Statistics in focus

RESEARCH AND DEVELOPMENT

THEME 9 – 1/2000

R&D STATISTICS

Contents

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Human Resources in Science & Technology: A European Perspective

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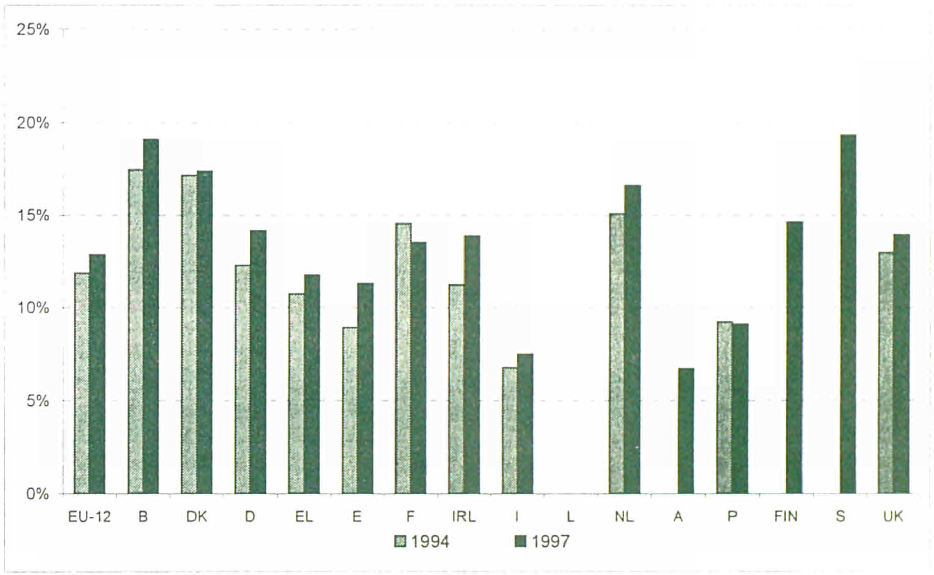


Figure 1: HRSTC as a proportion of the labour force (1994, 1997)

- According to the Community Labour Force Survey and the definitions laid down in the Canberra Manual, 21.7 million people (12.9% of the labour force) achieving a third level education were, in the EU-15 in 1997, working in a science and technology occupation (HRSTC).
- In a majority of countries, the importance of S&T related occupations has increased over the period 1994 to 1997.
- A majority of EU Member States have an HRST unemployment rate of between 3 and 5 per cent. This is significantly lower compared with unemployment among other persons.
- There has been an overall rise across the EU-15 in tertiary education levels over the time period analysed.
- In a majority of cases, annual average employment growth is higher for those S&E that have a third level education.
- Overall graduation rates have increased or remained constant in all the Member States, except for Italy.

Introduction/definitions

As countries have increasingly begun to recognise the importance of human capital as an engine of growth, with rising emphasis on the 'Knowledge based economy', there has been an increased interest in measuring the cohorts of these highly qualified persons. To what degree do nations and regions have the capacity to turn human potential into technological and innovative practices *(stocks)*? And are the respective education systems meeting this demand *(flows)*?

The measurement of stocks and flows of Human Resources in Science and Technology (HRST) aims to deal with these questions. HRST are people who have either (i) successfully completed education at the third level in a S&T field of study or (ii) are not formally qualified as above but employed in a S&T occupation where the above qualifications are normally required. Table 1 shows the different categories of HRST.

Table 1: Categories of HRST

		HRSTE (Education)		
		Third Level Education	< Third Level Education	TOTAL
		ISCED 7/ ISCED 6/ ISCED 5	ISCED < 5	
HRSTO (Occupation)	Professionals	HRST -core	HRST without third level education	
	Technicians			
	Managers			
	All other occupations	HRST non-core		
	Unemployed	HRST unemployed		
	Inactive	HRST inactive		
	Total			

Data is collected according to the guidelines set out in the Canberra Manual.[1] The stock data, which originates from the Community Labour Force Survey (CLFS), is broken down by gender, age and occupation. The CLFS has the advantage of being a rather harmonised data source and may facilitate international comparability. Data on education comes from the EU publication 'Education across the EU' (Statistics and Indicators, Theme 3, Population and Social Conditions). Education respects the International Standard Classification of Education (ISCED) and occupation follows the International Standard Classification of Occupation (ISCO).[2]

The aim of this Statistics in Focus is to give a snapshot of the recent trends in the stocks and flows of HRST across the European Union. However, in presenting these trends a few caveats should be emphasised. Differences in the duration of degrees and national education systems mean that some data need to be interpreted with caution. The length of the time series available also reduces the ability to detect anomalies in the data. The usual questions related to sample surveys obviously apply. The sample size in the CLFS does not allow a detailed HRST analysis for Luxembourg. Therefore, Luxembourg has been omitted from the analysis.

Stock Indicators

From table 2, we can see that, according to the CLFS, total HRST in the EU-15 was roughly equivalent to 61.5 million persons. In 1997, of these, 21.7 million (12.9 per cent of the labour force) had achieved a third level education and were also working in a S&T occupation (HRSTC). Over half of all those persons considered HRST were male (55 per cent). However, when measured as a proportion of the labour force, the higher percentage can be noted for females.

Table 2: The stock of EU-HRST (1997, thousands)

1997 EU-15	HRSTE Excluding HRSTC	HRSTO Excluding HRSTC	HRSTC	Total HRST	Total Labour Force	HRSTC as % of Labour
Total	21320	18437	21748	61505	168213	12,9
Male	12136	9758	11703	33597	96488	12,1
Female	9184	8679	10046	27908	71724	14,0

Source: Eurostat

Looking at HRST over time and as a proportion of the labour force gives a better idea of the increasing importance of HRST. Figure 2 shows that there has been a general increase in the relative importance of HRST over time. The lowest level can be observed in Portugal, which is, moreover, the only EU country where HRST as a proportion of the labour force has fallen (20.6 per cent to 19.8 per cent). The Netherlands, on the other hand, has retained the highest level of HRST over the period 1994 to 1997.

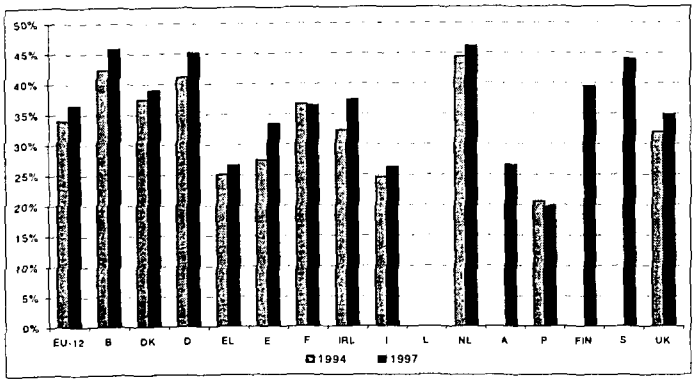


Figure 2: HRST as a proportion of the labour force (1994, 1997)

[1] *"Manual on the measurement of Human Resources devoted to Science & Technology - the Canberra Manual"*, (DSTI/EAS/STP/NESTI (94)2), Group of National Experts on Science and Technology Indicators, OECD, Paris 1995.

[2] For the breakdown of occupations see *International Standard Classification of Occupations: ISCO-88*, International Labour Office, Geneva, 1990.

Examination of HRSTE (those persons considered HRST by their education) as a proportion of the labour force over time reveals a slightly different picture (Figure 3). Here it increased in every EU country except Denmark where the level remained the same. Austria, Italy and Portugal have the lowest levels. But, considerable growth has been experienced in Ireland (25.4 per cent to 29.6 per cent).

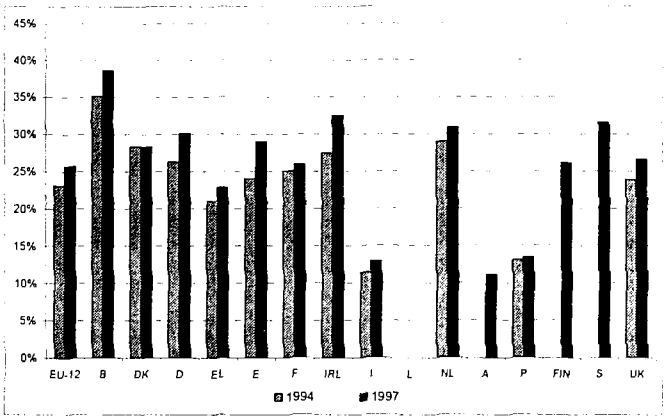


Figure 3: HRSTE as a proportion of the labour force (1994, 1997)

For those that work in a S&T occupation - HRSTO - (Figure 4), it is noteworthy that, in a majority of countries, the importance of S&T related occupations has increased over the period 1994 to 1997. France and Portugal are the only countries where there has been a reduction. All the other EU member states, where comparison is possible, have experienced moderate increases. The highest level is again in the Netherlands (32 per cent in 1997).

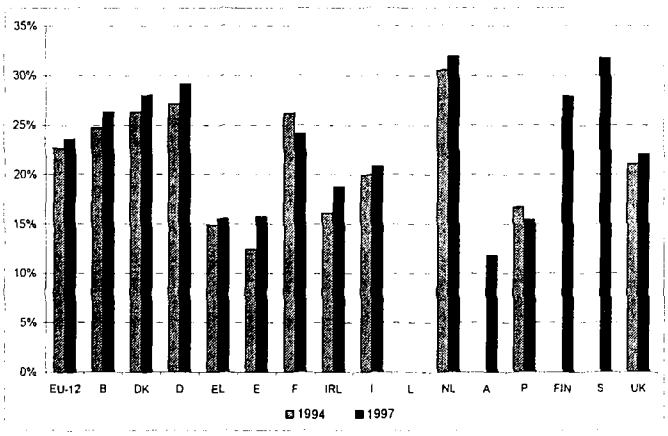


Figure 4: HRSTO as a proportion of the labour force (1994, 1997)

The number of HRSTC - those who have both third level education and work in a S&T occupation - has also increased in every country but Portugal between 1994 and 1997 (Figure 1, cover page). The highest rate can be observed in Sweden, implying that people there are more likely to work in a S&T occupation following third level education than in other EU countries. Ireland and Spain have experienced the strongest gains (11.3 per cent to 13.9 per cent and 9 per cent to 11.3 per cent, respectively).

Employment Patterns in HRST

But in what sectors of employment has this growth occurred? Figures 5 & 6 give a crude indication of development in Professionals (ISCO 2) and Technicians (ISCO 3).

Immediately visible is the general increase in almost all of the countries observed. In the case of Professionals, Portugal is the only exception. The largest expansion can be seen in Ireland with an average annual growth rate of close to 10 per cent. Spain has also undergone a relatively fast development in Professionals, on average 7.6 per cent per year. Most of the countries have experienced growth of under 5 per cent.

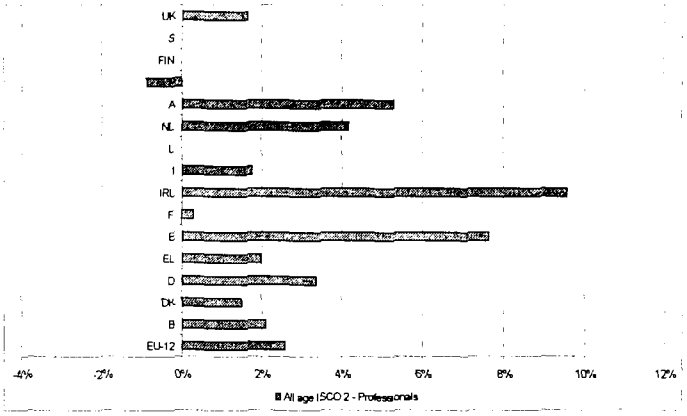


Figure 5: Average annual growth in persons employed in professional occupations - ISCO 2 (1994, 1997)

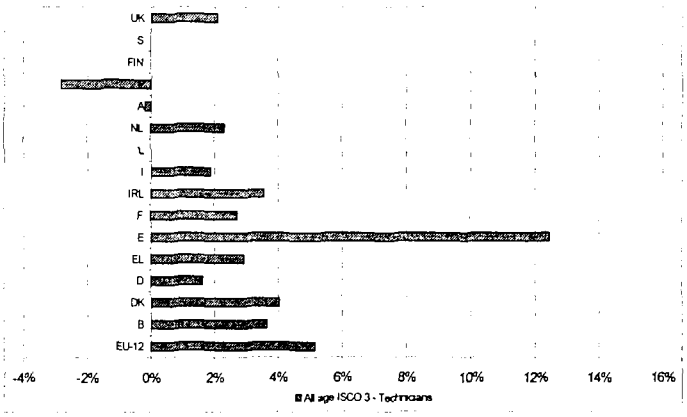


Figure 6: Average annual growth in persons employed in technician occupations - ISCO 3 (1994, 1997)

For Technicians, the trends do not display the same ranking. Again, Spain has a high growth rate. And, moreover, there is a general trend upwards. Beyond that, Ireland has a much weaker growth rate for Technicians than for Professionals. France, on the other hand, has witnessed higher growth in Technician related jobs than in Professionals. Portugal has also experienced a contraction in the number of Technicians.

Table 3: Scientists & Engineers in 1997

1997		ISCO 21	ISCO 21 (With third level education)	ISCO 22 [a]	ISCO 22 [a] (With third level education)	Total S&E (ISCO 21 & ISCO 22)	Annual average growth rate 1994-97 [b]	Total S&E (With third level education)	Annual average growth rate 1994-97 [b]
B	Total	126,259	115,083	173,200	142,660	299,459	2.34%	257,743	2.90%
	Male	109,184	99,727	49,633	47,893	158,816	2.79%	147,620	3.35%
	Female	17,076	15,356	123,567	94,767	140,643	1.85%	110,123	2.31%
DK	Total	77,278	62,679	35,807	35,807	113,085	2.67%	98,485	0.68%
	Male	66,623	53,664	17,403	17,403	84,027	4.08%	71,067	1.81%
	Female	10,655	9,015	18,403	18,403	29,058	-1.02%	27,418	-2.03%
D	Total	1,339,497	1,132,842	444,486	401,617	1,783,983	3.27%	1,534,459	5.34%
	Male	1,165,761	992,381	276,643	251,591	1,442,405	3.25%	1,243,972	5.18%
	Female	173,736	140,461	167,842	150,026	341,578	3.35%	290,487	6.06%
EL	Total	59,245	59,028	72,690	72,690	131,935	1.20%	131,718	2.25%
	Male	47,949	47,807	46,868	46,868	94,817	0.57%	94,675	1.61%
	Female	11,296	11,221	25,822	25,822	37,118	2.86%	37,043	3.98%
E	Total	220,143	212,017	313,413	310,258	533,556	7.49%	522,276	7.95%
	Male	192,500	186,015	124,211	121,892	316,711	4.65%	307,906	4.94%
	Female	27,643	26,003	189,202	188,367	216,845	12.28%	214,369	12.97%
F	Total	650,152	463,622	342,087	325,244	992,239	1.85%	788,866	2.01%
	Male	577,009	404,940	206,080	196,238	783,089	2.42%	601,178	2.70%
	Female	73,143	58,682	136,007	129,006	209,150	-0.16%	187,688	-0.07%
IRL	Total	52,831	39,362	59,032	45,333	111,863	6.68%	84,695	11.67%
	Male	42,616	31,922	12,182	10,590	54,798	7.91%	42,512	10.83%
	Female	10,215	7,439	46,850	34,743	57,065	5.55%	42,182	12.54%
I [c]	Total	180,569	180,569	358,506	358,506	539,075	4.99%	539,075	4.99%
	Male	153,330	153,330	237,989	237,989	391,319	4.12%	391,319	4.12%
	Female	27,239	27,239	120,517	120,517	147,756	7.44%	147,756	7.44%
L	Total	:	:	:	:	:	:	:	:
	Male	:	:	:	:	:	:	:	:
	Female	:	:	:	:	:	:	:	:
NL	Total	247,159	180,798	128,791	108,925	375,951	3.33%	289,723	3.33%
	Male	211,416	154,110	57,651	52,736	269,067	2.18%	206,846	1.45%
	Female	35,744	26,688	71,140	56,189	106,884	6.48%	82,877	8.71%
A	Total	36,148	35,177	42,977	41,976	79,125	6.83%	77,154	6.15%
	Male	31,505	30,535	26,310	25,703	57,815	9.81%	56,237	8.60%
	Female	4,643	4,643	16,668	16,274	21,310	-0.18%	20,917	0.30%
P [c]	Total	43,750	43,750	39,496	39,496	83,246	-4.88%	83,246	-4.88%
	Male	36,880	36,880	22,687	22,687	59,567	-2.24%	59,567	-2.24%
	Female	6,870	6,870	16,809	16,809	23,679	-10.45%	23,679	-10.45%
FIN	Total	81,754	61,671	92,640	87,393	174,393	:	149,064	:
	Male	65,287	49,570	15,190	14,064	80,476	:	63,634	:
	Female	16,467	12,101	77,450	73,329	93,917	:	85,430	:
S	Total	126,661	97,779	83,661	78,187	210,321	:	175,966	:
	Male	97,369	74,060	26,744	26,050	124,113	:	100,110	:
	Female	29,291	23,719	56,917	52,137	86,209	:	75,856	:
UK	Total	1,079,283	741,318	788,679	741,059	1,867,963	2.04%	1,482,377	2.28%
	Male	945,530	653,010	213,209	194,058	1,158,740	2.73%	847,068	3.07%
	Female	133,753	88,308	575,470	547,001	709,223	0.96%	635,309	1.26%

a) ISCO 22 includes Nursing and Midwifery professionals
b) Average annual growth rate for Austria is from 1995 - 1997
c) For Italy and Portugal, all Scientists and Engineers were classified as having a third level education

Table 3 shows the various levels of employment for those working either as physical, mathematical and engineering science professionals (ISCO 21) or as life science and health professionals (ISCO 22). For most of the Member States, employment in physical, mathematical and engineering science is characterised more by males. The opposite is true for life science and health professionals.

Furthermore, in a majority of cases, annual average employment growth is higher for core S&E professionals than for those who may or may not have a third level education. The exceptions to this trend are Denmark for both males and females and the Netherlands and Austria for males. In six of the Member States for which data were available, the growth rate (1994-1997) in S&E employment for those with a third level education is higher for females than for males.

On the whole, growth displays the same trends for both males and females. In Denmark, France and Austria, however, overall growth is accompanied by a rise in male and a decline in female S&E employment. In Austria, this is only true for those persons that may or may not have a third level education.

S&T Unemployment in the EU

An overview of the unemployment situation for persons with a third level education is given in figure 7. It is noticeable that, with the exception of Spain, France and Italy, most countries have an HRST unemployment rate (HRSTU) of between 3 and 5 per cent. In both 1994 and 1997, it is in Austria and Portugal that the lowest levels are evident. Spain has the highest level of unemployment in both 1994 and 1997.

Compared to the unemployment rate for those persons that do not have a third level education: two distinct trends for all countries can be observed from the data. Firstly, HRST unemployment is always lower (significantly in many cases) than non-HRST unemployment. Secondly, a rise in the unemployment rate for non-HRST tends to be accompanied by a rise in jobless HRST - and vice-versa - although relative differences are not shown.

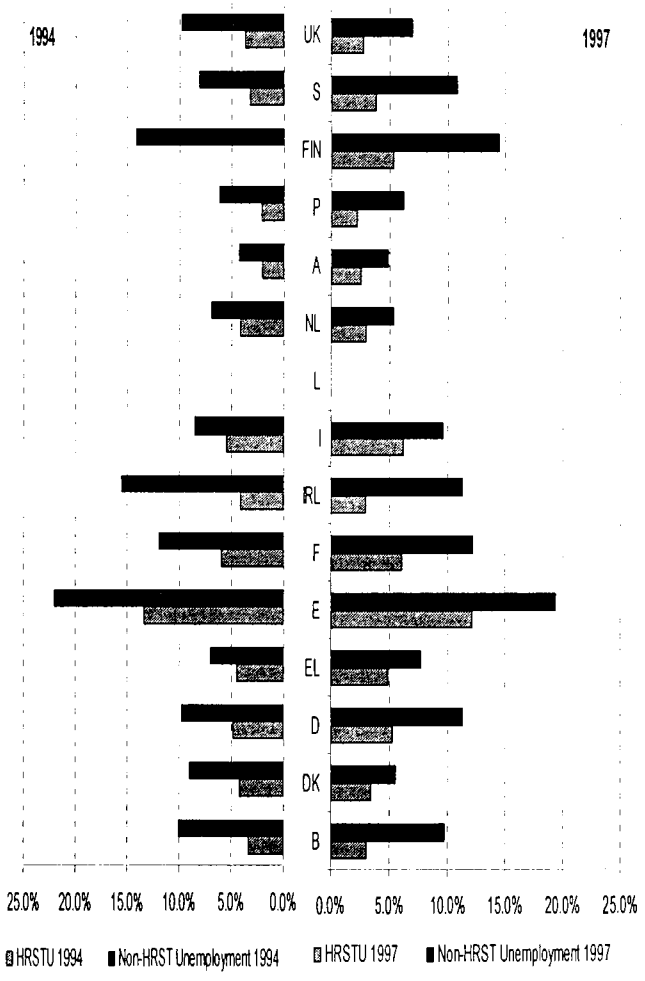
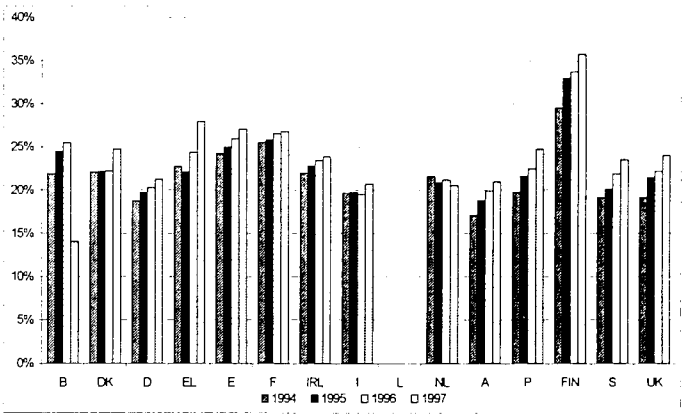


Figure 7: HRSTU versus Non-Hrst Unemployment (25-59 year olds, 1994, 1997)

In Greece the difference between the unemployment rate for HRST and for non-HRST is relatively small (4.5 per cent as compared with 7.0 per cent in 1994 and 4.9 per cent compared with 7.7 per cent in 1997). In Ireland, on the other hand the unemployment rate for non-HRST in 1994 is nearly fourfold its HRST counterpart (15.6 per cent against 4.2 per cent). And in 1997, it is again Ireland that demonstrates the largest disparity (11.3 per cent for non-HRST unemployment compared with 3.0 per cent for HRSTU).

Flow Indicators

In order to explain the differences in stock levels, understanding the flows of HRST is crucial. HRST stocks are supplied by two key flows: the inflows to HRST from the education system and flows through migration/mobility. Education flows can be ascertained largely from existing data, whereas data on mobility or migratory flows is less clear. For this reason, only education is considered here.



1997 data for Belgium refer to Flemish Community only

Figure 8: Participation in tertiary education as a percentage of persons aged 20-29 (1994-1997)

There has been considerable growth in the higher education systems of the EU. To put this into perspective, figure 8 demonstrates the proportion of young people participating in tertiary education as a percentage of persons aged 20-29. This reveals that there has been a general overall rise in participation levels in tertiary education.

Participation rates do not, on their own, give a comprehensive picture of flows into HRST. Rather they serve to illustrate *potential* HRST inflows. These figures should therefore be complemented by graduation rates (table 4).

Firstly, lower graduation rates in certain EU countries such as Austria and Italy can be partly explained by the longer duration of tertiary studies. Therefore, to a certain extent, comparability of education should be made with caution.

Closer scrutiny of table 4 reveals rising overall graduation rates. However, this trend is not uniform across all Member States for which data is available. Between the academic years 1993/94 and 1996/7, overall graduation rates have fallen only in Italy, and remained the same in Finland.

The highest graduation rates for both males and females as a proportion of the 25-29 year old population are witnessed in France and Ireland.

Another noticeable feature is that graduation rates are, except for Germany and Greece, higher for females than they are for males over the whole time period.

Table 4: Graduation rates from higher education as a proportion of 25-29 year olds (1994-1997)

	Graduation from higher education Females				Graduation from higher education Males				Graduation from higher education Total			
	1994	1995	1996	1997	1994	1995	1996	1997	1994	1995	1996	1997
B	8,1			5 8 [a]	7,4			5 7 [a]	7,7			5 4 [a]
DK	6,2	6,1	8,4	9,1	5,3	7,2	7,3	7,4	5,7	7,7	7,8	8,2
D	4,3	4,9	5,1	5 4 [b]	5,1	5,7	5,7	6 0 [b]	4,7	5,3	5,4	5 7 [b]
EL	4,1	4,8	4,4	3,9	3,4	4,1	3,9	4,3	3,8	4,5	4,2	4,1
E	5,8	7,2	8,1	9,6	4,6	5,3	6,0	6,4	5,2	6,2	7,0	7,9
F			15,9	14,6			11,8	11,5			13,9	13,1
IRL	12,2	13,7	12,4	13 7 [c]	11,6	13,1	12,6	12 9 [c]	11,9	13,4	12,5	13 3 [c]
I	4,8	4,3	4,1	4 1 [b]	3,7	3,4	3,2	3 2 [b]	4,2	3,9	3,7	3 7 [b]
L												
NL	5,5	6,0	7,1	7 1 [b]	5,9	6,1	6,7	6 6 [b]	5,7	6,1	6,9	6 8 [b]
A	2,7	2,9	2,9	3,4	2,6	2,6	2,7	3,1	2,6	2,7	2,8	3,3
P	6,5	7,4	8,1	9,2	4,2	4,7	4,6	5,0	5,4	6,1	6,4	7,1
FIN	10,2	9,4	9,5	10,2	7,2	6,9	6,9	7,1	8,7	8,1	8,2	8,7
S	6,8	6,4	6,1	6,9	4,1	4,6	4,5	4,8	5,4	5,5	5,3	5,8
UK	10,5	11,2	10,4	11,1	9,7	9,4	9,5	9,7	10,1	10,3	9,9	10,4

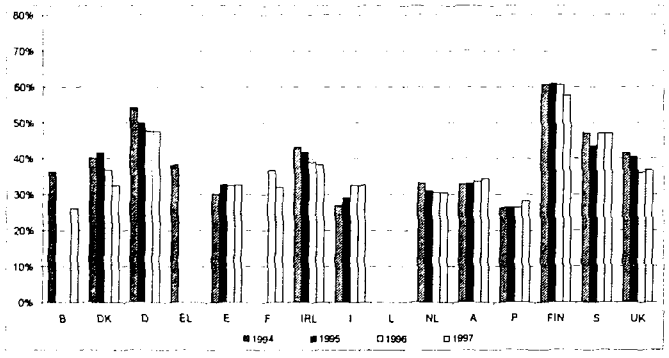
a) Flemish community only

b) 1995/1996 data

c) Includes students who graduated a second time at the same ISCED level (approx. 4 0). Excludes a number of students at ISCED 5 who receivec professional qualifications from various professionnal bodies (accountacy, marketing and secretarial)

Science and Engineering

Graduates of science and engineering programmes may often become a key component in a country's technological and economic performance.



1997 data for Belgium refer to Flemish Community only

Figure 9: Proportion of graduates with S&E degrees (1994-1997)

Figure 9 shows the recent trends in the proportion of science and engineering graduates across the European Union.[3]

Immediately visible is that there is a downward bias: discounting Belgium for which '97 data refer to the Flemish Community only, there has been a reduction in 8 of the 12 countries for which a time series is available, with particularly marked declines in Denmark, Germany and the UK. Spain, Italy and Austria, on the other hand, have witnessed marginal increases.

Finland has by far the highest proportion of graduates obtaining degrees in science and engineering related subjects (60 per cent in 1996). Furthermore, over the period of analysis, very little change has occurred. Germany and Sweden also have a comparatively high proportion of science and engineering graduates (48 and 47 per cent in 1997, respectively).

Conclusions and Future Work

There has been a general rise in the stocks of HRST across the European Union. This is partly a result of increases in the number of professional and technician level jobs, and partly a result of a flourishing number of graduates.

Despite general improvements in the measurement of HRST, still some caveats remain. For example, data availability makes it difficult to present EU-15 aggregated information for some indicators. But, as the time series grows longer, it becomes easier to identify, and consequently iron out, any queries.

As with any sample survey, results are subject to sampling and other errors. Sample size limitations of the CLFS also imply that the level of disaggregation is sometimes restricted. However, the nature of the CLFS does mean that the results are rather harmonised, improving international comparability.

In the near future, a field of study variable will be introduced to the CLFS as an additional, *ad hoc* question. This will allow a far more detailed analysis of the types of educational backgrounds across the different Member States of the European Union. Another improvement may come about with the collection of data using the revised version of ISCED, allowing more emphasis on doctoral level personnel.

Extending the data series beyond the EU-15 Member States, for example to include both the accession countries and the other EEA countries, could prove a valuable exercise also.

Some further recent and related research has concentrated on developing indicators on the mobility of these highly qualified persons. Hitherto, initial developments in the measurement of domestic mobility have been achieved, but not for international mobility, which remains more problematic. These will be further developed in the near future.

[3] This definition includes the following disciplines: Natural science, Mathematics, Computer science, Medical science, Engineering and Architecture, and can be found in the Eurostat publication *Education at a Glance*.

➢ ESSENTIAL INFORMATION – METHODOLOGICAL NOTES

NOTES/ABBREVIATIONS

HRST	Human Resources in Science and Technology
HRSTE	Human Resources in Science and Technology Education
HRSTO	Human Resources in Science and Technology Occupation
HRSTC	Human Resources in Science and Technology Core
HRSTI	Human Resources in Science and Technology Inactive
HRSTU	Human Resources in Science and Technology Unemployed
HRSTN	Human Resources in Science and Technology employed in a non S&T occupation
HRSTW	Human Resources in Science and Technology without third level education
CLFS	Community Labour Force Survey
ISCED	International Standard Classification of Education
ISCO	International Standard Classification of Occupation

HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY (HRST)

HRST are people who fulfil one or other of the following conditions:

- successfully completed education at the third level in an S&T field of study
- not formally qualified as above but employed in a S&T occupation where the above qualifications are normally required.

THE INTERNATIONAL STANDARD CLASSIFICATION OF EDUCATION (ISCED)

Designed to compile and present internationally comparable education indicators, statistics on education at the tertiary level are classified in three categories: ISCED 5, 6, and 7 (1976 version):

ISCED level 5	▪ education at the third level, first stage, of the type that leads to an award not equivalent to a first university degree
ISCED level 6	▪ education at the third level, first stage, of the type that leads to a first university degree or equivalent
ISCED level 7	▪ education at the third level, first stage, of the type that leads to a postgraduate university degree or equivalent

THE INTERNATIONAL STANDARD CLASSIFICATION OF OCCUPATIONS (ISCO)

ISCO 1 (legislators, senior officials and managers)	▪ occupations whose main tasks consist of ... planning, directing and co-ordinating the policies and activities of enterprises and organisations, or departments.
ISCO 2 (professionals)	▪ occupations whose main tasks require a high level of professional knowledge and experience in the fields of physical and life sciences, or social sciences and humanities.
ISCO 21	▪ Physical, mathematical and engineering science professionals
ISCO 22	▪ Life science and health professionals
ISCO 3 (technicians and associate professionals)	▪ occupations whose main tasks require technical knowledge and experience in one or more fields of physical and life sciences, or social sciences and humanities.

CANBERRA MANUAL

Prepared jointly by the OECD and the European Commission / Eurostat, this manual is intended to provide guidelines for the measurement of Human Resources devoted to Science and Technology (HRST) and the analysis of such data. The work was carried out in response to policy needs and priority issues identified by these and other organisations.

Further information:

➢ Databases

New Cronos: Theme 9
Domain: HRST

To obtain information or to order publications, databases and special sets of data, please contact the **Data Shop** network:

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