being ranked alongside the UK core on these indicators, yet having other characteristics of being a peripheral declining industrial region with low levels of business R&D.

Investigation of the proportion of innovative firms by region using the Community innovation Survey is inconclusive. Data for 2005 indicates a slightly lower level of innovative firms in Scotland but the variation between regions is so small that these differences cannot be significant. There is a however a general understanding that firms in Scotland are less technology focused and less innovative than firms in regions such as the South East and historically this has been shown in studies, but recent data is less conclusive and may show real improvement in the performance of Scottish firms.

2.2 Policy context

2.2.1 Governance structure and actors

National level

The United Kingdom is a unitary state with one sovereign parliament and government. Following devolution of power in 1997, Scotland was granted limited self-government. The British Parliament in Westminster retains the ability to amend, change, or broaden the devolved government system. The Scottish Executive which is the National Parliament for the devolved government is appointed by the majority party or parties headed by the First Minister. Following the devolution of power, UK Parliament at Westminster retained control over foreign affairs, defence, economic and monetary policy, social security, employment, energy regulation, the National Lottery and most aspects of taxation (although Scotland can vary the basic income tax rate by up to 3 percent). The Scottish Executive holds wide-ranging powers in areas such as education, health, housing, regional transport, the environment, agriculture, tourism, culture and the arts, administering an annual block grant from the UK government.

National government retains overall responsibility for science and technology policy: major national R&D facilities are funded by the UK government departments even though they may not be responsible for aspects of domestic policy in Scotland. The UK government is also responsible for the negotiation of international collaborative programmes, and has a number of UK-wide programmes that apply across Scotland as well.

The main national responsibility for Science and Technology policy lies with the Office of Science and Innovation, based in the Department of Trade and Industry. OSI oversees national science and innovation strategy and is also responsible for the funding for academic research through the Research Councils. This is known as the ‘Science Budget’ and is currently in excess of £3 billion per annum. The aim of the OSI is ‘to maximise the contribution made by our science, engineering and technology skills and resources to the UK’s economic development, and to the quality of our lives’. OSI is headed by the Chief Scientific Adviser (CSA) to the Prime Minister, who takes the lead in improving quality of science and its use across Government

In addition to its funding role, the OSI is responsible for improving the quality and use of science and technology (S&T) advice across Government and increasing public confidence in the Government's use of S&T. To achieve this OSI co-ordinates and develops policy on how Government seeks and uses scientific advice in policy making, the presentation of that advice and decisions based on it. It also monitors the performance of departments against objectives set out in the 10 year Science and Innovation Framework 2004-2014

The eight research councils, funded directly by OSI are the public bodies charged with investing public funding in science and research in the UK 'in order to advance knowledge and generate new ideas which can be used to create wealth and drive improvements in quality of life'. Each Research Council funds research and training activities in a different area of research ranging across the arts and humanities, social sciences, engineering and physical sciences and the medical and life sciences. The Councils employ around 12,000 staff, and support around 30,000 researchers, including 15,500 doctoral students in UK universities and in their own Research Institutes.

There are currently eight Research Councils:

- Arts and Humanities Research Council (AHRC)
- Biotechnology and Biological Sciences Research Council (BBSRC)
- Council for the Central Laboratory of the Research Councils (CCLRC)
- Engineering and Physical Sciences Research Council (EPSRC)
- Economic and Social Research Council (ESRC)
- Medical Research Council (MRC)
- Natural Environment Research Council (NERC)
- Particle Physics and Astronomy Research Council (PPARC)

All are Non-Departmental Public Bodies (NDPBs), established by Royal Charter and are independent legal bodies outside of Government, accountable to Parliament. In 1999-2000 the Research Councils spent £141million or 11% of their total budget in Scotland.

Other ministries have R&D budgets and in some cases research establishments and research funding programmes. In most cases these have no direct impact on Scotland either because the main research activities are based in England, or because the ministry's remit in Scotland is held by the Scottish Executive. However there are some department of Trade and Industry schemes which apply across the whole UK and would therefore be applicable by Scottish firms, and in areas such as defence then Scottish firms would be full participants in procurement based innovation contracts.

The Department of Trade and Industry's Five Year Programme set ministers in other departments the task of identifying 'Grand Challenges' where science and technology would form part of the solution to public policy issues. The Chief Scientific Adviser's Committee (CSAC) is the principal committee at official level dealing with issues relating to science, engineering and technology (SET), and chaired by, the Government Chief Scientific Adviser (GCSA), with membership drawn from the Departmental Chief Scientific Advisers (DCSAs). The GCSA along with the DCSAs play an active cross-Government role in helping to identify and meet the strategic public policy challenges (i.e. Grand challenges) where scientific evidence and technological innovation would form part of the solution across Government.

Scottish level

Since the formation of the Scottish Parliament and Executive, Scotland has been developing its own science and innovation policies, and in 2001, the Scottish Executive published "A Science Strategy for Scotland" to provide a framework of policies to guide the detailed development of policy for the support and use of science6. Science and research are concurrent powers (i.e. some aspects are devolved and others are reserved) under the Scotland Act 1998.

Dialogue and coordination between the Scottish Executive and UK national ministries on science and innovation matters takes place within the context of the overarching Memorandum of Understanding with the UK Government, a range of concordats with UK Government Departments and the Research Councils, and committees such as the Chief Scientific Adviser's

[6] A progress report was produced in February 2006.

Committee and the Science and Engineering Base Co-ordinating Committee, of which the Executive is a member.

Public funding for science research in Scottish Higher Education Institutes (HEIs), as in the rest of the UK, is through 2 main sources: core funding, for research infrastructure is provided by the Scottish Funding Council (SFC), while funding for specific research projects is through the UK Government's Office for Science and Technology, via the UK Research Councils. Overall, this system is termed the "dual support" funding system.

Scottish Ministers are responsible for policy on the SFC, and for powers in relation to knowledge transfer from higher and further education institutions into businesses and society. Research funding provided by the Executive through the SFC was increased significantly in real terms in both the Executive's Spending Review 2002 and in the Spending Review 2004. In the latter review the Executive increased overall funding for HEIs by 30% in real terms over the following 3 years. The Scottish Executive has also spent over £80 million on commercialisation and knowledge transfer activities since 1999, and continues to place a great deal of emphasis on this work.

The Executive also funds a significant amount of science research directly, in the Agricultural and Biological Research Institutes and in the NHS.

A "Science Strategy for Scotland" committed the Executive to establishing an independent Scottish Science Advisory Committee (SSAC). The SSAC was established in 2002, under the auspices of the Royal Society of Edinburgh (RSE), to provide independent advice to Scottish Executive Ministers on strategic scientific issues, including science strategy, science policy and science priorities. The Committee produces reports on various aspects of science strategy and science education such as specific opportunities for the science base in Scotland, including E-health, Medical Imaging, Energy and Animal Bioscience. Since the appointment of a new Chief Scientific Adviser for Scotland (CSA) in August 2006 this person has taken over as Chair of SSAC from 1 January 2007, and the Scottish Executive's Office of Chief Scientific Adviser also took on providing the Secretariat for the Committee on this date. The RSE no longer has any responsibilities for the Committee. The overall role of CSA for Scotland is to provide strong leadership on science in the Executive; to further enhance Scotland's reputation as a science nation and to provide independent advice on science issues and strategy to Ministers. The post of Chief Scientific Adviser for Scotland is in the in the Office of the Permanent Secretary and is supported by the Office of the Chief Scientific Adviser (OCSA). OCSA currently comprises two small teams dealing with science strategy and science engagement. The latter supports science and society initiatives through the science centres network and public other outreach programmes.

During the first half of 2007, the CSA will, with the help of the Committee, review future arrangements for SSAC, to ensure that the Executive continues to have effective engagement with the science community on science strategy issues. Any unfinished projects will also be completed. The Executive plans to have longer term arrangements for the SSAC in place by 1 July 2007.

Within the Executive, the CSA represents those sciences not presently covered by the Chief Scientists in the Health and Environment and Rural Affairs Departments. She leads on cross-cutting scientific issues across the Executive in partnership with the other two Chief Scientists, whose line management remains within their respective Departments. She also leads on the professional aspects of scientific staff within the Executive and represents Scotland in certain high level scientific committees in Whitehall.

The CSA's current high level priorities are to:

- Champion science in Scotland, and encourage an engaged and enthusiastic public

- Develop and maintain a strong research base
- Ensure that scientific evidence informs government policy
- Ensure good relationships with our national and international collaborators

Supporting the science investment, innovation is the responsibility of Scottish Enterprise and Highlands and Islands Enterprise, and their network of Local Enterprise Companies. The Enterprise network was established in the early 1990s and has been responsible since that time for the implementation of economic development policies including support for innovation, entrepreneurship, clusters and interactions between industry and universities. SE has promoted a series of initiatives in advance of the new Strategy for Science and the Smart, Successful Scotland strategy, including a major investigation of technology commercialisation in the mid 1990s, and the Business Birth Rate strategy in the late 1990s. SE has worked with other science institutions in Scotland including the Royal Society of Edinburgh, a traditional scientific institution representing the interests of the science community.

2.2.2 Policy Objectives

National policy objectives

In 2004 the UK Government set out its long term vision for science and innovation in the Ten Year Science & Innovation Investment Framework, which is designed 'to make Britain one of the best places in the world for science, research and innovation - the successful exploitation of new ideas incorporating new technologies, design and best practice'. This vision has a number of challenges which include 'sustaining and developing the UK's world-class research base, strengthening its links with business and other users, enabling knowledge transfer, and promoting innovation in products, services and processes'.

The Science and Innovation Investment Framework, sets out an ambition that public and private investment in R&D should reach 2.5 per cent of GDP by 2014. The ten-year framework follows on from the earlier 2002 Investing in Innovation strategy and the Excellence and Opportunity white paper published in 2000. Prior to the Labour Government of 1997, the previous administration had launched a number of science initiatives such as Foresight, and a variety of collaborative programmes, whilst at the same time reducing the investment in public R&D and privatising many existing public labs, such as the National Engineering Lab and the Atomic Energy Authority. The Labour Government has sought to increase investment in the science base, mainly in the universities, but also focused much more on the knowledge transfer mechanisms for both universities and other public research facilities.

Alongside the Science and Innovation Investment Framework the Government has also published a comprehensive set of indicators to monitor implementation of the ten-year framework, and made a commitment to report annually on progress against these indicators.

The Science and Innovation Investment Framework 2004-2014 set out a comprehensive vision for UK science and innovation, along six principal themes:

- world-class research at the UK's strongest centres of excellence;
- greater responsiveness of the publicly-funded research base to the needs of the economy and public services;
- increased business investment in R&D, and increased business engagement in drawing on the UK science base for ideas and talent;
- a strong supply of scientists, engineers and technologists;
- sustainable and financially robust universities and public laboratories across the UK; and
- confidence and increased awareness across UK society in scientific research and its innovative applications.

Some of the key measures to underpin this vision included:

- additional funding of over £1 billion over 2005-2008 to enhance the sustainability of the science base;
- dedicated funding for knowledge transfer from universities in England through the Higher Education Innovation Fund, rising to £110 million per annum by 2007-08;
- funding for industry-led collaborative research through the DTI Technology Strategy, rising to at least £178 million per annum by 2007-08;
- the Government's response to the Lambert Review of business-university collaboration, including new responsibilities for the Regional Development Agencies (RDAs) in this area; and
- measures to improve the teaching and learning of science, technology, engineering and mathematics (STEM) subjects at all levels.

The Government has since built on these measures, for example by:

- announcing in the 2004 Pre-Budget Report a new mandatory target for Government departments and agencies to place 2.5 per cent of their extra-mural R&D contracts with small- and medium-sized enterprises (SMEs), under the Small Business Research Initiative (SBRI);
- announcing in the 2005 Pre-Budget Report a package of measures to improve the environment for medical R&D in the UK, including a new NHS research strategy, and measures to promote excellence in clinical research and to facilitate the conduct of clinical trials; and
- announcing in the 2005 Pre-Budget Report an independent review of Intellectual Property (IP) in the UK, led by Andrew Gowers, to ensure that the UK's IP framework is appropriate for the digital age.

Scotland

In terms of the overarching policy framework for science and innovation there are two main policy documents that set out the objectives and priorities of the Scottish Executive. These are the new Science Strategy for Scotland and the Smart, Successful Scotland document which sets out the strategy for the enterprise networks and hence the innovation dimension.

The science policy objectives have been set out in 'A Science Strategy for Scotland' published in 2001. It had five main objectives:

- Maintain a strong science base fully connected to UK and international activity and funding
- Increase the effective exploitation of scientific research to grow string Scottish businesses and provide cutting edge science to meet the needs of the people of Scotland
- Ensure that enough people study science to a standard which will enable the future needs of the country to be met
- Promote the awareness, appreciation and understanding of science across society
- Ensure the effective use of scientific evidence in policy formulation and resource allocation by Government

The Smart, Successful Scotland strategy has a very simple set of objectives with three main elements:

- Growing businesses - Scotland: a fast learning, high earning nation
- Global connections - Scotland: a globally connected nation
- Learning and skills - Every Scot ready for tomorrow's jobs

Under the growing business heading, the strategy aims to enhance Scottish productivity and business growth, stimulate greater entrepreneurial dynamism and creativity, encourage the development of more e-business, increase the commercialisation of research and innovation, and achieve global success in key sectors.

The global connections element seeks to provide support for digital connectivity, helping Scottish firms to be more involved in global markets, promoting Scotland as a globally attractive location, and encouraging more people to live and work in Scotland.
Finally, the learning and skills element seeks to raise the employment rate across Scotland, improve the operation of the Scottish labour market, develop the talents of young people, narrow the gap in unemployment, and improve demand for high quality in-work training.

An additional statement on the diffusion and application of knowledge has been made by the Executive in response to the Lambert Review of UK Business-University Collaboration: a study undertaken for the Treasury in 2003. The Executive's response , "Business - University Collaboration in Scotland: The Scottish Executive's Response to the Lambert Review" was developed in partnership with a range of stakeholders (including the Enterprise Networks, the Scottish Higher Education Funding Council (SHEFC), Universities Scotland, CBI and representatives from Scottish universities) and was published in March 2005. The report outlines how universities and business are working together to improve the flow of knowledge and ideas from Scotland's science base into the business community and provides a list of actions.

Most of the funding for knowledge transfer activity is allocated by the Scottish Funding Council and will increase from £13 million in 2005/06 to over £15 million in 2006/07. This money helps researchers at Scottish universities turn their projects into commercial realities.

In late 2006 the Scottish Executive launched a consultation on a new science and innovation strategy, bringing together the previous separate strands into one. At the time of writing the response to the consultation was not yet published so it was inappropriate to discuss the possible form of this new policy framework.

2.2.3 Policy instruments

The following sections sets out the most important policy instruments at an EU, national and regional scale focused on regional levels of RTD.

A) Improve innovation and R&D governance
At the national level, the recent reorganisation of science and innovation policy into the Office of Science and Innovation, and the development of the new Science and Innovation Investment Framework, provides a new vision for UK science policy, and strengthens the coordination of policy to support innovation. The relative roles of the national government and devolved administration in Scotland has been established through a Memorandum of Understanding and monitored via interdepartmental committees.

Within Scotland the Executive has established an independent Scottish Scientific Advisory Committee chaired by a Chief Scientific Advisor in order to oversee science and innovation strategy, and to ensure effective participation from stakeholder groups in setting science priorities.

B) Creation of an innovation and entrepreneurial friendly environment
Policies at all scales from EU to national and Scotland aim to encourage the development of an entrepreneurial and innovative climate. At the EU scale Scotland benefits from access to FP6 and now FP7 in terms of access to funds to support RTD and promote Scottish participation in international networks. There is a specific scheme, the *Scottish Proposal Assistance Fund* which assists SMEs to participate in proposals to FP7.

At national level, the new Science and Innovation Investment Framework specifically aims to enhance the environment for innovation in the UK. This includes increased support for activities to promote public understanding and confidence in science.

A particular focus in recent years has been the direction of public support to entrepreneurial activities, especially university spin offs, with central government funding for Science Enterprise Centres in UK universities, and the University Challenge seed funds for spin offs. Scotland benefited from both these schemes with one of the SECs and with two University Challenge funds. The SECs delivered a number of specific programmes including:

- Teaching enterprise and entrepreneurship to science and technology students
- Transferring ideas and know-how to business
- Encouraging and supporting the development of new businesses by staff and students based upon intellectual property. (OST, 2002).

The University Challenge Fund was established with funding from the Treasury, the Wellcome Trust and the Gatsby Charitable Foundation. UCF awarded grants to a limited number of institutions (some operating in collaboration) in order to establish rolling funds to support commercialisation projects through seed funding. Altogether some £45 million was provided initially to provide the seed funds, with a further 25% of the total fund being raised by the universities themselves. Unlike other programmes these funds could only be used for commercialisation costs such as accessing managerial skills, intellectual property costs, R&D, prototype development, business plans, and legal costs. £45m was allocated in the first round of the competition in 1999, (with 15 seed funds being set up) and £15m more recently in October 2001 (which provided for additional 4 seed funds, and 1 extension). 57 universities now have access to UC seed funding. In the first two years of operation 105 new spinouts were created across the UK and £26.8m third party investment was attracted to complement the £16.8m UC funds committed.

In Scotland the new Science Strategy and Smart Successful Scotland policy frameworks have a number of measures to support the innovation environment, complementing the national support. One strand in the Science strategy is focused on promoting awareness, understanding and appreciation of science, and includes support for the Scottish Science Trust to develop a network of science centres. Another strand is focused on commercialisation and includes measures to promote management skills. Scottish Enterprise separately supports entrepreneurship through enhancing access to venture capital and business advice to new starts. As already noted Scottish universities have been relatively successful in recent years in the numbers of spin off firms.

Entrepreneurship has been a priority in Scotland for many years and in the mid 1990s Scottish Enterprise initiated an inquiry and then a programme on the Business Birth Rate, aiming to increase the number of start ups to reach UK levels. In spite of a host of measures however the overall rate of new business starts remains around 30% below the UK average and the policy has had little impact.

C) Development of human capital

National funding for the development of human capital within the science base has been enhanced by an increased budget for the research councils, both for the training of PhDs and for the expansion of competitive research grants employing young researchers. The Research Councils exert a specific influence on the HE sector through funding a major portion of the human research capital: supporting over 30,000 researchers at any one time including 15,500 doctoral students, 10,000 research staff in universities, 4,000 research staff in research institutes and 2,000 Research Fellows. The focus on the research councils on human capital has also been enhanced following the review for the Treasury by Sir Gareth Roberts of the supply of science and engineering skills in the UK. As a result the research councils have been tasked with increasing the participation in SET in HE; ensuring women and ethnic minority groups are fully represented; and being responsive to employers and skills needs of the economy.

In 2005, the Research Councils UK Research Careers and Diversity Unit was launched, to extend existing cross-Council working and take over the coordination of initiatives including the new Academic Fellowships programme. The new Research Careers and Diversity Strategy has five aims:

- To ensure that the best potential researchers are attracted into research careers;
- To help universities to improve the quality of their research training and improve the employability of early stage researchers; and
- To improve retention of the best researchers by promoting better career development and management of research staff in research organisations;
- To promote diversity within the research workforce at all levels and in the governance of research; and
- To enhance the attractiveness of the UK as a destination for the best researchers.

There are a variety of actions to implement these aims including enhancing the support for PhD training, improving PhD quality, providing new academic fellowship programmes, enhancing data on skills, promoting best practice etc.

Within Scotland, there has been further enhancement of expenditure in HE through the Funding Council grants to universities.

D) Networking, co-location and clustering measures

At the national level R&D funding for industry has been almost wholly oriented towards networking and collaborative programmes since the late 1980s. Programmes such as LINK which involve several firms collaborating with one or more universities have operated across a number of sectors and technologies.

Cluster initiatives have been seen as purely the responsibility of the regional scale, and Scotland has been a pathfinder within the UK for cluster policy, with sectoral programmes targeted on high technology industries such as electronics since the 1950s, and specific cluster initiatives since the mid 1990s. The weakness of Scottish industry in innovation has been at the centre of thee policies since the beginning. A very early scheme in the 1950s saw the establishment of a research centre in the firm Ferranti for defence projects with local Scottish subcontractors subsidised to participate in development projects and place staff in the Ferranti research centre during the project – the aim being to enhance their capacity to engage in R&D. Subsequently policy focused on attracting FDI, but with aftercare programmes to encourage firms to upgrade their plants, and some targeted recruitment of more R&D intensive plants within a model of integrated value chains. In spite of great success in attracting investment R&D levels remained low as did local purchasing.

A more recent attempt to stimulate networking has been the Alba Centre which was established to provide state of the art capacity in next generation technology for the electronics industry, especially in the area of chip design. It has three main modalities:

- identifying and acquiring third party IP for system on a chip design,
- providing an appropriate physical environment for chip design work, and
- producing a good supply of electronics graduates with relevant skills and, through the Institute of System Level Integration (ISLI).

ISLI was therefore designed to operate as a ‘magnet’ to attract talented individuals and to create a pool of workers with specialist skills to attract the engineering design functions of multinational firms.

Specific cluster development teams operate in Scotland for a number of high technology sectors including optoelectronics and oils and gas, but also more traditional industries such as food and drink where investment by Scottish firms in innovation is low, and where supporting knowledge institutions need strengthening.

E) Knowledge and technology transfer to enterprises

Funding for knowledge transfer has changed considerably since 1997. Prior to this time there were ad hoc national programmes, often modestly funded, and often based around the establishment of national networks that then closed down when funding ran out after three years, such as the Regional Technology Centres. Locally there were a wide range of initiatives often supported by the ERDF, and again often vulnerable to closure when funds ran out. Since 1997 there has been significant funding available for knowledge transfer within core third stream funds provided to universities through the respective funding councils. In Scotland this has been through the Knowledge Transfer grant, allocated to universities for individual programmes and infrastructure support.

The one exception of a national programme with long term success has been the Knowledge Transfer Partnerships, formerly called the Teaching Company Scheme. In this programme a company jointly funds a temporary employment post with assistance from the DTI and/or one of the research councils, for a graduate who is also supervised by an academic. The scheme pays a salary for the graduate and makes a contribution to the university, and the graduate undertakes a developmental project in the company with assistance from the academic supervisor. This programme has been running for over 25 years now, very successfully, and Scotland is well represented.

The success of Scottish HEIs in commercialisation of academic technologies and IP exploitation has already been discussed earlier. The Proof of Concept Programme has recently drawn much attention by generating in excess of £125 million for the Scottish economy. The Proof of Concept Programme was created in 1999 and aimed to address the lack of available funding, from both the public and private sector, to support the development of research concepts into commercial products or services. Recent research, conducted by PricewaterhouseCoopers LLP, examined the economic and wider impacts of the first six rounds of funding between June 2000 and June 2005. The Programme currently supports 184 groundbreaking projects and has already created over 500 new jobs.

The evaluation concludes that there are likely to be further significant future impacts for Scotland as Proof of Concept Programme projects mature. Longer-term predictions estimate that, over a 10 year period, any given Proof of Concept Programme funding round could result in between £40 million and £100 million GVA to Scotland's economy. As a result of the Proof of Concept Programme, there has been significant change within Scottish institutions towards the development of commercialisation activities, as well as encouragement of private sector interest, support and funding through Business Angels. The evaluation further states that the outputs from the Programme, now and in the future, are likely to support sustained and sustainable growth in commercialisation across Scotland's academic base.

F) Research collaboration of public research organisations with private sector

SCORE: The SCORE programme is designed to support R&D projects jointly undertaken between public sector research bodies (such as Higher Education Institutes (HEIs), Research Institutes, NHS Trusts) and Scottish SMEs. Under this scheme, an SME or group of SMEs with a specific technical problem or need can assign a significant part of the required scientific and technological research to a public sector research body.

SEEKIT: The SEEKIT programme is designed to support projects that will promote co-operation in R&D and knowledge transfer between small to medium sized enterprises (SMEs) and the Scottish public sector science base. Applications are invited from public bodies, such as Universities, Research Institutes, Technology Transfer Organisations and NHS Trusts.

G) Support of public research

There are a range of mechanisms whereby university research is supported, mainly through the research councils which each have a number of specific funding schemes in addition to the standard response mode grants which are available for topics identified by the applicants. All of the research councils now identify specific research themes and programmes in which they call for proposals within defined areas, plus other schemes for collaborative work with industry and for knowledge transfer. Research council funding has generally increased in recent years, but has become more prescriptive, and there is currently a debate about how to more efficiently allocate funds given the increasing level of applications and lower success rates. Research councils are also moving towards full economic costing which has meant intervention rate for an individual project has increased, and the overall budget has also increased to take this into account.

Across the UK, university investment in infrastructure has been supported through the Science Research Investment Fund (SRIF), a programme for refurbishing the university science estate, providing new science equipment and laboratories and communications networks. SRIF is a joint initiative between the Office of Science and Innovation (OSI) and the Department for Education and Skills with additional contributions made by the Scottish Funding Council and equivalents in Wales and Northern Ireland. The scheme commenced in 2002, with funding having increased from £400m a year in 2002 - 2004 to £500m a year in 2004 - 2006, which has gone some way in addressing the historic backlog in university science investment. In 2004 government announced a continuation of this level of funding to 2008. Additional funding for infrastructure improvements comes from charities, business sponsorship and research organisations. Universities themselves are required to contribute 10% of the total cost of SRIF projects, but this amount is often exceeded.

Recent studies undertaken by OSI indicate that SRIF funding is achieving significant benefits such as the establishment of laboratories to a high standard enabling universities to carry out quality projects from various funding sources, and to compete globally. The refurbished laboratories and new equipment are also attracting world-class researchers and academics to the UK. For SRIF3, which runs from 2006 to 2008, there is a requirement on universities to make their SRIF - funded facilities and related expertise open to access by business.

H) Financial R&D measures for the private sector

DTI provides R&D Tax Credits through HM Revenue and Customs. The aim of the tax credits is to encourage greater R&D spending in order to promote investment in innovation. By early 2006 about 22,000 claims had been made, just over 19,000 of which were made under the SME scheme and just under 3,000 of which were made under the large scheme, amounting to almost £1.8 billion of support claimed through both schemes. The R&D tax credit works by allowing companies to deduct up to 150% of qualifying expenditure on R&D activities when calculating their profit for tax purposes. Companies which are SMEs can, in certain circumstances, surrender this tax relief to claim payable tax credits in cash from the HM Revenue & Customs.

Innovative Product Development: Small Company Innovation Support: Provides vital financial support to single companies for projects that lead to the development and introduction of new products and processes.

R&D Plus: R&D Plus is open to all large companies located within Scotland or planning to establish a research and development presence in Scotland, with the aim of encouraging research and development investment and job creation.

SMART:SCOTLAND: Successful applicants receive funding of 75% of the cost of carrying out a technical and commercial feasibility study lasting between 6 and 18 months. The maximum award is £50,000. SMART:SCOTLAND winners who successfully complete their projects and

who need more help to develop a pre-production prototype can get further support through the SPUR programme.

SPUR: SPUR grants help small to medium sized enterprises (SMEs) to develop new products and processes involving a significant technological advance for the UK industry or sector concerned, up to pre-production prototype stage. Awards can be made to independent businesses and groups with less than 250 employees.

SPUR+: The programme provides grant support for expensive leading edge technology development in areas such as telecommunications and biotechnology. To be eligible for support, projects must normally involve eligible project costs of at least £1 million. Assistance of up to £500,000 at 35% of eligible costs is available to support development up to pre-production prototype stage.

Exhibit 1: RTDI policy mix affecting the region

Policy Areas[7]	Policy objectives and instruments at National* level affecting the region	Policy objectives and instruments at Regional* level
Improve innovation and R&D governance	Reforms to central organisation of research policy through the new mission for OSI	New Science Strategy for Scotland, Scottish Science Advisory Committee and new post of Chief Scientific Advisor
Creation of an innovation and entrepreneurial friendly environment	Development of ERA and FP, coupled with new Science and Investment Innovation Framework	Implementation of Science Strategy and Smart, Successful Scotland policy
Development of human capital	Investment in the development of researchers through PhD support and growth of research council funds	Increased investment in universities through the Scottish Funding Council.
Networking, co-location and clustering measures	Promotion of clustering and networking nationally but responsibility devolved to regional bodies	Cluster policy implemented by Scottish Enterprise
Knowledge and technology	Promotion of knowledge transfer	Funding for new knowledge

[7] Compilation from typologies described in the bibliography such as Boekholt, P. et al (2001), *An international review of methods to measure the relative effectiveness of technology policy instruments*, Technopolis B.V., Amsterdam;
Soete, L. et al (2002), *Benchmarking National Research Polices: The impact of RTD on Competitiveness nd Employment (IRCE)*, A STRATA-ETAN Expert Group Report, DG Research, European Commission, Brussels;
Guy, K. and Nauwelaers, C (2003), "Benchmarking STI Policies in Europe: In Search of Good Practice", *The IPTS Report*, Vol. 71, February, IPTS, Seville;
European Commission (2003), *Raising EU R&D Intensity: Improving the Effectiveness of the Mix of Public Support Mechanisms for Private Sector Research and Development*, Report to the European Commission by an Independent Expert Group, Brussels.
Also TrendChart has developed its own policy mix taxonomy.

transfer to enterprises	through Knowledge Transfer Partnerships, and through new orientation of research council funding towards industrial projects	transfer activities in universities through SFC, and associated measures such as Intermediary Technology Institutes
Research collaboration of public research organisations with private sector	National government encouragement for public research agencies to invest in commercialisation activities	Specific new Scottish programmes SCORE and SEEKIT.
Support of public research	Support for university science investment through SRIF. Direct funding for collaborative research through FP, other transnational programmes such as EUREKA and national programmes such as LINK	SRIF implemented in Scotland by SFC.
Financial R&D measures for the private sector	Introduction of new tax incentives for the private sector, and national programmes to grant aid new innovative projects such as SMART and SPUR	SMART and SPUR are implemented in Scotland in partnership between DTI and the Scottish Executive

[Policies at national level are those formulated and implemented by national actors even if they have a regional dimension, while policies at the regional level are those under the complete and exclusive control of the regional authorities. Shared policies planned and/or implemented jointly by national and regional authorities e.g. co-funding, will be regarded as regional.]*

2.3 Conclusions

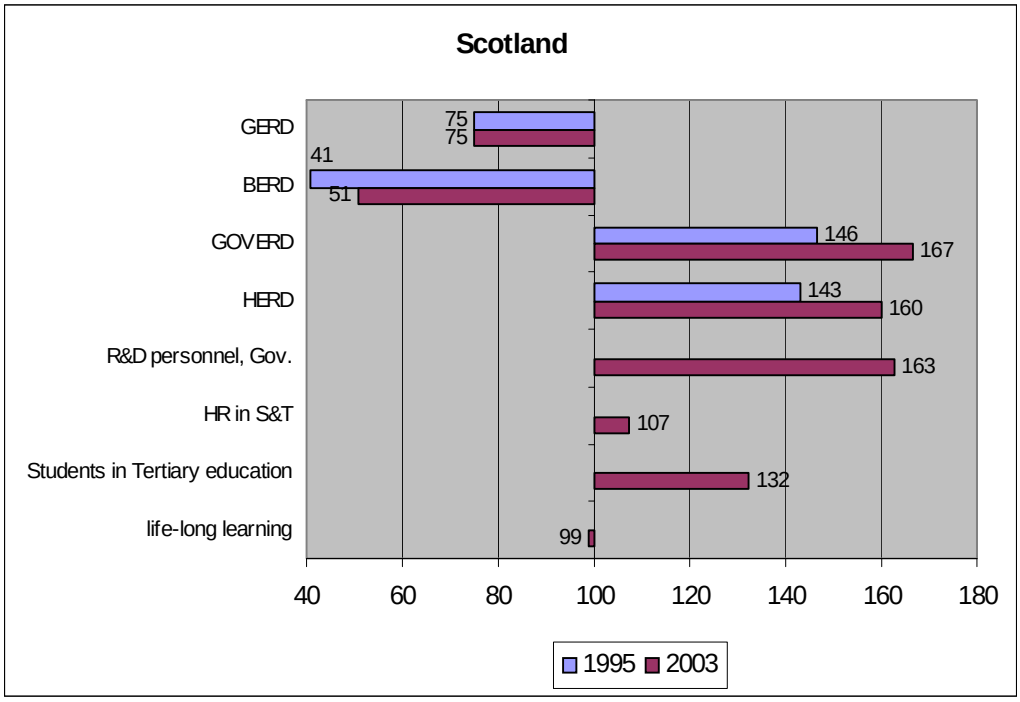
Scotland's regional innovation system is distinctive for the strength of the knowledge base in particular in the public sector and universities. The region has maintained a differentiated research infrastructure, with a set of research institutes that are specific to the needs of Scottish agriculture, food and fishing, and which have been transferred to the direct control of the Scottish Executive. The university system in Scotland is also distinctive compared with the rest of the UK, with a different system of undergraduate education, its own funding body, and different policies on student fees and on the funding of research. Scotland has continued to invest heavily in its universities and has supported real growth in research. This strong research base has been very successful in terms of commercialisation, notably in spin off firms, and for its size performs at international levels of quality. The weakness however is in the private sector which is structurally weak, and despite considerable success over many decades with the attraction of FDI, overseas owned firms still undertake relatively little R&D in Scotland. The indigenous firm base is also weak with Scotland lacking large locally owned technology intensive firms and SMEs typically being less innovative than in other UK regions.

This profile of strong public R&D and weak private R&D can be seen in the Summary Graph 1 below. Over the last decade there has been increased investment in the public sector research base but only limited growth in the private sector. The consequence of this has been continued investment by the Scottish Executive in knowledge transfer programmes with an emphasis on

connecting universities to businesses. However Scottish universities often see little benefit in working with local firms and have focused on developing their own spin off businesses instead.

The graph also shows a positive position on human resources, and in spite of the weaknesses of Scottish manufacturing, the Scottish economy has a strong base of graduates in the workforce and a higher than national level of students in higher education. Much of this human resource is based in the service sector though and Edinburgh and Glasgow in particular have a strong financial and business services sectors which absorb graduates including those in science and technology.

Summary Graph 1: Comparison of Scotland's knowledge base with the UK



There has been an increasing investment in policies to support innovation and knowledge transfer, especially since the establishment of the Scottish Parliament. Scotland has a very sophisticated innovation support system which has evolved over a long period of time. Scottish Enterprise has devoted considerable resources to benchmarking and studies to ensure policies are based on the best practices globally, yet despite this success tends to be limited to spin offs and specialised high tech sectors with limited uptake of support from the mass of SMEs.

It will be of great interest to see how the Scottish Executive proposes to modify its existing support system within the new science and innovation strategy due to be launched in the summer of 2007. There was recognition in the consultation document that more needs to be done to promote knowledge transfer between universities and business and that the strategy must embrace wider definitions of both science and innovation.

3 Regional economic structure

3.1 Description of the economic structure

3.1.1 The characteristics of the productive structure of region's economy

In contrast with UK, the overall GDP of Scotland rose by 1.8% over the year 2005 and by 0.6% over the latest quarter. In 2005, the UK experienced a 2.8% growth in services, a 1.9% decline in production and 1.1% growth in construction.

Scottish growth over the period 1975-2005 was lower than that of the UK at 1.8% per year compared to 2.3% per year. Over the period 1975-2005 Scotland's service sector had average annual growth of 2.5%, compared to growth of 0.5% in production and 0.9% in construction. Over the same period the UK's service sector had average annual growth of 2.8%, compared to growth of 1.2% in production and 1.9% in construction. Between 2000 and 2005, Scottish GDP grew by 9.2%, equating to an average annual growth rate of 1.8%. Since 1999, the growth rate for GDP as a whole has remained around 1.5% - 2.5% but has remained constant over 2% since 2003. Due to the contraction of the electronics and ICT sector the production sector has seen negative growth since 2000 although simultaneously the services sector has shown consistent growth of 5.3% in 2002. (High Level Summary of Statistics, 2006)

Manufacturing declined from 31% of gross value added in 1999 to only 24% in 2003, a dramatic fall in what had been the bedrock of the Scottish economy. Partly this can be attributed to the relative success of finance and business services, but also due to the increasingly relative lack of competitiveness of the UK compared with other countries for mobile investment. Around 2000, the electronics industry was hit by a number of closures of foreign owned plants, in a period when it has been difficult to replace such activities on a like for like basis, with large investors looking to Eastern Europe instead. Supply chains in the electronics industry have not been particularly well developed however due to the high level of globalisation in the industry, despite significant effort by Scottish Enterprise to enhance local supply chains. Around 1000 firms remain in electronics in the region, employing around 45,000 people. Key firms include Sun Microsystems, Motorola, IBM, Microsoft, Oracle Corporation, Cadence Design Systems, 3Com, Adobe Systems, and National Semiconductor.

Another traditionally strong industry in Scotland has been food and drink, with 17 per cent of Scotland's manufacturing workforce and generating annual sales of £7.3 billion - £3 billion of this being for whisky. Oil and Gas is also a key sector with 100,000 jobs directly dependent on the sector.

In the Scottish economy, the service sector accounts for 72% of the GDP, while production is responsible for 19%. The other sectors having marginal contribution to the overall GDP includes forestry and fishing contributing 1.8% and construction and agriculture amounting to 7.1%. There is a consistent shift over time in terms of relative importance to the economy with the growth of the services sector and decline of production, construction, agriculture, forestry and fishing. In particular, financial services make a major contribution to the life and economy of Scotland and generate £7 billion almost 7% of Scottish GDP. The industry accounts for 10% of Scottish jobs, employing over 113,000 people directly and over 100,000 more in support services. Financial services continues to be the fastest growing sector of the Scottish economy. In the last five years, 2000 to 2005, financial services in Scotland grew by 36% while the overall Scottish economy grew by 9% and the whole of the UK financial services industry grew by 15%. In the six years to 2004, the yearly average direct employment in financial services in Scotland rose by 31.5% compared with 7.5% for the economy as a whole.

Scottish GVA was estimated as £82 million in 2004. GVA per head in 2005 was £16,944 while for the whole of UK is £18,051. For London, GVA per head is £24,075 which is the highest

among all UK regions and accounts for 17% of total GVA per head. By industry grouping, in 2004 the contribution to GVA highest was from real estate, renting and business activities which amounted to £15,878 followed by manufacturing which was £12,192. (Office of National Statistics, 2005)

Innovation is at the core of Scottish Regional Economic Development policy. The Scottish Executive has commissioned several studies using the Community Innovation Survey (CIS) datasets. Reports from CIS3 (which was collected in 2001 by the Department of Trade and Industry and covers the period of 1998 – 2000) suggests Scotland's performance is in line with the UK average for innovative activity. Scotland has the highest proportion of firms describing themselves as novel innovators introducing products and services which were not just new to the firm but also new to the market or industry. The latest CIS survey, CIS4 which covered the period 2002 – 2004, found that 56% of the Scottish firms were innovation active which is an increase from 44% in CIS3. Scotland apparently has one of the highest levels of novel innovation production in the UK. Nearly 28% of Scottish Businesses have implemented some form of product or process innovation according to CIS4. 65% introduced new products (not just to the firm) but new to the market compared to the UK average of 59%. The major innovative activity in Scottish firms is 'acquisition of machinery, equipment and software'. Scottish firms also enjoy a large share of 40% in training activities which is the highest proportion among all the UK regions.

In November 2004, the total number of enterprises (including public sector and nationalised entities) was 270,430 including both registered and un-registered businesses which accounted for 2,429,420 jobs. These consisted of Companies (including Building Societies) 57,980, Sole Proprietorships 51,375, Partnerships 31,985, Public Corporations/ Nationalised bodies 30, Central and Local Governments 185, Non-profit making bodies and Civil Society organisations 7,655 which made a total of 149,210 registered enterprises, are registered for VAT and/ or PAYE. The estimate of unregistered enterprises was 121,220 accounting for 143,140 jobs. (Scottish Economics Statistics, 2006)

Small and Medium sized Enterprises (SMEs) - enterprises with fewer than 250 employees, made up 99% of all enterprises and provided 53% of all jobs. Although the large firms which were 2240 in number are dominant in terms of a share of 60% of the entire turnover. (High Level Summary of Statistics, 2006)

Labour Market: Both the employment rate and the economic activity rate (those in employment or seeking employment) are at historically high levels. The employment rate for the period Jan-Mar 2006 stood at 75.3%, with the economic activity rate at 79.6%. The employment rate has increased by around 4 percentage points since 1999 with almost 180,000 more people in employment than in 1999. (High Level Summary of Statistics, 2006)

Currently Scotland is fifth highest out of the 12 UK regions in terms of employment rates and fourth in terms of economic activity rates. Moreover Scotland has higher economic activity and employment rates than England, Wales, Northern Ireland and the UK as a whole. The latest data show that Scotland has an unemployment rate of 5.3%. This is a reduction of 2 percentage points since 1999. Scotland has the third highest unemployment rate out of the 12 UK regions. (High Level Summary of Statistics, 2006)

3.1.2 Systemic characteristics of the region

Clusters are reported in Scotland in the areas of energy, construction, financial services, tourism, and electronics which are the major contributors to the GVA. Other specialised sectors include, aerospace, life-sciences, shipbuilding, forest industries among several others.

Scotland formulated cluster policies at an early stage. In 1991 the US based Monitor Company, was hired by Scottish Enterprise to examine the strength and emergence of clusters in Scotland. The Scottish economy was then dependent on foreign ownership, and Scottish Enterprise had relatively weak policies or mechanisms for local infrastructure or supporting the growth of SMEs. In 1998, a few clusters were initiated as pilot projects which included biotechnology, food and drink, and semi-conductors and was followed over the years by others such as Opto-electronics, Forestry and Tourism. Scotland was the initiator of the "cluster approach" within the UK. Lying at the heart of local economic development, the cluster approach promotes the diversity of different actors within an innovation system including customers, suppliers, competitors, research facilities, universities, etc. – the identification and development of synergies and dynamics of the strategic interaction of such linkages which provides improved business and economic performance (Roper, et. al 2006).

The cluster strategy in Scotland has varied over time, with some reshaping and definition of cluster targets, but currently the clusters being supported include emerging clusters such as Digital Media and Creative Industries and Life Sciences as well as mature clusters such as Chemicals, Construction, Electronics, Food and Drink, Forestry, Shipbuilding, Textiles and Tourism. In 2005 Scottish Enterprise commissioned a study of cluster policies in Scotland which suggested that whilst the rationale for the selection of clusters in Scotland remained, some aspects of the implementation of policy had lost focus, and strategic focus, and that there was confusion between cluster and industry strategies.

Cluster initiatives operate through a variety of mechanisms. The electronics cluster for example has a variety of industry associations and bodies, programmes for supply chain development, a capability directory, a programme to support new product development, support for WEEE recycling, and access to proof of concept funds.

3.1.3 The regional economy in the international context

Exports: From Scotland's Global Connections Survey (GCS), in 2004, total Scottish exports were estimated to be £17.5 billion. £12.3 billion or 70% of that amount being from production, manufacturing and construction sectors. Within the manufacturing sector, the electronics industry as a whole (defined as SIC divisions 30-33) had estimated exports of £4.1 billion, accounting for 37% of manufactured exports (24% of total exports).The Service sector was attributed with £4.6 billion or 26% and £0.6 billion, 3% was generated by the primary sector industries. The top five industries that were listed for exporting were food and beverages (£2.8 billion of which alcoholic beverages accounted for 80%), information communication technology equipment including radio and television for £1.4 billion, chemical and petroleum products for £1.7 billion, machinery for £1.8 billion and business services £1.8 billion (which were also one of the top exporting services being 37% of the total service exports). The others were wholesale/ retail & repairs and the hospitality industry (hotels and restaurants) accounting for £1.2 billion being 26% of the total services exports, financial intermediation for £0.9 billion, 19% of the total service exports.

Geographical destination of Exports: In 2004, the top destination for exports was the USA, which accounted for an estimated £2.6 billion (15% of total exports). Other significant markets were Germany and Netherlands which accounted for £1.6 million, 9% each for the total exports. The USA, Netherlands, Germany, France and Spain are the top 5 markets for Scottish exporters, and together they account for £7.8 billion which is 45% of the total exports. There have been marginal variations of traditional Scottish export markets within the EU which was partially offset by an increase of £0.3 billion to Asia due to the consistent growth of Chinese and Indian economies.

FDI/ Inward Investments: Integrated Scottish Inward Investment programmes dates back as early as 1981 with the launch of Locate in Scotland (LIS) as the first one door inward invest-

ment operation in the United Kingdom, jointly operated with staff seconded from The Scottish Office and Scottish Development Agency (later Scottish Enterprise). This was later re-branded as Scottish Development International (SDI) (http://www.sdi.co.uk) with partnerships of Scottish Enterprise, Highlands and Islands Enterprise and the Scottish Executive. In August 2002, the value of inward investment programmes went up to £271 million from £1.7 billion as it was in the previous year. With the new geographies of investment flowing to the far-east, there has been a global slow down and fall of investments in the western economies with a 50% drop in western economies in 2001. From Ernst & Young's European Investment Monitor it is observed that Scotland's share of total UK investments has been fairly constant. Interestingly, the E&Y Report has also confirmed that 20% of the inward investments coming to Scotland have a core focus on Research and Development which is double the figure of that of rest of the UK and Europe.

3.1.4 The local financial market

Regional Selective Assistance (RSA): This is the national grant scheme of financial assistance to industry. It is administered by the Enterprise and Lifelong Learning of the Scottish Executive and is used for providing assistance to firms in the Assisted Areas (AAs) as designated for the regional aid under European Community Law for creating and safeguarding employment, and enhance competitiveness and overall prosperity of the AAs through various projects. Since 2001 the Executive has received 1,118 applications for RSA totalling £514.9 million out of which 816 offers were accepted amounting to £281.5 million primarily linked to planned capital investment. This would create and safeguard 40,161 jobs out of £1.2 billion. So far £204 million was disbursed to the companies out of which UK-owned firms accounted for £172.8 million relating to projects with investments of £758.8 million and anticipated creation of 24,813 jobs. Among the accepted offers 664 UK firms compromised of 80% of the total offers. There were 72 firms from the US, 51 from Europe and 29 firms from the rest of the world. (Scottish Economic Statistics, 2006)

Other Financial Instruments

Scotland is well geared up encourage small business start-ups in the region as it has explored its strength in small firms as mentioned earlier. Through the Scottish Enterprise there are several grants and loans available to start a business, offering subsidies to major investments, technological innovations and development of business plans. They are dependent on the growth potential of the business: expected number of jobs and size of the investment; location and market sector whether technological innovation based or not, which might receive more priority and eligibility of the entrepreneur: age, qualifications for running the proposed business, employment status and if any matching funds secure from anywhere else. All of these services are managed by Business Gateway (http://www.bgateway.com/), which is a joint partnership between Scottish Enterprise, Scottish Executive and Local Authorities.

The following mechanisms of financing are available through Business Gateway

Soft Loans: These are unsecured loans without any collateral security, usually at better terms and lower interests than commercial bank loans. Amounts offered are generally between £5,000 and £10,000. The Small Firms Loan Guarantee Scheme offers a government guarantee against bank loans, particularly helpful for companies lacking collateral, which can be accessed through any bank.

Microcredit: Microcredit Programme provides low-cost, flexible loans as well as help and support to enable businesses to start up and develop more effectively. The maximum loan available to any person member is £5000 - and the maximum level of the first loan is £500.

Consultancy Scheme: Local enterprise companies, local authorities and other agencies also offer grants to support the costs of hiring consultants to develop and grow businesses.

High-Growth Businesses: The Business Gateway defines high growth companies as those with the potential to employ 15 or more employees, or to reach a turnover of at least £750,000 within their first three years. These kinds of companies are eligible for the Business Gateway's High-Growth Start-up Programme and are more likely to be eligible for other grants. Specialist support is available from local enterprise companies in the form of expert advice and business development and additional support may be available for innovative hi-tech businesses. The Scottish Executive also offers support to major investment projects and investments in technological innovations or significant business growth.

Prince's Scottish Youth Business Trust: The PSYBT leads Scotland in the promotion and support of self-employment and business creation amongst young people (between 18-25 years old), thus contributing to the economic development and community regeneration of the country's regions in line with the policy of the Scottish Executive.

There are other special schemes available which are restricted to particular locations, such as rural areas or areas with high levels of long-term unemployment.

Additionally, there are other funding tools which are supported directly by Scottish Enterprise and the Business Gate Way which include; Bootstrap finance, Venture Capitals and Business Angels. The Gate Way also supports services of managing finance and tax issues through set of specialist advisors.
(http://www.bgateway.com/bg-home/pg-bg-finance-and-grants/bg-other-funding-sources.htm)

3.2 Policy context

3.2.1 Policy objectives

The Scottish Executive has taken a very strong interest to promote innovation and entrepreneurship through a variety of programmes and subsidies. The Executive's enterprise strategy highlights the role which science, technology and innovation can play in increasing competitiveness and improving Scotland's economic performance in today's knowledge-based economy and they have clear strategies to maximise science and its application is a key driver of Scotland's future economic success and quality of life. The current budget for Scottish Enterprise for the year 2006-2007 is £550 million and there is additional emphasis through Smart Successful Scotland, on the drive to enhance skills and learning and drastically reduce the number of young people not in education, employment or training.

Highlands and Islands Enterprise is a public body headed by a Chief Executive and other members nominated by the First Minister of the Scottish Executive. The main body sits in Inverness with 9 Local Enterprise Companies (LECs) located around Highland Scotland; which act as a focal point of contact for businesses and communities for advice. Although Scottish Enterprise and Highlands and Islands Enterprise are separate entities their policies including those of economic development, innovation and entrepreneurship are defined by the Scottish Executive for promotion of business development in the regions.

Since mid and late 90’s the UK government has set its economic agenda on achieving high sustainable economic growth and levels of employment with regional policy being in the core. Particular attention has been placed on the business birth rate.

3.2.2 Policy instruments

At the national level, the Department of Trade and Industry (DTI) is responsible for supporting enterprise promotion and development related activities.. For smaller firms or SMEs and start-ups there are various opportunities available for business support, which are discussed below.

The main regional policy instruments that have an impact on RTDI are as follows:

Regional Structural Change: Scottish Enterprise through its diverse range of programmes constantly endeavours to provide tailor made solutions for regional businesses. Although after the devolution of power from the Scottish Office to the Scottish Executive, there have been several changes to funding allocation strategies. Since the establishment of Scottish Enterprise in 1991, it has been active in developing regional cluster strategies and specialisation of industry concentration in certain sectors. Over the last few years, the Scottish Executive particularly has promoted technological innovation led activities by providing additional funding to such organisations engaged in innovation.

Internationalisation of Regional Businesses: Scottish Enterprise has a specific division to support the internationalisation of regional firms globally. They have developed a specialist programme called Scottish Exhibition and Mission Programme (SEMP). Scottish businesses are encouraged to take part in such exhibitions to gain further knowledge on setting up businesses abroad. They maintain an online portal (http://www.scottish-enterprise.com/sedotcom_home/services_to_business_international/eo/events-semp.htm) which lists all countries they are about visit over the next few months with their details of respective trade missions in their embassies or consulates. Their links with UK Trade and Investment is excellent and provides a comprehensive portfolio to get market, sector and industry information of other countries. This has supported the Business Gateway Programme.

Entrepreneurship: Scottish Enterprise has programmes in place such as Enterprise Fellowships. These are jointly funded by the Scottish Enterprise and jointly delivered the Royal Society of Edinburgh for budding entrepreneurs who have an idea that they would like to commercialise. Apart from providing a full salary at the fellow's choice of institution for a year, it also provides access to a series of training sessions and workshops, network of professionals and the appropriate business training needed to run such proposed businesses.

SMEs: SME Technology Transfer in Optoelectronics and Microelectronics (TTOM) programme which is a £0.5m 3 year initiative funded jointly by the Scottish Enterprise Micro & Opto Electronics Team, ERDF and Scottish Executive SEEKIT programme to fund studies, of up to £5000, by partnerships involving any Scottish SME and researchers involved in microelectronics, optoelectronics and associated activities. Its aim is to enable a minimum of 25 technology transfer projects, particularly with a cross-sectoral and inter-disciplinary focus.

Qualification of Human Resources: In addition to the programmes as discussed above, Scottish Enterprise supports training and skills for young people. Careers Scotland (http://www.careers-scotland.org.uk/) is a careers advisory service which is jointly supported by Scottish Enterprise and the Highlands and Islands Enterprise and provides helps in filling in vacancies and with information on labour markets to the individuals. FutureSkills Scotland (http://www.futureskillsscotland.org.uk/) is a part of Scottish Enterprise and Highlands & Islands Enterprise aiming to help employers and others make decisions using labour market intelligence.

Exhibit 2: Effects of policies complementary to RTDI instruments on R&D and innovation capacity of the region

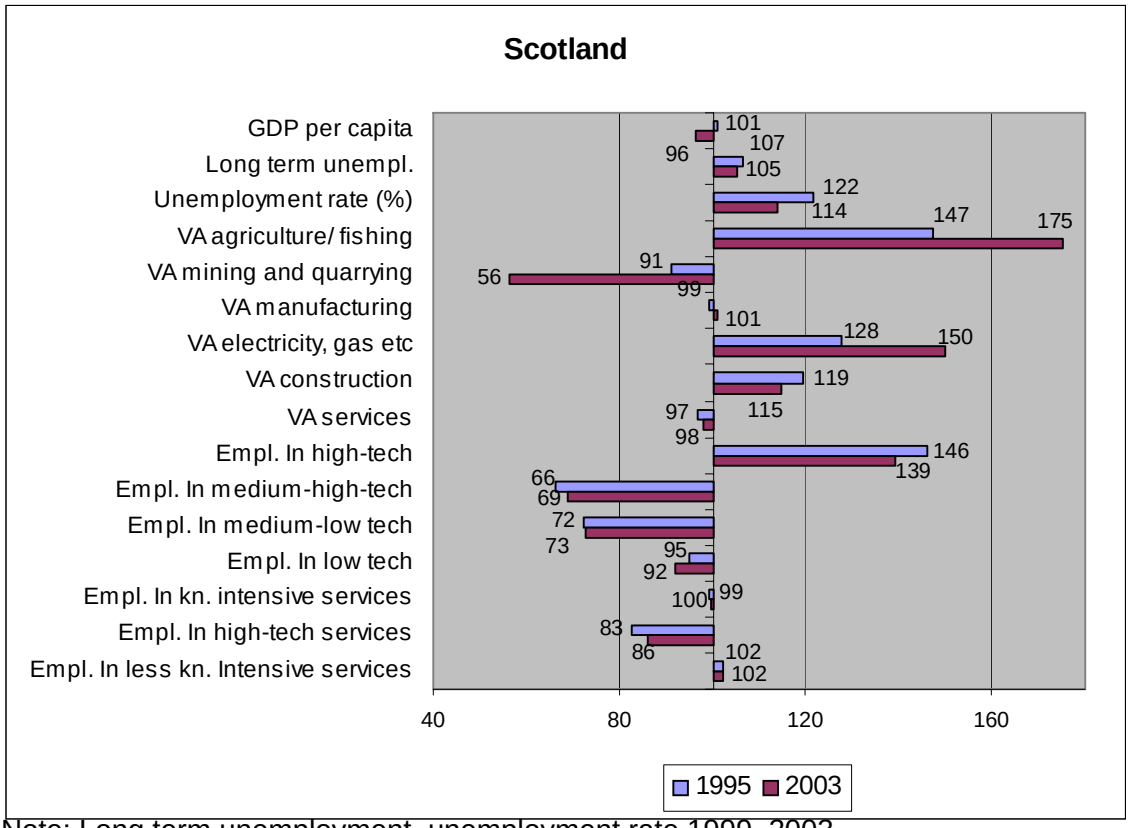
Policy Areas	Policies complementary to RTDI instruments affecting policy area*	Effects on R&D and innovation capacity of the region
Improve innovation and R&D governance	None	None
Creation of an innovation and entrepreneurial friendly environment	Various venture capital and finance schemes	Some support for new R&D performing firms
Development of human capital	Considerable investments have been made in human capital right across the spectrum from basic education to skills for employability and to high level technical and business skills.	Basic educational investment stimulates the interest of young people in careers in science and technology. Advanced skills provide capacity in the private sector to better absorb technical knowledge from outside the firm.
Networking, co-location and clustering measures	Scottish Enterprise cluster initiatives	Complementary initiatives
Knowledge and technology transfer to enterprises	Supported indirectly by a variety of cluster development policies which reinforce the need for access to the knowledge base.	Increased interest in collaboration between universities and industry.
Research collaboration of public research organisations with private sector	None	None
Support of public research	None	None
Financial R&D measures for the private sector	Regional funding programmes assist R&D based projects	Direct financial support is available.

*[*Examples* of *such policies are the fiscal, industrial, regional, educational, labour, trade and competition policies.]*

3.3 Conclusions

In recent years the Scottish economy has converged somewhat with the UK average particularly based around growth in services. Unemployment remains above the national average but is relatively low still in EU terms. There remains a degree of specialisation in agriculture and energy, which is geographically determined, and relates to specific clusters in food and oil and gas. Construction also has a high share of GVA and is perhaps related to a low share of services, and similar apparent concentration of construction can be observed in other peripheral regions.

Summary Graph 2: Comparison of Scotland's economic structure with the economic structure of the UK



Note: Long term unemployment, unemployment rate 1999, 2003

Within manufacturing there is an over-representation of high tech industries relative to other manufacturing industries, largely as a result of high historic investments in electronics and ICTs from overseas. This is however qualitatively different from high tech concentrations elsewhere in the UK and is characterised by high levels of routine production work relative to R&D and other high status activities.

Services are quite strong in Scotland, notably in the form of financial services in Edinburgh and Glasgow and as such fares better than many other peripheral regions in the UK. Despite this, and the strengths in ICT manufacturing though, Scotland remains slightly weak in new knowledge based and high tech services as there is no connection between the ICT manufacturing and service sectors.

4 Conclusions

4.1 Assessment of the RIS

Scotland has many of the elements that one would expect of an innovation system, and in some respects has elements with national characteristics, yet there are limits to the degree of coherence, particularly in the private sector, and this leads to a questioning of the systemic nature of innovation in Scotland. The system is particularly strong and well-defined on the public sector side, and in addition to a set of well established and well funded initiatives and universities, there is a clear policymaking capacity which seeks to provide coherence and coordination. Policy has been devoted both to developing the research and science base and supporting innovation and exploitation. There has been analysis of existing structures and strengths and weaknesses and attempts to adjust policy to fill the gaps and overcome structural weaknesses.

The system has been developed through investment in the knowledge base and support for the transfer of knowledge out from the universities and public sector, and hence there has been significant effort devoted to the development of a rich network of interactions and linkages among the different actors. One example of this is the Connect Scotland initiative which has fostered links between the technology base and networks of business and financial services, but oriented to the formation of new ventures. This is also typical of an infrastructure that focuses more on new ventures than on transferring knowledge to existing SMEs. Consequently we can say that networking for innovation development is relatively under-developed, and all public programmes struggle to involve SMEs.

Scotland has a strong track record of investment in strategy building, and there has been a number of high profile and well resourced studies of the economic problems, all of which have aimed at understanding the nature of the problem and learning lessons from success and from elsewhere. Compared with other UK regions the learning capacity of Scotland is very well developed.

Scotland also has a high degree of autonomy to decide or influence decisions on investments and policy measures, as a result of devolution and the wide-ranging powers given to the Scottish Parliament and Executive. This can be seen in the development of the Science Strategy and the responsibility of Scotland for higher education and for some aspects of basic science investment. Scotland has a higher degree of autonomy than any other region or devolved body in the UK.

Scotland also has strong financial capacity with a great number of public and private financing mechanisms. The public sector support for finance is well developed, and well targeted on spin off firms. Private sector finance resources are extremely well developed in general although less well focused on small new technology based firms. The financial institutions are well networked through Connect Scotland and there are good learning processes between firms.

Whilst there is some degree of match between the knowledge specialisation of the region and the main economic clusters, there are also areas of excellence in the universities that do not connect well with the local economy. Scottish Enterprise has been trying to enhance the connections between the research base and the industrial base through its cluster strategies and more recently through the development of ITIs but is always hampered by the weak industrial base. Many of the universities retain very strong links with international business, both within Scotland and elsewhere, and would see the continuation of such links as important to their own development strategy.

Exhibit 3: Matching of knowledge and economic specialisation

Knowledge production in the region	Related economic sectors	Specialisation of the Regions' economy	Conclusions
Biotech	Agro-food Pharma	Agro-food Growing pharmaceutical industry	Biotech capabilities with links to agro-food but focused on smaller specialised firms.
ICT	ICT manufacture	ICT manufacture	Longstanding focus on ICT with some connections between HEIs and overseas owned businesses
Oil and gas	Offshore oil industry	Offshore oil specialisation in Aberdeen region	Local orientation of Aberdeen University to the needs of the local oil and gas cluster.

Exhibit 4: Strengths and weaknesses of the regional innovation system

	Strengths	***Weaknesses***
Knowledge creation capacity	*Particularly strong in terms of university research capacity and high emphasis on the development of human capital.*	*Level of private sector investment in R&D is low. Public sector research institutions are heavily oriented to agriculture and environmental areas rather than industrial technologies. Absence of a set of industrial research and transfer institutions like the Fraunhofer institutes, only partly addressed by the new ITIs.*
Knowledge diffusion capacity	*Extensive network of transfer mechanisms within the universities. Increasing resources available to support knowledge transfer*	*Tendency to discount the possibility of diffusion to local Scottish firms in favour of spin offs.*
Knowledge absorption capacity	*High participation in higher education and strong skill base within the workforce*	*Weak absorptive capacity among SMEs in the manufacturing sector*
Interactions of main actors	*Good networking among the knowledge creation sector, and between universities and financial services etc*	*Weak links between HEIs and local Scottish firms*
RTDI governance capacity	*Clear governance structures developing under the influence of the Scottish Executive. Clear strategies for science and for innovation and economic development*	*Weak involvement from the SME sector*

Economic Structure	*Very strong financial resources in Edinburgh. Strengths also in some high tech sectors such as electronics, although dominated by overseas owned companies*	*Weak SME base.*

4.2 Assessment of policies

Scotland has been developing RTDI policies since the early 1990s and has made significant investment in policy analysis and development during the 1990s, leading to initiatives to support technology commercialisation, entrepreneurship and knowledge transfer. Devolution has enhanced this process with greater autonomy over public sector research activities, a stringer role in higher education policy, and new strategies for science and innovation. It is expected these will be further integrated in a new science and innovation strategy in mid 2007.

The existing policies have been effective at developing and strengthening the science base, and also at promoting commercialisation through spin offs and Scotland appears to be successful at starting new spin offs when compared with the UK and US. However the long term successful growth of such firms remains unproven despite a very favourable policy regime.

Where policies have been less successful has been in the effective development of indigenous SMEs and the encouragement of innovation and knowledge exchange to this group. Considerable focus on cluster development and endogenous enterprise over recent years has yet to realise real benefits as manufacturing continues to shrink, and the real successes of the Scottish economy have been in services, and like the rest of the UK regions recent employment growth has been concentrated in consumer and business services and in the public sector. It is difficult to show that this employment growth owes anything to RTDI policies.

4.3 Challenges and trends of the knowledge economy

Scotland is in many ways well placed to benefit from the knowledge economy, with high levels of graduates in the labour market, a high participation rate in HE, and a strong service and financial base in Edinburgh and Glasgow. Scotland also has a well developed cultural and tourism sector again with good knowledge intensive components. The main weakness lies in the manufacturing sector and in some aspects of knowledge based services. Yet the manufacturing sector is the source of Scotland's difficulties in terms of a traditional, underskilled low value added economic base.

Scotland remains well short of the targets for R&D activity, mainly as a result of poor levels of business R&D, although currently in the UK there is a debate over whether R&D measures are appropriate ways to assess investment in knowledge economy activities as many of the knowledge sector where the UK is strong do not declare significant R&D investments, such as creative industries and financial services.
The most important challenges for Scotland in the knowledge economy are:

- To enhance the investment in the manufacturing and SME sector in product innovation and related marketing and value adding activities.
- To ensure that there is a closer relationship between higher education and industry in the region
- To raise the level of entrepreneurship especially in technology based services.

Exhibit 5: Identification of policy challenges

Policy challenge	**Corroborating indicator**	**Effective approaches** *[only measures which appear to have a significant contribution to facing the challenge are presented]*
To enhance the investment in the manufacturing and SME sector in product innovation and related marketing and value adding activities	• *Low BERD*	*Effective measures still to be identified*
To ensure that there is a closer relationship between higher education and industry in the region	• *Low rates of knowledge transfer to SMEs*	*Effective measures still to be identified*
To raise the level of entrepreneurship especially in technology based services	• *Low rate of firm formation*	*Effective measures still to be identified*

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Annex 1: Definition of policy mix typology

- **Improve innovation and R&D governance capacity**: Technical assistance type funding used by public authorities, regional agencies and public-private partnerships in developing and improving policies and strategies in support of R&D investments and innovation. This could include changes in the organisation of decision making, national and regional foresight, measures for improvement of evaluation etc.
- **Creation of an innovation and entrepreneurial friendly environment**: This category covers a wide range of actions which seek to improve the overall environment in which enterprises, universities and research organisations innovate. In this category the following measures are included:
    - Promotion of an entrepreneurial and innovation culture in the private sector by undertaking awareness initiatives and by changing regulations and disincentives which discourage entrepreneurship;
    - Regulation and initiatives addressing the intellectual property rights either by improving legislation in cases of commercialisation of public or collaborative research or by covering protection costs.
    - Direct or indirect support of spin-offs and New Technology Based Firms (NTBFs). Direct support includes public financial schemes such as pre-seed and first stage capital, while indirect measures include funding of incubators, training related to entrepreneurship, etc.
- **Development of human capital:** This category includes measures aiming at the upgrading of human resources in R&D and innovation related activities, such as supporting science and technology graduates to follow research and innovation-oriented careers; training of researchers in enterprises or research centres; intra- and international mobility of scientists; curriculum development in higher education aimed at developing science and technology; orientated under- and post-graduate courses etc.
- **Networking, co-location and clustering measures**: Policies under this category focus on remedying deficiencies in innovation systems by promoting cooperation, networking and interaction. Measures promoting co-location of industrial and scientific organisations (e.g. innovation poles), funding for clusters infrastructure and activities with technological and innovation orientation and support of innovation networking (e.g. information exchange clubs) are some of possible interventions under this category.
- **Knowledge and technology transfer to industry**: This category includes policies supporting directly or indirectly knowledge and technology transfer from universities and public research organisations and commercialisation of public research results. Direct support includes aid schemes for utilising technology-related services or for implementing technology transfer projects from public or private sector to the private sector. Indirect policies include development of infrastructures facilitating technology transfer such as technology parks, innovation centres, university liaison and transfer offices, etc.

- **Research collaboration of public research organisations with private sector:** Measures supporting collaborative research projects and development of common (for use by private and public sector) research infrastructures are included.
- **Support of public research:** Measures under this category include:
    - public investments in research infrastructure and direct funding of public R&D e.g. setting up new infrastructures, or supporting centres of excellence.
    - grants for R&D projects implemented in Universities and other Public Research Organisations.
    - regulatory changes and incentives for universities and other public research organisations which encourage the commercialisation of research results and collaboration with industry.
- **Financial R&D measures for the private sector**: Two main categories of measures are included:
    - **Direct and indirect financial R&D measures for the private sector:** Direct measures **i**nclude direct public funding of R&D in the private sector e.g. grants, conditional loans etc. Indirect measures include tax incentives for firms to undertake R&D activities.
    - **Catalytic Financial R&D Measures for the private sector:** Includes instruments facilitating the access of R&D performers to external private sector sources of finance. Typical measures of this type are measures encouraging the use of *risk capital* (e.g. venture capital funds) for both R&D and innovation related activities and the *loan and equity guarantee measures.*

Annex 2: Description of key indicators used in Summary Graphs 1 and 2

Period of coverage: Two years are used i.e., 1995 and 2004 or the closest possible years
Index: Country=100
Source: Eurostat, 2006

Summary Graph 1: Key indicators of region's knowledge base development in comparison to country

1. Total intramural R&D expenditure as a percentage of GDP
   - GERD
   - BERD
   - GOVERD
   - HERD
   - PNPERD .
2. R&D personnel as a percentage of total employment
   - All sectors
   - Business
   - Government
   - Higher education
   - Private non-profit
3. Human Resources in S&T as a percentage of labour force
4. Patent applications at EPO per million inhabitants
5. Students in tertiary education (ISCED 5+6) per thousand inhabitants.
6. Life Long Learning: Participation of adults aged 25-64 in education and training as a percentage of population

Summary Graph 2: Key indicators on Region's economic structure and development

1. GDP per capita at current market prices.
2. Long-term unemployment rate (on total unemployment).
3. Unemployment rate (%).
4. Value-added at basic prices (EUR million): Share (%) of sectors to total.
   - Agriculture/ fishing
   - Mining and quarrying
   - Manufacturing
   - Electricity, gas and water supply
   - Construction
   - Services (excl. extra-territorial organizations and bodies)
5. Annual data on employment in technology and knowledge-intensive sectors at the regional level : Percentage of total employment
   - High technology manufacturing: NACE Rev. 1.1 codes 30, 32 and 33
   - Medium high technology manufacturing: NACE Rev. 1.1 codes 24, 29, 31, 34 and 35
   - Medium low technology: NACE Rev. 1.1 codes 23 and 25 to 28
   - Low-technology: NACE Rev. 1.1 codes 15 to 22 and 36 to 37
   - Total knowledge-intensive services: NACE Rev. 1.1 codes 61, 62, 64 to 67, 70 to 74, 80, 85 and 92
   - Knowledge-intensive high-technology services: NACE Rev. 1.1 codes 64, 72, 73
   - Total less-knowledge-intensive services: NACE Rev. 1.1 codes 50, 51, 52, 55, 60, 63, 75, 90, 91, 93, 95 and 99

Annex 3: Tables and Figures

Figure 1: Universities in Scotland

	Students 2004-05	External research income 2004-5 (000s)
University of Abertay Dundee	4,155	1721
Edinburgh College of Art	1,710	454
Glasgow School of Art	1,575	802
Queen Margaret College	5,150	2390
RSAMD	700	89
The Robert Gordon University	12,440	3012
The University of Paisley	13,155	1817
Glasgow Caledonian University	16,550	3411
Napier University	15,240	2708
The University of Edinburgh	23,635	103969
The University of Glasgow	24,490	76993
The University of Strathclyde	25,290	26290
The University of Aberdeen	15,355	38622
Heriot-Watt University	18,110	15059
The University of Dundee	19,110	41647
The University of St Andrews	8,190	22492
The University of Stirling	8,465	7629
Scottish Agricultural College	795	8563
UHI Millennium Institute	6,365	7631
Bell College	3,915	126

Source Higher Education Statistics Agency

Figure 2igure 3: Public research centres and institutes

	Research income from Scottish Executive (£000)	Other research income (£000)	Total research income (£000)
SEERAD Main Research Providers			
Hannah Research Institute	6,960	4,640	11,600
Moredun Research Institute	6,770	2,408	9,178
Macaulay Land Use Research Institute	7,150	2,030	9,180
Rowett Research Institute	6,960	2,784	9,744
Scottish Crop Research Institute	9,488	1,841	11,329
Scottish Agricultural College	5,633	6,614	12,247
Total	42,961	20,317	63,278
Other Research Institutes			
Roslin Institute	---	12,570	12,570
SAMS	N.A.	N.A.	N.A.
Total	42,961	32,887	75,848

[1] Time period varies from 2001 to 2003.
Source: Various

Source: Roper et al 2006

Figure 3: BERD by UK region 2003 to 2005

	2003	2004	2005	% total 2005
Scotland	508	494	584	4.4
North East	152	153	158	1.2
North West	1545	1742	1887	14.1
York-shire/Humber	345	348	350	2.6
East Midlands	868	960	1019	7.6
West Midlands	809	772	735	5.5
East of England	2936	2703	3316	24.7
London	709	792	630	4.7
South East	3252	3214	3163	23.6
South West	1229	1297	1201	9.0
Wales	207	226	231	1.7
Northern Ireland	116	116	136	1.0

Source ONS, Buisness Monitor MA14, 2007

Figure 4: GERD as a % of GVA by region

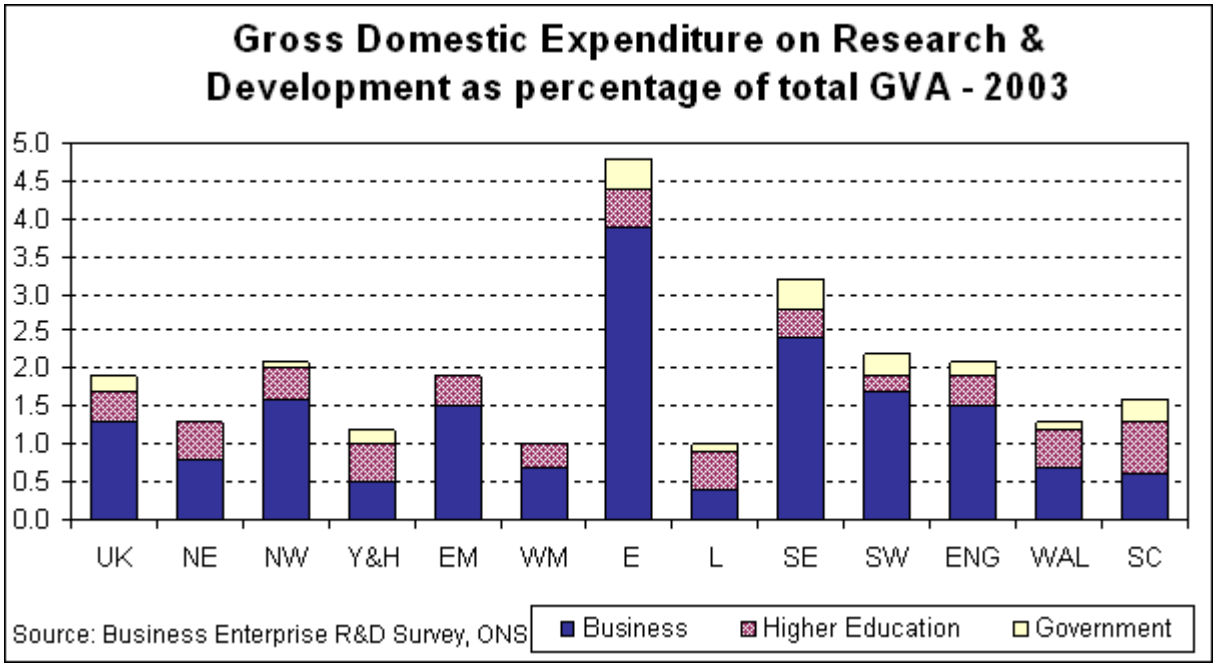
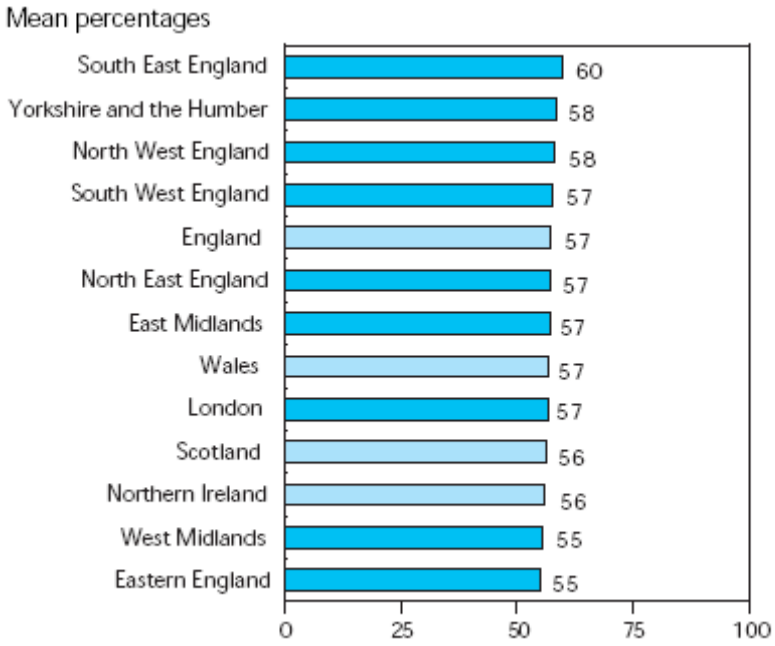


Figure 5: Proportion of innovative businesses by region, 2005



Source: Community Innovation Survey 2005, published in Robson, S and Ortmans, L (2006) First findings from the UK Innovation Survey, 2005, Economic Trends, 628 March 2006

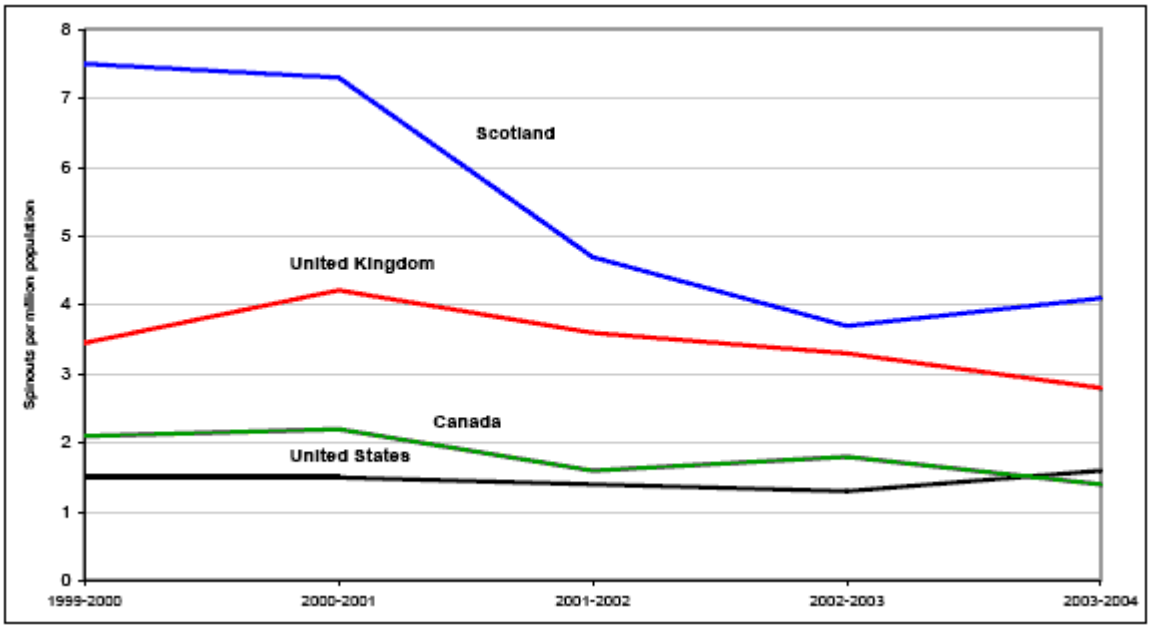
Figure 6: R&D Expenditure in Manufacturing: Scotland and the UK - 2002

	Scotland £ per employee	UK £ per employee	Scotland UK=100
Food Products and beverages: Tobacco	119	648	18.4
Textiles, clothing and leather products	78	98	79.4
Pulp, paper and paper products; Printing and publishing: Wood products	21	85	24.3
Refined petroleum products and coke oven products: Processing of nuclear fuel	na	10167	Na
Chemicals. Man-made fibres, Pharmaceuticals	16630	16664	99.8
Rubber and plastic products	na	294	Na
Other non-metallic mineral products	na	374	na
Basic Metals	na	500	na
Fabricated metal products	205	165	123.9
Machinery and equipment	2437	2465	98.8
Office machinery and computers	503	3563	14.1
Electrical machinery and apparatus	2744	3168	86.6
Radio, television and communication equipment	9700	11052	87.8
Precision instruments	5971	3408	175.2
Motor vehicles and parts	537	4494	12.0
Transport Equipment	1106	16148	6.8
Furniture: Other manufactured goods	361	250	144.4
Recycling	na	216	na
All Manufacturing	2093	2885	66.4

Notes and Sources: R&D Spending, Table 2, Scottish Executive (2004).
Employment, ABI for Great Britain and Scotland (from Nomisweb), ABI report from DETI in Northern Ireland.

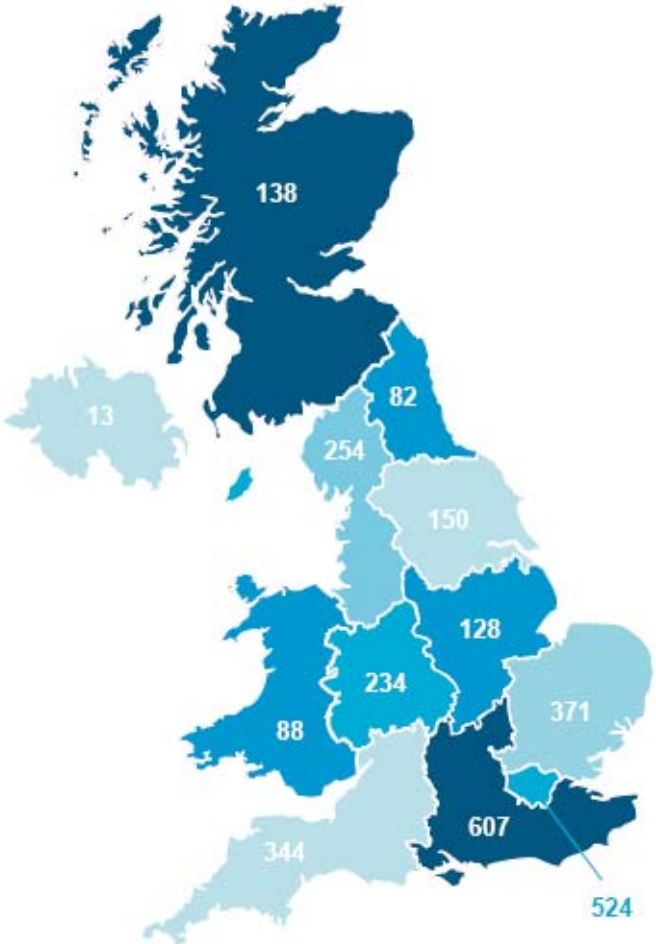
Source: from Roper et al, 2006

Figure 7: University spin outs per million of population



Source: AUTM (2005), HEFCE (2006), ONS (2006), OECD (2006).

Figure 8: UK patents by region (2006)



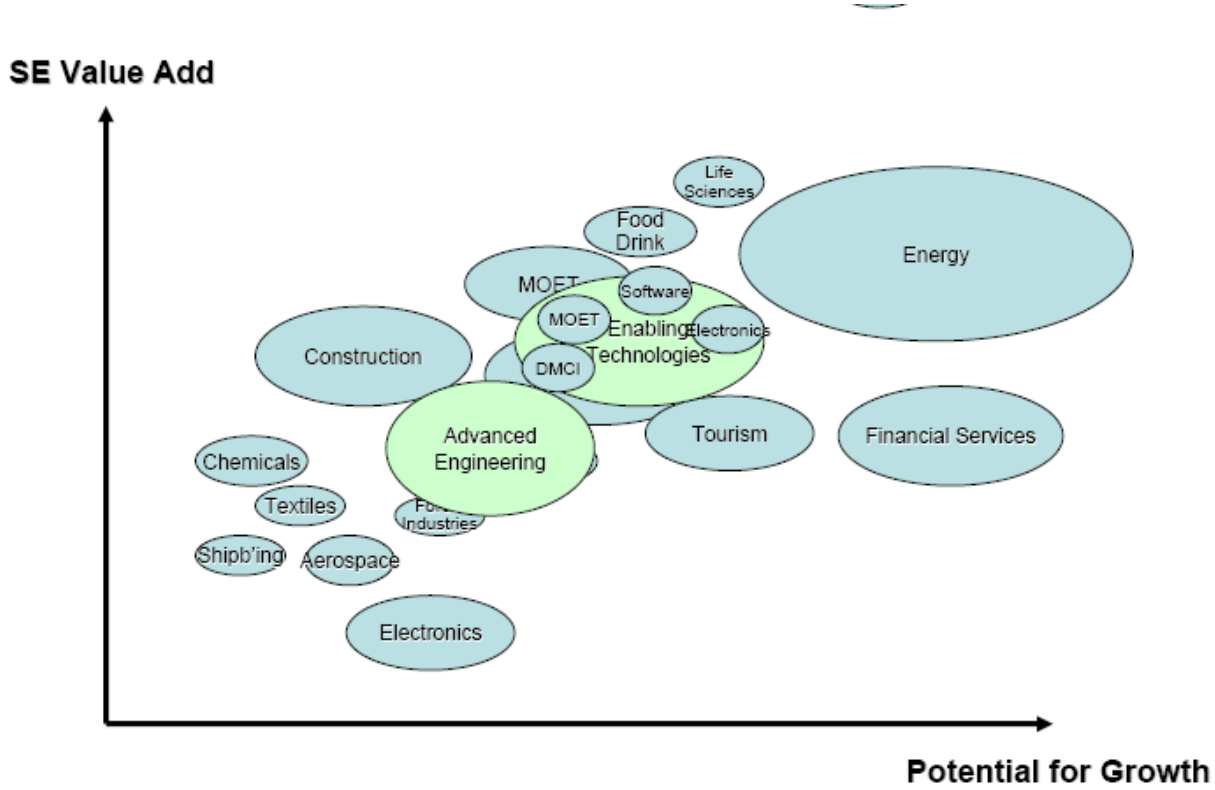
Source Patent Office Annual review 2006

Figure 9: Patent applications filed and granted by region*

	Number of Applications Filed		Number of Applications Granted	
Region	2005	2006	2005	2006
East Midlands	775	768	174	128
East of England	2,181	2,082	484	371
London	3,242	3,075	570	524
North West	1,497	1,537	312	254
Northern Ireland	253	238	32	13
North East	417	357	64	82
Scotland	1,053	1,131	179	138
South East	3,184	3,106	822	607
South West	1,580	1,764	390	344
Wales	621	652	147	88
West Midlands	1,280	1,219	287	234
Yorkshire	1,227	1,301	200	150
Unmatched Postcodes**	178	254	90	45
Total	**17,488**	**17,484**	**3,751**	**2,978**

* Patent applications for the first named applicant at the time of filing.
** Full address details not given at point of data capture.

Figure 10: Cluster positioning, size and growth potential



Source: Scottish Enterprise (no date)

Figure 11: Employment in high and medium tech industry

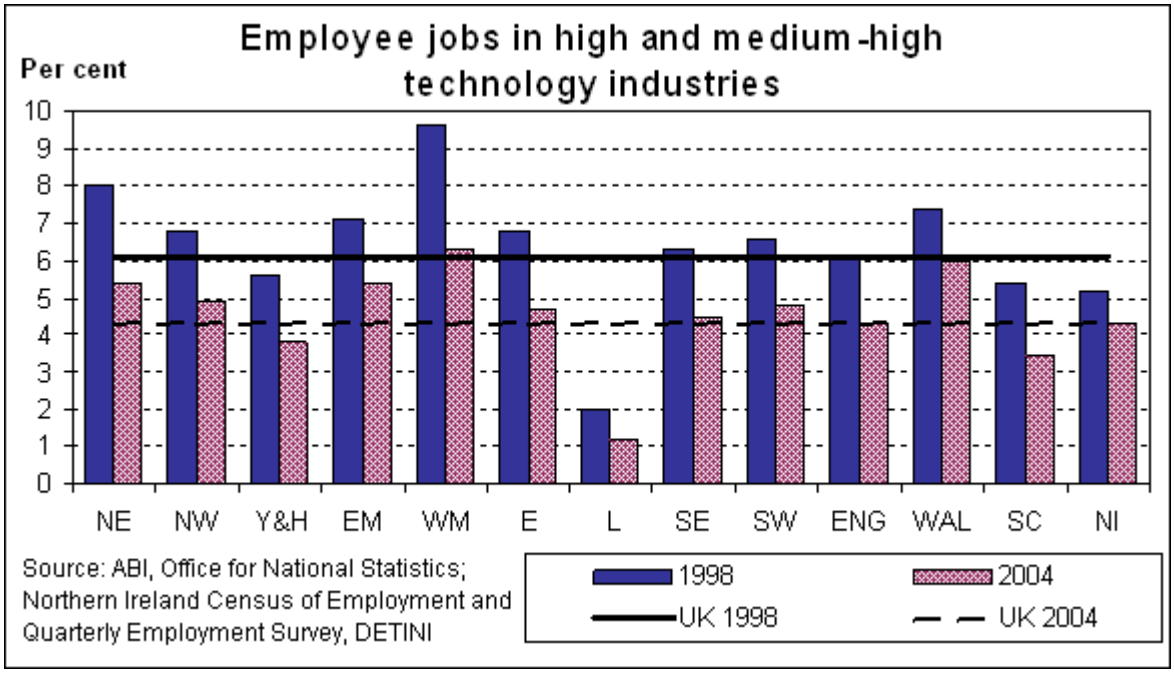


Figure 12: Scottish Food and Drink cluster

Launched in 1999, Scottish Food & Drink is an industry-led strategy which seeks to increase the competitiveness of the food and drink industry in Scotland by 2010. The clear vision it sets out is one of a thriving industry with an unrivalled reputation, achieving profitable growth that is consumer focused, market led and successful internationally. Scottish Food & Drink is now acknowledged as a unifying identity for the industry and is recognised as a force which helps meet the industry's specific challenges.

From the outset it was a strategy led by industry and facilitated by Scottish Enterprise, with support from key stakeholders including the Scottish Executive Environment and Rural Affairs Department (SEERAD) and Highland and Island Enterprise. It was formulated after extensive consultation with more than 1000 members of the food and drink cluster which includes the food, drink, agriculture, fish, aquaculture, science and the education base, as well as other supporting organisations. It is driven by an Industry Strategy Group with membership from key industry players

The highly successful performance of the industry over the last few years parallels the launch and implementation of the strategy. A review of progress at the half-way stage shows that from being an industry in decline before the strategy was launched, strong growth has been experienced since then, with the industry out-performing manufacturing in Scotland and the economy as a whole.

The food sector has delivered positive gross value add (GVA) growth in 14 out of 18 quarters since the strategy was launched in 1999. It consistently outperforms the economy and the manufacturing sector, exceeding manufacturing in 15 out of 18 of the quarters covered, and the total economy in 12 of the quarters covered.

A particular focus has been on establishing an industry that can work together – one that shares best practices and co-operates to achieve a competitive advantage in the marketplace. It aims to promote strong linkages across the cluster – between farmers, fishermen, processors and customers, with the whole industry pulling in one direction with a culture of innovation and investment in people, processes and marketing. It has concentrated on helping the industry to achieve growth and increase productivity through cost efficiencies, adding value and targeting market opportunities which will give the greatest returns.

Extract from http://www.scottishfoodanddrink.com/view_item.aspx?item_id=7180

Annex 4: RTD policies

Title of the measure or initiative: *SMART:SCOTLAND*
Objectives: SMART:SCOTLAND is intended to help small and medium-sized businesses to improve their competitiveness by developing new, highly innovative and commercially viable products or processes to the benefit of the national economy.
Policy Area *(Taxonomy used in Exhibit 1)***: Financial R&D ,measures for the private sector**
Main instruments and structure: Successful applicants receive funding of 75% of the cost of carrying out a technical and commercial feasibility study lasting between 6 and 18 months. The maximum award is £50,000. SMART:SCOTLAND winners who successfully complete their projects and who need more help to develop a pre-production prototype can get further support through the SPUR programme.
Main beneficiaries /target group: SMEs and start up firms in high technology sectors
Achievements or failures *(why it is an example of good practice or a failure)***:** An evaluation of SMART in Scotland has been undertaken by PACEC and their main conclusions are as follows: • "SMART has genuinely encouraged technological innovation in SMEs. Although it is not clear to what extent this innovation has been significant, it should be noted that award winners were rather more concerned with developing entirely new products, processes and services, rather than with improving existing products, processes and services. • The large majority of projects result in at least some market place impact, but SMART is likely to have longer term effects because it changes award winners and helps them to develop, rather than simply enabling them to obtain sales of project outputs. • The scheme addresses distinct market failures in the supply of finance to SMEs. • The effects of SMART projects are largely additional (i.e. would not happen anyway in the absence of the scheme). • There is only limited scope to improve the administration of the scheme. This would mainly involve providing firms with more assistance with the preparation of their applications. • It is not clear how well SMART is integrated with the rest of the business support infrastructure."

Title of the measure or initiative: Proof of concept programme

Objectives: The Proof of Concept Programme supports the pre-commercialisation of leading-edge technologies emerging from Scotland's Universities, Research Institutes and NHS Boards. It helps researchers to export their ideas and inventions from the lab to the global marketplace.

Policy Area: Knowledge and technology transfer to enterprises

Main instruments and structure:

Projects can be typically defined as occurring after advances made during curiosity-driven or strategic research. This is usually after a background patent has been filed, but before the following:

- A full lab-scale demonstration of the technology.
- Any pre-production development/prototyping.
- Commercial funds for development have been made available (because of the existing level of technical and market risk).

The project can fund the following costs for the development of the product:
Personnel – salaries;.
consumables;
market assessment;
patent costs;
equipment essential to the project;
subcontracting; and,
travel.

Main beneficiaries /target group:

Academic researchers and spin offs

Achievements or failures *(why it is an example of good practice or a failure)***:**

Since its inception in 1999, the Programme has supported 184 groundbreaking projects worth over £30 million and has already created over 500 new jobs through 33 spin out/start up companies and 31 licensing deals.