12 Science and technology

Research and development (R & D) is often considered as a driving force behind growth and job creation. However, its influence extends well beyond the economic sphere, as it can potentially, among others, resolve environmental concerns, ensure safer food, or lead to the development of new medicines to fight illness and disease.

The seventh framework programme for research and technological development (FP7) is the EU's main instrument for funding research in Europe ([1]); it runs from 2007-2013 and has a total budget of EUR 53 200 million. This money is generally intended to finance grants to research actors all over Europe, usually through co-financing research, technological development and demonstration projects. Grants are determined on the basis of calls for proposals and a peer review process.

The main aims of FP7 are to increase Europe's growth, competitiveness and employment. This is done through a number of initiatives and existing programmes including, the competitiveness and innovation framework programme ([2]), educational and training programmes, as well as regional development through structural and cohesion funds. FP7 is made up of four broad programmes – cooperation (collaborative research), ideas (European Research Council), people (human potential, Marie Curie actions) and capacities (research capacity). Through these four specific programmes, the aim is to create European 'poles of excellence' across a wide array of scientific themes, such as information technologies, energy and climate change, health, food and social sciences. FP7 also foresees specific programmes for EURATOM nuclear research and training

([1]) For more information: http://cordis.europa.eu/fp7/home_en.html.

([2]) For more information: http://cordis.europa.eu/innovation/en/policy/cip.htm.

activities, and direct research at the European Commission's own research institute (the Joint Research Centre (JRC)), where activities are focussed on: food, chemical products and health; environment and sustainability; and nuclear safety and security.

Science is becoming increasingly complex and costly. Today's researchers increasingly need to work together and they need access to advanced technical equipment. In 2000, the EU decided to create the European Research Area (ERA): a unified area all across Europe, which should:

- enable researchers to move and interact seamlessly, benefit from world-class infrastructures, and work with excellent networks of research institutions;
- share, teach, value and use knowledge effectively for social, business and policy purposes;
- optimise and open European, national and regional research programmes in order to support the best research throughout Europe and coordinate these programmes to address major challenges together;
- develop strong links with partners around the world so that Europe benefits from the worldwide progress of knowledge, contributes to global development and takes a leading role in international initiatives to solve global issues.

A debate was conducted during 2007 on what should be done to create a more unified and attractive research area to meet the needs of business, the scientific community and citizens. In May 2008 a set of ideas to develop the ERA were launched as part of what has become known as the 'Ljubljana process', including specific initiatives for five different areas: researchers' careers and mobility; research infrastructures; knowledge sharing; research programmes, and; international science and technology cooperation. In December 2008, the Competitiveness Council adopted a 2020 ERA vision ([3]), which foresees the introduction of a 'fifth freedom' across the ERA – namely, the free circulation of researchers, knowledge and technology.

12.1 Expenditure

Introduction

Research and development (R & D) comprises creative work undertaken to increase the stock of knowledge (of man, culture and society) and to devise new applications. The European Commission has placed renewed emphasis on the conversion of Europe's scientific expertise into marketable products and services. R & D lies at the heart of the EU's strategy to become the most competitive and dynamic knowledge-based economy by 2010; one of the original goals set by the Lisbon Strategy was for the EU to increase its R & D expenditure to at least 3 % of GDP by 2010.

One area that has received notable attention in recent years is the structural difference in R & D funding between Europe and its main competitors. Policy-makers in Europe have tried to increase R & D business expenditure so that it is

([3]) For more information: http://ec.europa.eu/research/era/2020_era_vision_en.html.

more in line with the ratios observed in Japan or the United States. The European Research Area (ERA) is designed to overcome some of these barriers that are thought to have hampered European research efforts, for example, by addressing geographical, institutional, disciplinary and sectoral boundaries.

In January 2006 the European Commission presented to the European Council its 2006 annual report on the revised Lisbon Strategy, in the form of a Communication – COM(2006) 30 – titled 'time to move up a gear – the new partnership for growth and jobs' ([4]). One of the four areas for priority actions was to invest more in knowledge and innovation, and to increase the proportion of national wealth devoted to research and development through to 2010. The Communication also referred to planned spending targets for R & D, stating that if these were met in the 18 countries that had set targets as part of their national plans then R & D expenditure was estimated to rise to 2.6 % of GDP by 2010. The Communication also stressed that while all Member States appreciate the importance of the spread and effective use of information and communication technologies and environmental technologies, the link between the identified challenges and the measures proposed to address them in national plans was not always clear.

In November 2009, the EU industrial R & D investment scoreboard was released ([5]). This presents information on the top 1 000 investors whose registered offices are in the EU and the top 1 000 companies registered elsewhere. The report shows that R & D investment by these EU companies grew by 8.1 % in 2008 despite the economic crisis that took hold in the second half of the year. This rate of growth was faster than that recorded for companies from either Japan or the United States, although higher R & D investment growth was registered by companies based in the emerging economies of China and India. Volkswagen had the highest level of R & D investment (EUR 5 930 million) among EU companies in 2008, while Nokia was also among the global top 10, which was led by Toyota Motors (Japan) and Microsoft (United States).

Definitions and data availability

Gross domestic expenditure on R & D (often referred to as GERD) is composed of four separate sectors of performance: business enterprises, government, higher education, and private non-profit organisations. Expenditure data consider the research spend on the national territory, regardless of the source of funds; data are usually expressed in relation to GDP, otherwise known as R & D intensity.

R & D expenditure is a basic measure that covers intramural expenditure, in other words, all expenditures for R & D that are performed within a statistical unit or sector of the economy. Expenditures made outside the statistical unit or sector but in support of intramural R & D (for example, purchase of supplies for R & D) are included; both current and capital expenditures are included.

Government budget appropriations or outlays for research and development (GBAORD) cover the amounts govern-

([4]) For more information: http://eur-lex.europa.eu/LexUriServ/site/en/com/2006/com2006_0030en01.pdf.

([5]) For more information: http://iri.jrc.ec.europa.eu/research/scoreboard_2009.htm.

ments allocate towards R & D activities and include all appropriations allocated to R & D in central (or federal) government budgets. Provincial (or state) government is only included if the contribution is significant, whereas local government funds are excluded. Comparisons of GBAORD across countries give an impression of the relative importance attached to state-funded R & D.

Main findings

Gross domestic expenditure on R & D (GERD) stood at EUR 228 681 million in the EU-27 in 2007, equivalent to 85 % of the total for the United States, but almost double the level of R & D expenditure in Japan (in 2006). In order to normalise these figures, GERD is generally expressed relative to GDP. This ratio increased marginally in the EU-27 during the five-year period up to 2002 from 1.78 % to 1.87 %. However, in 2003 it fell and this pattern was repeated again in 2004, while there was no change in the relative importance of R & D expenditure in 2005. The latest information available shows GERD increased and then stabilised, accounting for 1.85 % of the EU-27's GDP in both 2006 and 2007.

The EU-27's R & D expenditure relative to GDP tends to lag behind that of Japan (3.40 % in 2006) and the United States (2.67 % in 2007); this pattern has existed for a lengthy period. An analysis of the latest ten-year period for which data are available shows that the relative importance of GERD as a share of GDP rose by a modest 0.07 percentage points in the EU-27 between 1997 and 2007, while a similar trend was witnessed in the United States (up 0.11 points). In contrast, there was a far higher increase in the relative importance of GERD in the Japanese economy, its share of GDP rising by 0.53 percentage points during the period 1997 to 2006; note however that Japanese economic growth was subdued during the period under consideration. The evolution of GERD (in current price euro terms) shows an overall increase of 64.9 % in the EU-27's R & D expenditure between 1997 and 2007, compared with growth of 43.5 % for the United States and 9.6 % for Japan (1997 to 2006).

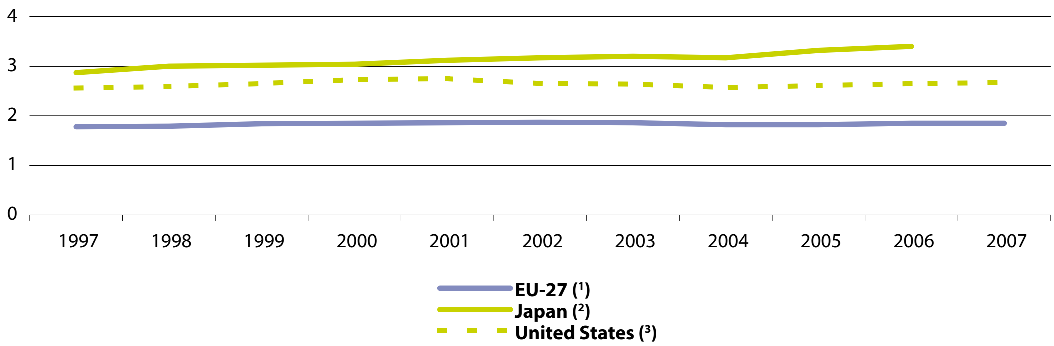
Increasing investment in R & D is one of the key objectives of the Lisbon Strategy, in order to provide a stimulus to increase the EU's competitiveness. The Lisbon target of GERD representing 3 % of GDP remains the EU's objective for 2010, although most countries have specified their own targets in national reform programmes. Among the Member States, the highest R & D intensity was recorded in Sweden (3.60 % in 2007) and Finland (3.46 % in 2008), the only Member States to record ratios above the Lisbon target. Aside from Finland and Sweden (where a high proportion of research expenditure is focused on telecommunications), relatively high degrees of R & D intensity are found clustered in southern Germany (motor vehicles), through Switzerland into France (chemicals and pharmaceuticals) and on towards the Pyrenees (aerospace); regions containing capital cities also tend to be relatively R & D intensive. In contrast, there were ten Member States that reported R & D expenditure accounting for less than 1 % of their

GDP in 2007, with Bulgaria, Cyprus and Slovakia below 0.5 %; the regions with the lowest R & D intensity are generally found in southern and eastern Europe.

The differences in the relative weight of GERD among Triad members are often explained by referring to levels of expenditure within the business enterprise sector, as these are relatively low in the EU-27 (1.18 % of GDP) when compared with the United States (1.92 %) in 2007, and especially Japan (2.63 % in 2006). The relative importance of R & D expenditure in the government and higher education sectors was broadly similar across all three members of the Triad.

When focusing on the breakdown of GERD by source of funds, slightly more than half (55.4 %) of the gross expenditure on R & D in the EU-27 came from business enterprises in 2006, while just over one third (33.5 %) was from government, and a further 8.6 % from abroad; business-funded R & D accounted for 77.1 % of total R & D expenditure in Japan and 66.4 % in the United States (2007).

Figure 12.1: Gross domestic expenditure on R&D (% share of GDP)



(¹) Estimates.
(²) Not available, 2007.
(³) Break in series, 1998; excludes most or all capital expenditure.

Source: Eurostat (tsc00001), OECD

Table 12.1: Gross domestic expenditure on R&D
(% share of GDP)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
EU-27	*1.79*	*1.84*	*1.85*	*1.86*	*1.87*	*1.86*	*1.82*	*1.82*	*1.85*	*1.85*	:
Euro area	:	:	*1.84*	*1.85*	*1.87*	*1.86*	*1.84*	*1.83*	*1.86*	*1.87*	:
Belgium	1.86	1.94	1.97	2.08	1.94	1.88	1.87	1.84	*1.88*	*1.87*	:
Bulgaria (1)	0.57	0.57	0.52	0.47	0.49	0.50	0.50	0.49	0.48	0.48	:
Czech Republic	1.15	1.14	1.21	1.20	1.20	1.25	1.25	1.41	1.55	1.54	:
Denmark	2.04	2.18	2.24	2.39	2.51	2.58	2.48	2.46	2.48	*2.55*	:
Germany	2.27	2.40	2.45	2.46	2.49	2.52	2.49	2.48	2.54	*2.54*	:
Estonia	0.57	0.69	0.61	0.71	0.72	0.77	0.86	0.94	1.15	1.14	*1.29*
Ireland	1.24	*1.18*	1.12	1.10	1.10	1.17	1.24	1.25	*1.30*	*1.31*	*1.45*
Greece	:	0.60	:	0.58	:	0.57	*0.55*	0.58	*0.57*	*0.57*	:
Spain	0.87	0.86	0.91	0.91	0.99	1.05	1.06	1.12	1.20	1.27	:
France (2,3)	2.14	2.16	2.15	2.20	2.23	2.17	2.15	2.10	*2.10*	*2.08*	:
Italy	1.05	1.02	1.05	1.09	1.13	1.11	1.10	1.09	1.13	:	:
Cyprus	0.22	0.23	0.24	0.25	0.30	0.35	0.37	0.40	0.43	*0.45*	:
Latvia	0.40	0.36	0.44	0.41	0.42	0.38	0.42	0.56	0.70	0.59	:
Lithuania	0.55	0.50	0.59	0.67	0.66	0.67	0.75	0.75	0.79	0.82	:
Luxembourg	:	:	1.65	:	:	1.65	1.63	1.56	1.66	*1.62*	:
Hungary (3)	0.68	0.69	0.78	0.92	1.00	0.93	0.88	0.94	1.00	0.97	:
Malta (3)	:	:	:	:	0.26	0.26	0.53	0.57	0.61	*0.59*	:
Netherlands (1)	1.90	1.96	1.82	1.80	1.72	1.76	1.78	1.72	1.71	1.70	:
Austria	1.78	*1.90*	*1.94*	*2.07*	2.14	*2.26*	2.26	*2.44*	2.46	*2.56*	*2.66*
Poland	0.67	0.69	0.64	0.62	0.56	0.54	0.56	0.57	0.56	0.57	:
Portugal	0.65	0.71	*0.76*	0.80	*0.76*	0.74	*0.77*	0.81	*1.00*	*1.18*	:
Romania	0.49	0.40	0.37	0.39	0.38	0.39	0.39	0.41	0.45	0.53	:
Slovenia	1.34	1.37	1.39	1.50	1.47	1.27	1.40	1.44	1.56	1.45	:
Slovakia	0.78	0.66	0.65	0.63	0.57	0.57	0.51	0.51	0.49	0.46	:
Finland	2.87	3.16	3.35	3.30	3.36	3.43	3.45	3.48	3.45	3.47	*3.46*
Sweden (4)	:	3.61	:	4.17	:	3.85	3.62	3.60	3.74	*3.60*	:
United Kingdom	1.76	1.82	1.81	1.79	1.79	1.75	1.69	1.73	1.76	*1.79*	:
Croatia	:	:	:	:	0.96	0.97	1.05	0.87	0.76	0.81	:
Turkey	0.37	0.47	0.48	0.54	0.53	0.48	0.52	0.59	0.58	0.72	:
Iceland	2.00	2.30	*2.67*	2.95	*2.95*	2.82	:	2.77	2.99	2.75	2.90
Norway	:	1.64	:	1.59	1.66	1.71	1.59	1.52	1.52	1.64	:
Switzerland	:	:	2.53	:	:	:	2.90	:	:	:	:
Japan	3.00	3.02	3.04	3.12	3.17	3.20	3.17	3.32	3.40	:	:
United States	2.59	2.65	2.73	2.75	2.65	2.64	2.57	2.61	2.65	*2.67*	:

(1) Break in series, 1999.
(2) Break in series, 2000.
(3) Break in series, 2004.
(4) Break in series, 2005.

Source: Eurostat (tsiir020), OECD

Table 12.2: Gross domestic expenditure on R&D by sector (% share of GDP)

	Business enterprise sector		Government sector		Higher education sector	
	2002	2007	2002	2007	2002	2007
EU-27	*1.20*	*1.18*	*0.24*	*0.24*	*0.41*	*0.40*
Euro area	*1.18*	*1.19*	*0.27*	*0.27*	*0.40*	*0.39*
Belgium	1.37	*1.30*	0.14	*0.16*	0.41	0.41
Bulgaria	0.09	0.15	0.35	0.28	0.05	0.05
Czech Republic	0.73	0.98	0.28	0.29	0.19	0.26
Denmark	1.73	*1.66*	0.18	0.18	0.58	0.70
Germany	1.72	*1.77*	0.34	0.35	0.42	*0.41*
Estonia	0.22	0.54	0.12	0.10	0.34	0.48
Ireland	0.76	:	0.10	0.09	0.25	*0.35*
Greece	0.18	*0.15*	:	*0.12*	:	0.29
Spain	0.54	0.71	0.15	0.22	0.29	0.33
France (1,2)	1.41	*1.31*	0.37	*0.34*	0.42	*0.40*
Italy (3)	0.54	*0.55*	0.20	*0.21*	0.37	:
Cyprus	0.06	*0.10*	0.12	*0.12*	0.09	*0.19*
Latvia	0.17	0.19	0.08	0.14	0.17	0.26
Lithuania	0.11	0.23	0.22	0.17	0.33	0.41
Luxembourg	:	*1.36*	0.16	*0.22*	:	*0.05*
Hungary (4)	0.35	0.49	0.33	0.23	0.25	0.23
Malta (1)	0.07	*0.39*	0.04	*0.02*	0.16	*0.18*
Netherlands (5)	0.98	*1.03*	0.24	*0.22*	0.50	0.45
Austria	1.43	*1.81*	0.12	*0.13*	0.58	*0.62*
Poland	0.11	0.17	0.25	0.20	0.19	0.19
Portugal	*0.25*	*0.61*	*0.14*	*0.11*	*0.29*	*0.35*
Romania	0.23	0.22	0.09	0.18	0.06	0.13
Slovenia	0.88	0.87	0.34	0.36	0.23	0.23
Slovakia	0.37	0.18	0.15	0.16	0.05	0.11
Finland	2.35	2.51	0.35	0.29	0.64	0.65
Sweden	:	2.66	:	0.17	:	0.77
United Kingdom	1.16	*1.15*	0.16	0.17	0.43	*0.44*
Croatia	0.41	0.33	0.21	0.21	0.34	0.27
Turkey	0.15	0.30	0.04	0.08	0.34	0.35
Iceland	*1.69*	1.50	*0.72*	0.49	*0.47*	0.69
Norway	0.95	0.88	0.26	0.25	0.44	0.51
Switzerland	:	:	0.03	:	0.64	:
Japan (6)	2.36	2.63	0.30	0.28	0.44	0.43
United States	1.85	*1.92*	0.32	*0.29*	0.36	*0.35*

(1) Break in series, business enterprise sector, 2004.
(2) Break in series, higher education sector, 2004.
(3) Break in series, higher education sector, 2005.
(4) Break in series, government sector, 2004.
(5) Break in series, government sector, 2003.
(6) 2006 instead of 2007.

Source: Eurostat (tsc00001), OECD

Table 12.3: Gross domestic expenditure on R&D by source of funds
(% of total gross expenditure on R&D)

	Business enterprises		Government		Abroad	
	2002 (1)	2007 (2)	2002 (1)	2007 (2)	2002 (1)	2007 (2)
EU-27	*54.6*	*55.4*	*34.3*	*33.5*	*8.9*	*8.6*
Euro area	*56.2*	*57.1*	*36.2*	*34.4*	*6.4*	*6.9*
Belgium	59.4	59.7	23.2	24.7	14.3	12.4
Bulgaria	24.8	30.6	69.8	61.9	5.0	6.5
Czech Republic	53.7	54.0	42.1	41.2	2.7	4.1
Denmark	61.4	59.5	28.2	27.6	7.8	10.1
Germany	*65.5*	68.1	*31.6*	27.8	*2.4*	3.8
Estonia	29.1	41.6	53.9	45.6	14.3	11.7
Ireland	63.4	*59.3*	27.5	30.1	7.1	8.9
Greece	33.0	31.1	46.6	46.8	18.4	19.0
Spain	48.9	47.1	39.1	42.5	6.8	5.9
France (3)	52.1	52.4	38.3	38.4	8.0	7.0
Italy	:	40.4	:	48.3	:	8.3
Cyprus	17.4	15.9	61.6	66.5	15.1	12.1
Latvia	21.7	36.4	42.7	55.2	35.6	7.5
Lithuania	27.9	24.5	65.1	47.9	7.1	19.6
Luxembourg	90.7	79.7	7.7	16.6	1.6	3.6
Hungary (4)	29.7	43.9	58.5	44.4	10.4	11.1
Malta	18.6	*45.4*	59.8	*3.3*	21.6	*28.4*
Netherlands	50.0	:	37.1	:	11.6	:
Austria	44.6	*47.7*	33.6	*35.6*	21.4	*16.3*
Poland	30.1	34.3	61.9	58.6	4.8	6.7
Portugal	*31.6*	36.3	*60.5*	55.2	*5.0*	4.7
Romania	41.6	26.9	48.4	67.1	7.0	4.5
Slovenia	60.0	58.3	35.6	35.6	3.7	5.8
Slovakia	53.6	35.6	44.1	53.9	2.1	10.2
Finland (5)	69.5	68.2	26.1	24.1	3.1	6.5
Sweden (6)	71.7	63.9	22.3	24.4	3.4	8.1
United Kingdom	43.5	*47.2*	28.9	*29.3*	21.5	*17.7*
Croatia	45.7	35.5	46.4	50.4	1.5	10.9
Turkey	41.3	48.4	50.6	47.1	1.3	0.5
Iceland	*46.2*	50.4	34.0	38.8	18.3	10.0
Norway	51.6	45.3	39.8	44.9	7.1	8.3
Japan	74.1	77.1	18.4	16.2	0.4	0.4
United States	65.2	66.4	29.1	*27.7*	:	:

(1) Denmark, Greece, Sweden, Iceland and Norway, 2001; Luxembourg, 2000.
(2) EU-27, euro area, Bulgaria, Germany, Ireland, Spain, France, Italy and Japan, 2006; Belgium, Denmark, Greece, Luxembourg, Portugal and Sweden, 2005.
(3) Break in series, 2004.
(4) Break in series for government sector, 2004.
(5) Break in series for abroad, 2005.
(6) Break in series, 2005.

Source: Eurostat (tsiir030), OECD

12.2 Personnel

Introduction

One means of helping to achieve the goal of becoming the 'most competitive and dynamic knowledge-based economy in the world' is through an investment in human capital. Scientific and technological development has since been placed at the core of EU objectives, with an increasing interest in the role and measurement of skills within the labour force. The need for increasing human resources in this area may be tempered by a range of factors, including:

- young people's knowledge of careers in science;
- teaching in schools and universities preparing students for careers in science;
- a low level participation in scientific domains among women and minorities;
- the attractiveness of the EU for science students, scientists/engineers from the rest of the world;
- the professional status of researchers and science professionals;
- barriers to mobility within research and scientific professions.

As part of the European Commission's strategy to address the Lisbon goals, an independent group on increasing human resources for science and technology in Europe was appointed. Its objective was to identify actions or policy measures that would contribute towards increasing the number of research personnel (in particular) and science and technology professionals (in general). With the re-launch of the Lisbon Strategy in 2005, policy focus switched to the concept of 'knowledge for growth', with renewed emphasis on improving the mobility of European researchers, encouraging networks between researchers from different Member States, and promoting R & D as an occupation for women. This latter point has been one particular area of concern for policymakers who consider that women's intellectual potential, and their contribution to society are not being fully capitalised upon. In particular, the participation of women is low in certain branches of the natural sciences, engineering and technology, which are considered key R & D areas. Furthermore, women are also under-represented in the business enterprise sector where the EU's R & D is most highly concentrated, as well as in senior academic grades and influential positions (6).

The European Research Area (ERA) aims at creating a unified area, in which researchers can move and interact seamlessly. As noted above, plans for the development of ERA by 2020 include the introduction of a 'fifth freedom' – the free circulation of researchers, knowledge and technology across Europe. In May 2008, the European Commission adopted a Communication to launch an initiative titled, 'better careers and more mobility: a European partnership for researchers' (7). Its goal was to improve mobility and to enhance the diffusion of knowledge throughout Europe, via: the creation of a partnership for mobility and career development; balancing demand and supply for researchers at a European level; helping create centres of excellence, and; improving

(6) For more information: http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id=27.

(7) For more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0317:FIN:EN:HTML.

the skills of researchers in Europe. It is hoped that ERA will inspire the most talented students to enter research careers, stimulate industry to invest more in European research, and contribute to the creation of sustainable growth and jobs. If such changes take place, then it may be hoped that improving career prospects for researchers will lead more young people to choose a research career, help keep researchers in Europe and attract more talented non-European researchers.

Definitions and data availability

Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and in the management of the projects concerned. The data on the number of researchers may be presented in the form of head counts or as full-time equivalents (FTEs).

Data on **R & D personnel** provide indicators for international comparisons of human resources devoted to R & D activity; they include all persons employed directly on R & D, as well as persons supplying direct services to R & D, such as managers, administrative staff and office staff. For statistical purposes, indicators on R & D personnel who are mainly or partly employed on R & D are compiled as head counts (HC) and as full-time equivalents (FTEs), or person-years.

Human resources in science and technology (HRST) are defined as stocks of persons having either successfully completed tertiary education, or persons who are employed in an occupation where such an education is normally required; those who fulfil both these criteria are classified as the HRST core. HRST can be shown as absolute figures or relative total employment (among the age group 25-64). The data may be broken down by gender, age, region, sector of activity, occupation, educational attainment and fields of education (although it should be noted that not all combinations are possible).

Information pertaining to stocks of HRST (as shown here) provide details relating to the characteristics of the current labour force involved in science and technology. It is also possible to study flows of HRST, either from the perspective of job-to-job mobility, or flows of persons from education into the science and technology labour force. Information on HRST stocks and job-to-job mobility is derived from the labour force survey (LFS), while information on HRST flows from education are obtained from a UNESCO/OECD/Eurostat questionnaire on education. The latter can be used to provide a measure of the current and future supply of HRST from the education system, in terms of actual inflows (graduates from the reference period) and potential inflows (students participating in higher education during the reference period).

Education statistics are based on the international standard classification of education (ISCED); the basic unit of classification is the educational programme. Indicators based on the number of **PhD graduates** give an idea of the extent to which countries will have researchers at the highest level of education in the future. The data relate to numbers of new graduates in the reference year, not to the total number (stock) of graduates in the labour market that year. The number of PhD graduates is measured as graduates from ISCED level 6: a PhD is defined in terms of tertiary programmes which lead to the award of an advanced research degree, e.g. a doctorate in economics. These programmes should be devoted to advanced study and original research and are not based on course-work alone; a PhD usually requires 3-5 years. **Science and technology graduates** are defined as the number of new graduates from all public and private institutions completing science and technology-related graduate and post-graduate studies in the reference year; it is expressed relative to the total number of persons aged 20-29 years.

Main findings

The number of researchers in the EU-27 has increased considerably in recent years: there were 1.36 million full-time equivalents in 2007, which marked an increase of almost 250 thousand (or 22.5 %) when compared with 2000. A gender breakdown shows that men accounted for slightly less than three quarters (72 %) of the EU-27's research workforce in 2007; there was almost no change in the relative balance between male and female researchers during the period 2000-2007.

A breakdown of the number of researchers by institutional sector in 2007 shows that almost half (48.8 %) of all researchers in the EU-27 were concentrated in the business enterprise sector, while just over one third (36.1 %) were in the higher education sector and 13.8 % in the government sector. The relative importance of the different institutional sectors varied considerably across the Member States, with business enterprises accounting for 70 % of researchers in Luxembourg, and upwards of 60 % in Sweden, Austria, Denmark and Germany; these shares were broadly in line with the latest data for Japan (68.1 % in 2006). Bulgaria was the only country to report a majority (55.1 %) of its researchers employed within the government sector, while more than half of all researchers working in the Baltic Member States, Slovakia, Poland, Greece and Cyprus were employed within the higher education sector.

One objective for European universities is to attract and maintain highly-qualified staff and students in order to support their research capabilities. Within the EU-27 there were 13.4 science and technology graduates per thousand persons aged 20 to 29 years in 2007, with particularly high ratios in France, Finland, Ireland, Lithuania and Portugal (all above 18). The number of science and technology graduates should be interpreted with care, insofar as some students could be foreigners who return home following their studies, whereas others may seek employment in a completely different domain as soon as they have graduated.

A similar (but more specific) measure of a country's potential research capability is provided by the number of PhD students; this may be broken down by their chosen subject. There were 525 800 PhD students in the EU-27 in 2007, compared with 396 200 in the United States and 75 500 in Japan. In relative terms, the broad subject group of science, mathematics, computing, engineering, manufacturing and construction-related studies accounted for more than one third (36.4 %) of the PhD students in the EU-27 in 2007, a proportion that was somewhat higher than in Japan (32.6 %) or the United States (30.2 %).

Across the whole of the EU-27, women accounted for 47.8 % of PhD students in 2007, a share that was not too dissimilar from that recorded in the United States, where women were in a slight majority (52.1 %); in contrast, men accounted for a much higher share of PhD students in Japan (almost 70 %). The gender split of PhD students across the Member States was typically quite balanced in 2007: with women accounting for more than half of all the PhD students in the Baltic Member States, Portugal, Italy, Finland, Spain and Poland, and at least 40 % of all PhD students in the remaining Member States for which data are available, with the exception of the Czech Republic (39.1 %) and Malta (34.7 %).

Human resources in science and technology (HRST) provide a broad measure of the stock of personnel employed in science and technology-related occupations. Some 64.5 million people were employed in the EU-27 within science and technology occupations in 2007; this amounted to 29.8 % of total employment. Between 2004 and 2007 there was a modest increase in the relative importance of HRST within the EU-27 workforce, as their share rose by 0.9 percentage points. The HRST 'core' – made up of people with a university level degree who also work in a science and technology occupation – amounted to 35.2 million persons in 2007 (or 16.3 % of the total number of persons employed).

HRST accounted for almost 40 % of the workforce in Luxembourg and Sweden in 2007, while relatively high shares were also recorded in the Netherlands, Germany, Denmark and Finland. The most rapid growth in HRST between 2004 and 2007 (in relation to total employment) was reported for the Baltic Member States (in particular, Latvia), Malta, the Czech Republic and Italy, where the relative weight of HRST rose by at least 2 percentage points; Austria, Bulgaria, the Netherlands and Ireland were the only Member States where the share of HRST in the total employment fell.

Table 12.4: Researchers, by institutional sector, 2007 (1)

	Total - all sectors	Business enterprise sector		Government sector		Higher education sector	
	(1 000 FTE)	(1 000 FTE)	(% of total)	(1 000 FTE)	(% of total)	(1 000 FTE)	(% of total)
EU-27	*1 355.7*	*661.9*	*48.8*	*186.7*	*13.8*	*489.3*	*36.1*
Euro area	*949.8*	*480.1*	*50.6*	*135.1*	*14.2*	*321.6*	*33.9*
Belgium	*35.9*	*18.4*	*51.3*	*2.5*	*7.1*	*14.8*	*41.1*
Bulgaria	11.2	1.3	11.8	6.2	55.1	3.6	32.2
Czech Republic	27.9	12.5	44.8	6.6	23.8	8.7	31.1
Denmark	*29.6*	*18.1*	*61.4*	*2.2*	*7.5*	*9.0*	*30.4*
Germany	*284.3*	*172.7*	*60.8*	43.6	15.3	*68.0*	*23.9*
Estonia	3.7	1.0	26.0	0.5	14.8	2.1	56.5
Ireland (2)	12.2	7.0	57.5	*0.5*	*4.1*	4.7	38.4
Greece	*20.8*	*6.1*	*29.3*	*2.2*	*10.6*	*12.4*	*59.5*
Spain	122.6	42.1	34.3	21.4	17.5	58.8	48.0
France	*211.1*	*114.1*	*54.0*	*25.6*	*12.1*	*67.9*	*32.2*
Italy (3)	88.4	*36.7*	*33.9*	*17.8*	*18.8*	37.6	42.6
Cyprus	*0.8*	*0.2*	*22.6*	*0.1*	*13.8*	*0.5*	*57.9*
Latvia	4.2	0.5	11.0	0.7	17.6	3.0	71.4
Lithuania	8.5	1.3	15.4	1.7	19.7	5.5	64.9
Luxembourg	*2.2*	*1.5*	*70.0*	*0.5*	*22.7*	0.2	7.3
Hungary	17.4	7.0	40.2	4.6	26.3	5.8	33.5
Malta	*0.5*	*0.3*	*50.9*	*0.0*	*3.3*	*0.2*	*45.8*
Netherlands	*44.1*	*26.1*	*59.2*	*6.9*	*15.5*	11.2	25.3
Austria	*31.4*	*19.8*	*63.3*	*1.4*	*4.6*	*9.9*	*31.7*
Poland	61.4	9.8	16.0	12.8	20.9	38.6	62.8
Portugal	*28.0*	*8.6*	*30.9*	*3.1*	*11.1*	*13.1*	*46.8*
Romania	18.8	7.8	41.2	5.8	30.9	5.1	27.1
Slovenia	6.3	2.6	41.1	2.0	32.0	1.7	26.5
Slovakia	12.4	1.6	12.9	2.9	23.4	7.9	63.6
Finland	39.0	22.0	56.4	4.5	11.5	12.2	31.2
Sweden	47.8	30.9	64.8	1.9	4.1	14.8	31.1
United Kingdom (4)	*175.5*	*91.5*	*52.2*	*8.5*	*4.8*	*71.5*	*40.7*
Croatia	6.1	0.9	14.4	1.9	30.4	3.4	55.2
Turkey	49.7	15.3	30.8	4.8	9.7	29.5	59.5
Iceland	2.2	1.1	48.4	0.5	20.8	0.6	28.1
Norway	24.8	12.4	50.1	3.9	15.7	8.5	34.2
Switzerland (4)	:	:	:	0.4	:	*12.7*	:
Japan (2)	709.7	483.3	68.1	33.6	4.7	184.3	26.0
United States (5)	:	1 135.5	:	:	:	:	:

(1) Shares do not sum to 100 % due to estimates, differences in reference years, the exclusion of private non-profit sector data from the table and the conversion of data to a count in terms of FTE.

(2) 2006.

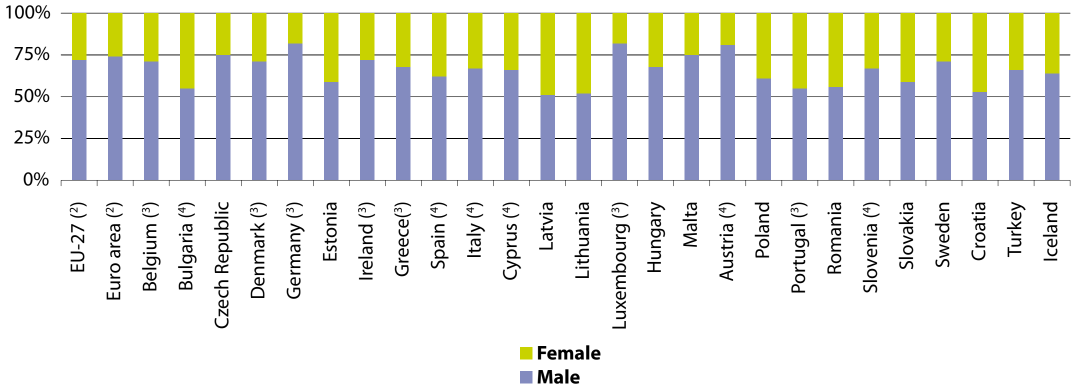
(3) Total - all sectors and higher education sector, 2006.

(4) Government sector and higher-education sector, 2006.

(5) Business enterprise sector, 2006.

Source: Eurostat (tsc00004), OECD

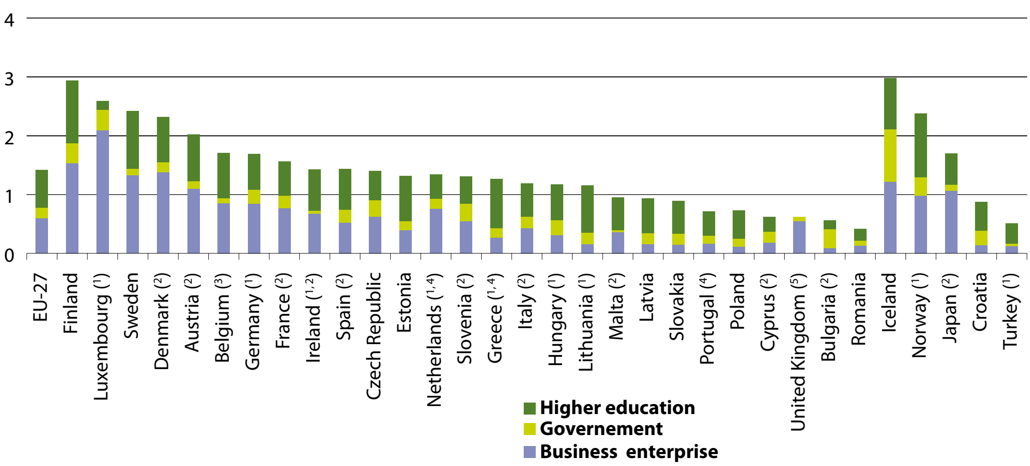
Figure 12.2: Gender breakdown of researchers in all institutional sectors, 2007 (1)
(% of total researchers, based on FTEs)



(1) France, the Netherlands, Finland and the United Kingdom, not available.
(2) Estimates.
(3) 2005.
(4) 2006.

Source: Eurostat (tsc00006)

Figure 12.3: Proportion of research and development personnel by sector, 2007
(% of active population)



(1) Private non-profit, not available.
(2) 2006.
(3) Business enterprises, 2006; government, higher education and private non-profit sectors, 2005.
(4) 2005.
(5) Higher education, not available.

Source: Eurostat (tsc00002)

Table 12.5: Science and technology graduates
(tertiary graduates in science and technology per 1 000 persons aged 20-29 years)

	Total		Male		Female	
	2002	2007	2002	2007	2002	2007
EU-27	*11.3*	13.4	*15.4*	17.9	*7.1*	8.7
Belgium	10.5	14.0	16.1	15.3	7.5	6.9
Bulgaria	11.7	8.4	13.9	14.2	4.8	5.1
Czech Republic	6.0	12.0	9.7	12.2	6.5	6.1
Denmark	11.7	16.4	:	9.1	:	7.8
Germany	8.1	11.4	6.8	9.2	2.8	3.5
Estonia	8.0	13.3	5.6	5.8	2.1	2.7
Ireland	20.5	18.7	15.7	20.8	7.5	11.9
Greece	:	8.5	7.3	14.0	4.4	9.8
Spain	11.9	11.2	4.5	8.5	1.7	5.5
France (1)	20.1	20.5	13.8	10.0	9.5	6.8
Italy	7.4	8.2	10.1	15.1	5.3	8.6
Cyprus	3.8	4.2	27.2	23.8	13.3	11.0
Latvia	8.1	9.2	10.6	16.7	5.9	11.1
Lithuania	14.6	18.1	12.2	15.9	3.8	6.9
Luxembourg	:	:	15.7	20.4	5.2	7.6
Hungary	4.8	6.4	17.0	17.8	9.3	9.2
Malta	3.1	7.1	24.6	26.1	9.9	11.1
Netherlands	6.6	8.9	8.6	23.3	6.1	12.8
Austria	7.9	11.0	10.8	14.4	2.4	3.4
Poland	8.3	13.9	28.1	29.3	12.0	11.6
Portugal	7.4	18.1	9.6	16.0	6.4	10.4
Romania	5.8	11.9	18.3	24.0	10.9	12.0
Slovenia	9.5	9.8	12.4	16.6	3.4	5.3
Slovakia	7.8	11.9	:	:	:	:
Finland	17.4	18.8	8.3	16.6	3.5	7.2
Sweden	13.3	13.6	9.4	10.2	5.4	6.2
United Kingdom	20.3	17.5	26.4	25.5	14.6	11.8
Croatia	:	6.8	:	8.6	:	4.8
FYR of Macedonia	3.1	4.6	3.4	5.4	2.8	3.7
Turkey	5.0	6.7	6.7	9.1	3.1	4.3
Iceland	9.2	10.2	12.1	13.1	6.2	7.2
Liechtenstein	:	10.5	:	14.4	:	6.5
Norway	7.7	9.3	11.1	13.1	4.2	5.4
Switzerland	15.1	17.9	25.5	29.4	4.6	6.4
Japan	13.0	14.4	21.9	24.2	3.8	4.2
United States	10.0	10.1	13.3	13.5	6.6	6.4

(1) 2001 instead of 2002.

Source: Eurostat (tsiir050)

Table 12.6: PhD students (ISCED level 6), 2007
(% of total PhD students)

	Total number of PhD students (1 000)	Male	Female	Social sciences, business & law	Teacher training & educ.; humanities & arts	Science, maths & computing; engineering, manuf. & construction	Agriculture & veterinary	Health & welfare; services	Others (1)
EU-27	*525.8*	*52.2*	*47.8*	21.8	21.0	36.4	2.9	14.5	2.0
Belgium	7.4	57.3	42.7	19.3	13.7	45.0	7.6	14.5	0.0
Bulgaria	4.8	50.4	49.6	19.5	22.3	41.8	2.9	13.5	0.0
Czech Republic	23.7	60.9	39.1	16.6	15.6	46.2	4.3	15.5	1.9
Denmark	4.8	53.6	46.4	12.6	14.9	34.7	8.7	29.1	0.0
Germany	:	:	:	:	:	:	:	:	:
Estonia	2.1	45.1	54.9	22.5	21.2	42.7	5.3	8.3	0.0
Ireland	5.6	53.0	47.0	17.0	23.2	47.3	1.7	8.9	1.8
Greece	21.7	57.5	42.5	14.3	24.7	34.3	4.4	22.4	0.0
Spain	72.7	48.2	51.8	22.8	21.7	21.3	2.1	19.9	12.3
France	71.6	53.5	46.5	29.3	25.6	41.7	0.1	3.3	0.0
Italy	40.1	47.8	52.2	19.7	14.9	42.5	6.1	16.4	0.5
Cyprus	0.4	52.4	47.6	16.0	32.2	51.9	0.0	0.0	0.0
Latvia	1.8	39.0	61.0	34.8	24.0	28.2	1.9	11.1	0.0
Lithuania	2.9	42.2	57.8	31.6	13.6	39.8	4.8	10.2	0.0
Luxembourg	:	:	:	:	:	:	:	:	:
Hungary	7.8	51.4	48.6	21.7	25.6	29.3	6.3	17.1	0.0
Malta	0.1	65.3	34.7	18.1	34.7	33.3	0.0	13.9	0.0
Netherlands	7.5	58.0	42.0	:	:	:	:	:	:
Austria	18.2	54.2	45.8	36.2	22.4	31.1	3.2	4.6	2.5
Poland	31.8	50.0	50.0	20.8	31.2	33.0	5.3	9.7	0.0
Portugal	18.7	44.2	55.8	29.6	20.8	31.4	1.6	16.6	0.0
Romania	27.7	54.4	45.6	17.2	15.4	43.0	7.0	17.4	0.0
Slovenia	1.3	52.2	47.8	13.3	17.1	49.2	3.0	17.4	0.0
Slovakia	11.1	55.1	44.9	20.9	18.1	37.1	3.2	20.8	:
Finland	21.9	47.9	52.1	22.6	24.2	39.8	2.1	11.4	0.0
Sweden	20.8	50.5	49.5	12.1	12.2	41.6	1.9	32.2	0.0
United Kingdom	99.4	54.8	45.2	21.1	21.6	40.3	1.3	15.3	0.3
Croatia	1.8	54.6	45.4	3.6	17.0	55.1	1.4	23.0	0.0
FYR of Macedonia	0.1	50.4	49.6	22.7	26.1	26.9	1.7	22.7	0.0
Turkey	33.8	59.0	41.0	23.9	22.6	34.0	7.8	11.7	0.0
Iceland	0.2	42.8	57.2	16.4	27.4	31.8	0.0	24.4	0.0
Liechtenstein	0.0	72.2	27.8	0.0	22.2	0.0	0.0	77.8	0.0
Norway	5.7	53.3	46.7	18.9	11.9	41.9	2.8	24.4	0.0
Switzerland	17.6	58.7	41.3	26.7	15.8	39.1	2.7	15.3	0.4
Japan	75.5	69.9	30.1	13.1	13.7	32.6	5.8	32.2	2.4
United States	396.2	47.9	52.1	26.9	24.4	30.2	0.8	17.7	0.0

(1) Unknown or not specified.

Source: Eurostat (educ_enrl5)

Table 12.7: Human resources in science and technology (¹)

	People working in a S&T occupation					People who have a third level education and work in a S&T occupation				
	(1 000)	(% of total employment)				(1 000)	(% of total employment)			
	2007 (²)	2004	2005	2006	2007	2007 (²)	2004	2005	2006	2007
EU-27	64 450	29.0	29.4	29.7	29.8	35 151	15.5	15.9	16.1	16.3
Belgium	1 441	31.5	32.7	33.0	33.0	967	20.9	21.2	21.6	22.2
Bulgaria	710	22.6	23.2	21.5	21.9	513	15.7	16.4	15.7	15.8
Czech Republic	1 638	30.9	32.6	32.6	33.3	540	10.2	10.8	11.1	11.0
Denmark (³)	995	35.6	36.7	37.0	36.2	592	22.9	23.7	24.1	21.5
Germany	13 782	35.7	36.2	36.6	36.4	6 610	17.2	17.5	17.2	17.4
Estonia	173	27.2	29.4	28.9	29.4	103	15.1	17.5	17.9	17.4
Ireland	486	23.6	23.1	23.2	23.4	338	15.7	15.4	16.1	16.2
Greece	1 038	21.9	22.0	22.8	23.1	778	16.4	16.4	17.0	17.3
Spain	4 928	24.1	24.9	24.0	24.2	3 592	17.6	18.0	17.8	17.7
France	7 935	30.9	31.2	31.6	31.8	4 525	17.3	17.8	18.3	18.1
Italy	7 403	29.9	29.7	31.1	32.0	2 797	10.9	11.2	11.5	12.1
Cyprus	102	25.6	25.7	26.1	27.0	75	18.0	17.7	18.4	19.8
Latvia	332	23.1	24.5	26.9	29.7	156	11.5	12.3	13.0	13.9
Lithuania	412	24.8	26.1	25.8	26.9	268	15.2	16.5	16.4	17.5
Luxembourg	80	39.5	38.7	39.0	39.5	52	22.7	25.1	23.2	25.9
Hungary	1 041	26.4	26.0	26.6	26.5	576	13.9	14.0	14.5	14.7
Malta	41	24.0	25.5	26.9	26.6	17	10.7	10.3	10.9	10.9
Netherlands	2 963	37.7	37.4	36.2	37.2	1 649	20.6	20.9	20.2	20.7
Austria	1 193	32.9	30.6	30.5	29.7	446	12.2	11.6	11.3	11.1
Poland	3 987	25.3	25.9	26.2	26.2	2 318	13.5	14.6	15.1	15.3
Portugal	893	16.7	17.0	17.7	17.6	527	9.5	9.6	10.3	10.4
Romania	1 739	17.3	17.8	18.6	18.6	973	8.6	9.3	10.1	10.4
Slovenia	299	29.6	30.8	31.7	30.9	168	14.7	16.0	17.1	17.4
Slovakia	690	28.5	29.6	29.7	29.3	272	10.4	11.5	11.9	11.5
Finland	854	33.4	33.6	34.1	34.5	562	22.2	22.0	22.4	22.7
Sweden	1 757	38.9	39.4	39.4	39.5	1 030	21.6	22.6	22.8	23.2
United Kingdom	7 539	25.8	26.0	27.0	26.9	4 710	16.0	16.2	16.7	16.8
Croatia	384	23.4	23.8	24.4	:	223	14.3	14.1	14.2	:
Turkey	2 646	:	:	12.5	12.5	1 470	:	:	6.7	7.0
Iceland	55	30.1	31.2	32.7	:	22	17.8	17.3	13.2	:
Norway	892	35.3	36.3	36.4	37.0	599	22.4	23.8	24.1	24.8
Switzerland	1 604	37.8	38.4	38.9	39.4	800	17.7	18.5	19.0	19.7

(¹) Break in series, 2006, with the exception of Belgium and Luxembourg.
(²) Croatia and Iceland, 2006.
(³) Break in series, 2007.

Source: Eurostat (hrst_st_nsec)

12.3 Innovation

Introduction

Innovation (ideas applied successfully in practice) provides the potential for society to tackle some of the world's major issues – for example, climate change, depleted energy resources, disease and illness.

Europe has a long-standing tradition of producing inventions. However, commentators often focus on an entrepreneurial gap in order to explain why some ideas for new products or services do not become a success in the marketplace, or why other ideas relating to new processes do not get implemented, thereby surrendering the opportunity to make efficiency gains on production lines or within industrial organisations. Hence, while Europe is very good at producing ideas, it is not as good at bringing them to market; as such, EU policy in this field increasingly aims to provide more focus to industry-driven, applied R & D.

Education is another area seen as key to developing an innovation-orientated society, through the acquisition of entrepreneurial, managerial, scientific, mathematical and foreign language skills, as well as digital literacy. Policymakers express concern at the numbers of science and technology graduates who directly apply their education once they move into the labour market, while a lack of job mobility between universities and industry may potentially hinder the transfer of ideas, thereby reducing the EU's innovation performance (see the previous subchapter for more details relating to labour-market issues).

Globalisation and the rising economic power of developing nations have resulted in some European enterprises needing to become more innovative just to maintain their competitive position. The European Commission is trying to make sure that innovation is thoroughly understood: indeed, 2009 was the European year of creativity and innovation. The EU seeks to contribute to greater competitiveness, sustainability and job creation, through the promotion of innovation (among others):

- providing financial support for innovators;
- providing innovation support services (notably for start-ups);
- encouraging venture capital;
- developing and testing new forms of business support;
- facilitating transnational cooperation;
- mobilising resources for the creation of a European innovation space.

Placing competitiveness at the heart of the European political agenda, the Lisbon Strategy aims to boost entrepreneurial initiative and create a productive environment where innovation capacity can grow and develop. With this in mind, on 29 October 2006, the European Parliament and the Council adopted a Decision 1639/2006/CE establishing a competitiveness and innovation framework programme (CIP) for the period 2007-2013 (8).

The European Council called for a plan on innovation in December 2008 and these reflections on future innovation policy

(8) For more information: http://ec.europa.eu/cip/index_en.htm.

are likely to be part of a wider debate on the Lisbon Strategy post-2010 (EU 2020). This Council initiative provided the basis for a period of public consultation and business debate, for example, a first roundtable on future European innovation policy was held in June 2009; three months later the European Commission adopted a Communication 'reviewing Community innovation policy in a changing world' (9).

As part of these on-going reforms, the EU has set up a European Institute of Innovation and Technology (EIT); this is an independent Community body whose mission is to address Europe's innovation gap through the 'stimulation of world-leading innovation', such that Europe may capitalise fully on its innovation capacity and the capability of its actors (higher education staff, researchers, business leaders and entrepreneurs) through the creation of knowledge and innovation communities (KICs).

Definitions and data availability

Innovations are based on the results of new technological developments, new combinations of existing technology, or the utilisation of other knowledge acquired (by the enterprise). For the purpose of the Community innovation survey (CIS) an **innovation** is defined as a new or significantly improved product (good or service) introduced to the market, or the introduction within an enterprise of a new or significantly improved process. Such innovations may be developed by the innovating enterprise or by another enterprise. However, purely selling innovations wholly produced and developed by other enterprises is not included as an innovation activity, nor is introducing products with purely aesthetic changes. Innovations should therefore be new to the enterprise concerned: for product innovations they do not necessarily have to be new to the market, and for process innovations the enterprise does not necessarily have to be the first one to have introduced the process.

Enterprises with innovation activity include all types of innovator, namely product innovators, process innovators, as well as enterprises with only on-going and/or abandoned innovation activities. Enterprises may cooperate with other parties (for example suppliers, competitors, customers, educational/research establishments) when engaging in an innovative activity. The proportion of enterprises with innovation activity is also referred to as the propensity to innovate.

The CIS collects information pertaining to both product and process, organisational and marketing innovations. The legal basis for the collection of these statistics is Commission Regulation (EC) 1450/2004 of 13 August 2004 implementing Decision No 1608/2003/EC of the European Parliament and of the Council concerning the production and development of

(9) COM(2009) 442 final; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0442:FIN:EN:PDF.

Community statistics on innovation. Note that the European Commission accorded on 22 July 2005 a derogation to France concerning CIS 2006 data. As a result, CIS data for France for 2006 only cover the manufacturing sector (NACE Rev. 1.1 Section D) for enterprises with more than 50 employees.

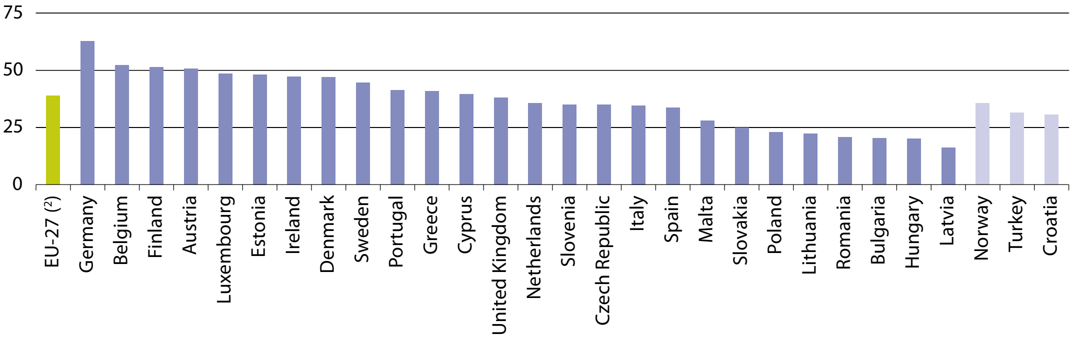
Main findings

In 2006, some 38.9 % of EU-27 enterprises were considered as innovative. The highest propensity to innovate was recorded in Germany (62.6 %), while Belgium, Finland and Austria also reported that more than one in every two enterprises were innovative. At the other end of the range, the lowest propensity to innovate was registered by enterprises in Latvia (16.2 %), while Hungary, Bulgaria, Romania, Lithuania, Poland and Slovakia also reported that fewer than one in four enterprises innovated. Note that large enterprises tend to innovate more than SMEs and as such these figures may, at least to some degree, reflect the enterprise structure of each economy.

New or significantly improved products contributed a relatively small proportion of total turnover among innovative enterprises in 2006, some 10.0 % for the EU-27 in 2006, with 11 of the Member States reporting single digit shares. These products did however account for a much higher share of sales in the Czech Republic (16.0 %), Bulgaria (17.0 %), Greece (22.8 %) and Malta (where their relative importance rose to 33.4 % of turnover).

Almost half (47.5 %) of the large enterprises in the EU-27 (with 250 or more employees) brought product innovations to market in 2006, compared with 36.8 % of medium-sized enterprises (50 to 249 employees) and 29.7 % of small enterprises (10 to 49 employees). A similar size class breakdown for process innovations that are developed within the enterprise also showed that large innovative enterprises were also more likely to introduce processes innovations.

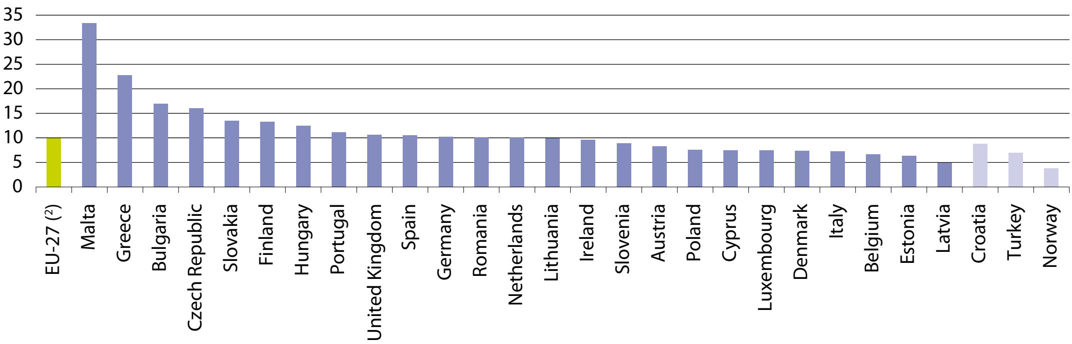
Figure 12.4: Proportion of innovative enterprises, 2006 (1)
(% of all enterprises)



(1) France, not available (derogation accorded on 22 July 2005).
(2) Excluding France.

Source: Eurostat (inn_cis5_prod)

Figure 12.5: Turnover from new or significantly improved products new to the market, 2006 (1)
(% of total turnover of innovative enterprises)



(1) France (derogation accorded on 22 July 2005) and Sweden, not available.
(2) Excluding France and Sweden.

Source: Eurostat (inn_cis5_prod)

Table 12.8: Proportion of innovative enterprises which introduced products new to the market or own-developed process innovations, 2006
(% of enterprises within size class or total)

	Process innovations: developed by the enterprise or group				Product innovations: new to market			
	Total	With 10 to 49 employees	With 50 to 249 employees	With > 250 employees	Total	With 10 to 49 employees	With 50 to 249 employees	With > 250 employees
EU-27 (1)	:	:	:	:	32.6	29.7	36.8	47.5
Belgium	20.9	18.6	27.0	40.6	41.4	38.6	44.1	65.3
Bulgaria	7.7	6.3	10.1	21.8	41.3	38.6	46.2	45.7
Czech Republic	13.6	10.9	20.3	28.0	38.9	32.5	48.3	51.3
Denmark	16.4	13.7	24.6	33.3	33.8	30.9	37.9	50.6
Germany	19.3	15.8	23.3	43.8	30.4	25.9	35.3	47.7
Estonia	19.9	17.2	26.9	50.0	32.8	32.9	32.1	37.0
Ireland	20.0	17.6	26.3	44.1	40.8	38.0	47.0	51.6
Greece	19.8	17.4	31.1	35.3	49.5	48.1	50.2	70.7
Spain	16.1	13.9	25.2	39.0	18.3	14.8	26.0	39.5
France	:	:	:	:	:	:	:	:
Italy	:	:	:	:	29.5	26.8	37.2	50.1
Cyprus	12.5	11.5	17.9	10.7	34.5	30.9	42.3	52.2
Latvia	:	:	:	:	44.7	49.7	33.8	41.9
Lithuania	7.8	6.1	15.9	21.7	36.0	36.8	32.4	38.5
Luxembourg	22.0	18.3	28.9	44.9	58.9	59.3	52.6	75.4
Hungary	5.7	4.5	8.1	18.8	30.9	30.1	29.6	38.2
Malta	13.1	9.2	23.8	51.9	31.3	29.4	29.2	47.6
Netherlands	8.2	6.9	11.0	23.2	48.1	46.1	50.8	59.5
Austria	18.8	15.7	26.9	39.8	45.4	42.1	48.8	65.0
Poland	10.8	7.4	17.4	29.5	32.7	33.1	30.6	37.5
Portugal	19.1	17.1	26.9	36.8	29.8	26.5	37.1	48.5
Romania	14.3	12.0	18.1	28.4	24.7	22.1	26.6	33.9
Slovenia	13.8	11.4	18.0	30.8	51.1	52.5	44.9	59.4
Slovakia	7.9	5.0	13.1	21.6	37.6	34.7	39.8	43.8
Finland	19.7	17.8	23.3	35.0	44.6	44.3	40.7	58.1
Sweden	16.3	14.9	:	:	51.3	49.3	55.8	58.4
United Kingdom	:	:	:	:	31.6	31.0	31.7	39.8
Croatia	11.0	9.3	14.7	20.9	31.7	28.5	33.1	47.5
Turkey	20.2	19.1	23.4	30.4	59.6	62.3	50.5	52.9
Norway	10.4	9.1	14.3	21.1	39.9	40.6	37.0	42.0

(1) Excluding France (derogation accorded on 22 July 2005).

Source: Eurostat (inn_cis5_prod))

12.4 Patents

Introduction

Intellectual property law establishes protection over intangibles – for example, when a manufactured product is sold, the product itself becomes the property of the purchaser, however, intellectual property rights allow intangible elements to remain in the ownership of the creator; these intangibles include (among others) the idea itself, or the name or sign/logo used to distinguish the product from others.

Patents and trademarks are common ways to protect industrial property. Patents are a limited term exclusive right granted to an inventor, maintained through the payment of fees. While patents are generally used to protect R & D results, they are also a source of technical information, which can potentially prevent re-inventing and re-developing ideas. A count of patents shows a country's capacity to exploit knowledge and translate it into potential economic gains; in this context, patent statistics are widely used to assess the inventive and innovative performance. Most studies show that innovative enterprises tend to make more use of intellectual property protection than companies that do not innovate. Enterprise size and the economic sector in which an enterprise operates are also likely to play an important role in determining whether an enterprise chooses to protect its intellectual property.

The use of patents is relatively restricted within the EU: this may be due to a range of influences: their relative cost; the overlap between national and European procedures; or the need for translation into foreign languages. Furthermore, the increasing number and complexity of patent applications worldwide has resulted in a backlog of pending applications, while the constant expansion of the human knowledge base makes it increasingly difficult for patent offices to keep abreast of technological developments.

The European Council held in Lisbon in March 2000 called for the creation of a Community patent system to address shortcomings in the legal protection of inventions, while providing an incentive for investments in R & D. In July of the same year the European Commission made a first proposal for the creation of a Community patent: this was discussed at various levels and despite a number of proposals and amendments for a Council Regulation during 2003 and 2004 no legal basis was forthcoming. In April 2007 the European Commission released a Communication titled, 'enhancing the patent system in Europe' ([10]); this claimed that European patent systems were more expensive, uncertain and unattractive compared with patent systems in non-member countries.

In July 2008 the European Commission ([11]) adopted a Communication titled, 'an industrial property rights strategy for Europe'. This foresees the development of legislation, arguing that the harmonisation of patent law could make it easier for European companies to patent their inventions both within and outside the EU.

On 4 December 2009, the European Council unanimously adopted conclusions on an enhanced patent system in the EU. The

([10]) COM(2007) 165 final; for more information: http://eur-lex.europa.eu/LexUriServ/site/en/com/2007/com2007_0165en01.pdf.

([11]) COM(2008) 465 final; for more information: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0465:FIN:EN:PDF.

package agreed covers two main areas: firstly, agreement on the approach to be adopted in order to move towards an EU patent regulation; secondly, an agreement on establishing a new patent court in the EU. It is hoped that these measures will together make it less costly for businesses to protect innovative technology and make litigation more accessible and predictable. However, the creation of the EU patent depends on a solution being found for translation arrangements which will be the subject of separate legislation.

Definitions and data availability

From 2007 onwards, Eurostat's production of European Patent Office (EPO) data has been based almost exclusively on the EPO's worldwide statistical patent database (PATSTAT) ([12]).The EPO grants European patents for the contracting states to the European Patent Convention (EPC), of which there are currently 32 – the Member States, Iceland, Liechtenstein, Switzerland, Monaco and Turkey.

European patent applications refer to applications filed directly under the European Patent Convention or to applications filed under the Patent Cooperation Treaty (PCT) and designated to the EPO (Euro-PCT). Patent applications are counted according to the year in which they are filed and are assigned to a country according to the inventor's place of residence, using fractional counting if there are multiple inventors.

In contrast, the United States Patent and Trademark Office (USPTO) data refer to patents granted; data are recorded by year of publication as opposed to the year of filing. This methodological difference implies that any comparison between EPO and USPTO patents data should be interpreted with caution.

High-technology patents are counted following criteria established by the trilateral statistical report (drafted by the EPO, USPTO and the Japan Patent Office (JPO)), where the following technical fields are defined as high-technology groups in accordance with the international patent classification (IPC): computer and automated business equipment; micro-organism and genetic engineering; aviation; communication technology; semiconductors; and lasers.

Main findings

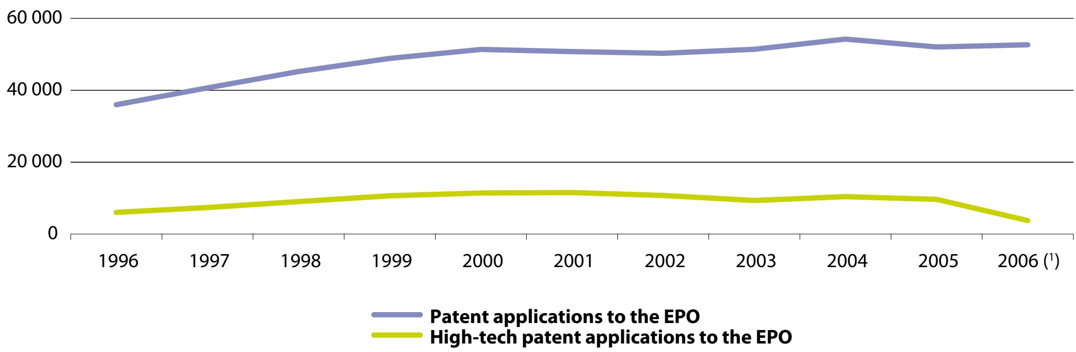
Having grown at a relatively fast pace during the 1990's the number of EU-27 patent applications filed with the EPO remained relatively stable (within the range of 50 253 to 54 216) during the period 2000 to 2006. Among the Member States, Germany had by far the highest number of patent applications to the EPO, some 22 675 in 2006 (43.0 % of the EU-27 total). In relative terms, Germany was also the Member State with the highest number of patent applications per million inhabitants (275.1), followed by Sweden (243.2), Luxembourg (228.3) and Finland (226.3).

EU-27 high-technology patent applications to the EPO represented an increasing share of total patent applications up until 2001 when they accounted for 22.8 % of all applications. Their relative importance declined somewhat after this, as did their absolute number. From a high of 11 543 high-tech patent applications in 2001, there was a relatively slow reduction through to 2004, followed by a collapse

([12]) For more information: http://www.epo.org/about-us/epo.html.

in the number of high-tech applications, falling to 3 754 in 2006. This pattern was observed across the majority of the Member States and particularly for the larger countries or those countries with traditionally the highest propensity to make patent applications. Luxembourg and Germany registered the highest number of high-technology patent applications per million inhabitants in 2006, the figures for both countries being around 20, while Belgium, France, Finland and Austria were the only other Member States to record double-digit ratios. The considerable reduction in high-technology patent applications filed with the EPO may reflect the length of patent procedures. Given the increasing speed of technological change and the rapid pace at which imitators are able to bring new technologies to market, it is perhaps not surprising that many enterprises increasingly choose to invest in continued innovation rather than spend time and resources to protect goods or services that may soon become copied or obsolete.

Figure 12.6: Patent applications to the European Patent Office (EPO), EU-27 (number of applications)



(1) Estimate.

Source: Eurostat (tsc00009 and pat_ep_ntec), European Patent Office

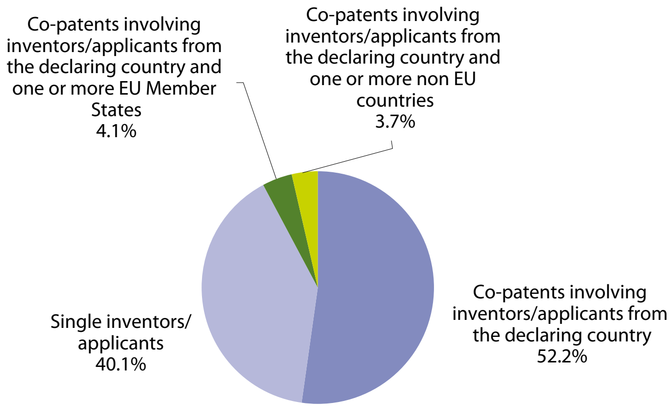
Table 12.9: Patent applications to the European Patent Office (EPO) and patents granted by the USPTO

	Patent applications to the EPO			High-technology patent applications to the EPO			Patents granted by the US Patent & Trademark Office (USPTO)		
	(number of applications)		(per million inhab.)	(number of applications)		(per million inhab.)	(number of patents granted)		(per million inhab.)
	2001	2006	2006	2001	2006 (1)	2006 (1)	1998	2003 (2)	2003 (2)
EU-27	50 734	52 612	106.7	11 543	3 754	7.6	30 530	15 988	32.9
Euro area	41 924	44 277	139.3	9 076	3 344	10.5	23 750	13 161	42.2
Belgium	1 192	1 365	129.9	260	175	16.6	780	394	38.1
Bulgaria	16	20	2.6	3	2	0.3	7	3	0.4
Czech Republic	72	97	9.4	6	9	0.9	38	42	4.1
Denmark	896	1 011	186.3	227	27	5.0	564	219	40.8
Germany	21 757	22 675	275.1	3 889	1 617	19.6	12 747	7 258	87.9
Estonia	10	6	4.7	4	5	3.5	4	1	0.7
Ireland	243	251	59.7	80	17	4.1	164	117	29.6
Greece	71	116	10.4	13	9	0.8	33	25	2.3
Spain	861	1 333	30.5	151	69	1.6	351	249	6.0
France	7 234	7 891	125.3	1 848	876	13.9	4 602	2 085	33.7
Italy	3 960	4 736	80.6	396	240	4.1	1 893	1 226	21.4
Cyprus	16	17	22.1	4	0	0.2	0	2	3.1
Latvia	5	22	9.7	0	2	0.9	4	3	1.5
Lithuania	3	11	3.3	1	2	0.6	1	12	3.5
Luxembourg	73	107	228.3	8	10	21.0	40	29	64.7
Hungary	99	96	9.5	25	5	0.5	36	38	3.7
Malta	5	13	32.1	:	1	3.0	0	0	5.3
Netherlands	3 859	2 900	177.5	1 565	142	8.7	1 516	927	57.3
Austria	1 194	1 451	175.6	184	99	12.0	595	403	49.7
Poland	58	122	3.2	9	12	0.3	20	30	0.8
Portugal	41	129	12.2	8	18	1.7	13	13	1.3
Romania	10	29	1.4	4	0	0.0	6	9	0.4
Slovenia	48	102	51.1	7	2	0.8	28	19	9.5
Slovakia	12	30	5.5	5	3	0.6	7	6	1.1
Finland	1 371	1 190	226.3	663	70	13.3	987	425	81.6
Sweden	2 086	2 200	243.2	514	75	8.3	1 764	546	61.1
United Kingdom	5 543	4 691	77.7	1 667	274	4.5	4 329	1 925	32.4
Croatia	21	27	6.1	2	4	1.0	16	25	5.5
Turkey	45	154	2.1	0	12	0.2	18	18	0.3
Iceland	21	25	84.4	7	2	6.7	22	18	61.1
Liechtenstein	28	24	689.6	3	1	14.3	22	13	379.2
Norway	354	457	98.5	73	12	2.5	295	127	28.0
Switzerland	2 768	3 024	405.5	462	177	23.8	1 528	809	110.6
Japan	19 723	19 990	:	6 283	2 969	:	36 079	29 598	231.8
United States	29 899	31 403	:	10 407	1 347	:	100 276	86 574	297.4

(1) Estonia, Cyprus and Latvia, 2005.
(2) Malta, 2002.

Source: Eurostat (tsc00009, tsiir060, pat_ep_ntec, tsc00010, pat_us_ntot and tsiir070), European Patent Office, USPTO

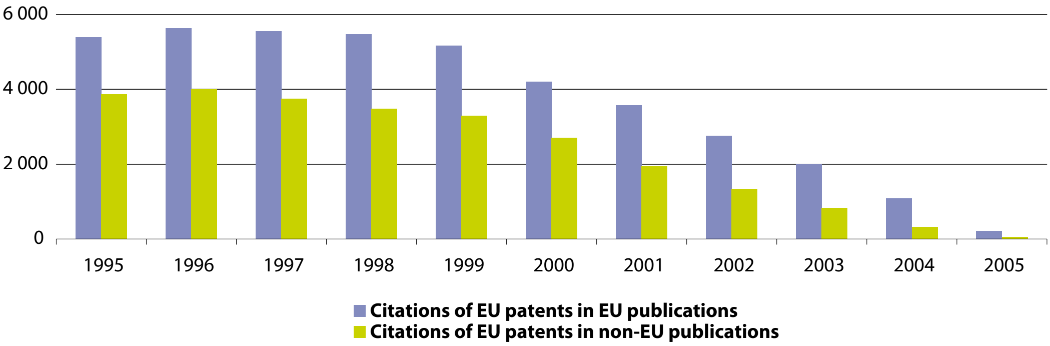
Figure 12.7: Co-patenting at the EPO according to inventors' country of residence, EU-27, 2005 (1)
(% of total)



(1) Figures do not sum to 100 % due to rounding.

Source: Eurostat (pat_ep_cpi)

Figure 12.8: Patent citations, EU-27
(number)



Source: Eurostat (pat_ep_cti)