Human Resources in Science & Technology: A European Perspective

Ibrahim Laafia

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

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Education</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>HRSTE</td>
<td>HRST</td>
<td>TOTAL</td>
</tr>
<tr>
<td>Professors</td>
<td>HRST Core</td>
<td>HRST Core</td>
</tr>
<tr>
<td>Technicians</td>
<td>HRST Core</td>
<td>HRST Core</td>
</tr>
<tr>
<td>Managers</td>
<td>HRST Core</td>
<td>HRST Core</td>
</tr>
<tr>
<td>XRSTE</td>
<td>HRST Core</td>
<td>HRST Core</td>
</tr>
<tr>
<td>Total HRST</td>
<td>Total HRST</td>
<td>Total HRST</td>
</tr>
<tr>
<td>Male</td>
<td>Female</td>
<td>Female</td>
</tr>
<tr>
<td>HRST Core</td>
<td>HRST Core</td>
<td>HRST Core</td>
</tr>
<tr>
<td>HRST Core</td>
<td>HRST Core</td>
<td>HRST Core</td>
</tr>
<tr>
<td>HRST Core</td>
<td>HRST Core</td>
<td>HRST Core</td>
</tr>
</tbody>
</table>

Data is collected according to the guidelines set out in the Canberra Manual.

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).

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)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HRSTE</td>
<td>HRSTC</td>
<td>HRSTC</td>
<td>HRSTC</td>
<td>HRSTC</td>
<td>HRSTC</td>
<td>HRSTC</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>Total</td>
<td>Total</td>
<td>Total</td>
<td>Total</td>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>EU-15</td>
<td>21320</td>
<td>18437</td>
<td>21748</td>
<td>61505</td>
<td>168213</td>
<td>12,9</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>12136</td>
<td>9758</td>
<td>11703</td>
<td>33597</td>
<td>96488</td>
<td>12,1</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>9184</td>
<td>8679</td>
<td>10046</td>
<td>27908</td>
<td>71724</td>
<td>14,0</td>
<td></td>
</tr>
</tbody>
</table>

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)
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).

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).

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.

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.
The exceptions to this trend are Denmark 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.

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.

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)

<table>
<thead>
<tr>
<th></th>
<th>Graduates from higher education females</th>
<th>Graduates from higher education males</th>
<th>Graduates from higher education total</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>8.1</td>
<td>6.7</td>
<td>6.2</td>
</tr>
<tr>
<td>DK</td>
<td>6.2</td>
<td>6.1</td>
<td>6.4</td>
</tr>
<tr>
<td>EE</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
</tr>
<tr>
<td>EL</td>
<td>6.1</td>
<td>6.3</td>
<td>5.7</td>
</tr>
<tr>
<td>ES</td>
<td>5.5</td>
<td>5.5</td>
<td>5.5</td>
</tr>
<tr>
<td>F</td>
<td>10.9</td>
<td>10.9</td>
<td>10.7</td>
</tr>
<tr>
<td>NL</td>
<td>12.9</td>
<td>12.9</td>
<td>12.9</td>
</tr>
<tr>
<td>I</td>
<td>4.9</td>
<td>4.9</td>
<td>4.9</td>
</tr>
<tr>
<td>L</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>NL</td>
<td>11.6</td>
<td>11.8</td>
<td>12.0</td>
</tr>
<tr>
<td>I</td>
<td>4.9</td>
<td>5.1</td>
<td>5.3</td>
</tr>
<tr>
<td>L</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>NL</td>
<td>11.6</td>
<td>11.6</td>
<td>11.6</td>
</tr>
<tr>
<td>I</td>
<td>5.1</td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td>L</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>NL</td>
<td>11.6</td>
<td>11.6</td>
<td>11.6</td>
</tr>
<tr>
<td>I</td>
<td>5.1</td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td>L</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>NL</td>
<td>11.6</td>
<td>11.6</td>
<td>11.6</td>
</tr>
<tr>
<td>I</td>
<td>5.1</td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td>L</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>NL</td>
<td>11.6</td>
<td>11.6</td>
<td>11.6</td>
</tr>
<tr>
<td>I</td>
<td>5.1</td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td>L</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>NL</td>
<td>11.6</td>
<td>11.6</td>
<td>11.6</td>
</tr>
<tr>
<td>I</td>
<td>5.1</td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td>L</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
<tr>
<td>NL</td>
<td>11.6</td>
<td>11.6</td>
<td>11.6</td>
</tr>
<tr>
<td>I</td>
<td>5.1</td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td>L</td>
<td>5.6</td>
<td>5.6</td>
<td>5.6</td>
</tr>
</tbody>
</table>

1997 data for Belgium refer to Flemish Community only.

### Conclusion 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.

---

1 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.*
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:

**BELGIQUE/BELGIË**
Eurostat Data Shop
 Brussels/Brussel
Plantin-Botleuse
124 Rue du Commerce
Handelsstraat 124
B-1000 BRUXELLES/BRUSSEL
Tel. (32-2) 234 67 50
Fax (32-2) 234 67 51
E-Mail: datashop@planstats.be

**ITALIA – Milano**
ISTAT
Ufficio Regionale per la Lombardia
Eurostat Data Shop
Via Fraco, 3
I-20123 MILANO
Tel. (39-02) 8861 3268
Fax (39-02) 8861 3264
E-Mail: info@datashop.inse.it

**SVEDE**
Statistics Sweden
Enquiries & advice and publications
Office for National Statistics
2 rue Mercier – L-2955 Luxembourg
Tel. (352) 4301 32469
Fax (352) 4301 32459
E-Mail: eudatashop.asp

**UK – LONDON SW1V 2QQ**
Office for National Statistics
Tel. (44-171) 374 7350
Fax: (44-191) 384 4971
UK-LONDON DH1 3SW
Tel. (44-191) 374 7350
Fax (44-191) 384 4971
E-Mail: datashop@ons.gov.uk

**KOREA – SEOUL – KYONGBI GONG**
Tel. (82-2) 724 8781
Fax (82-2) 724 8782
Kong Dong mail: E-Mail: datashop@kostat.or.kr

**RUSSIA – MOSCOW**
Telephone: (7) 246 23 35
Fax: (7) 246 23 36
E-Mail: datashop@stat.gov.ru

**UNITED STATES OF AMERICA**
Haver Analytics
Eurostat Data Shop
80 East 43rd Street
Suite 3310
USA-NEWYORK, NY 10165
Tel. (1-212) 986 93 00
Fax (1-212) 986 92 97
E-Mail: eurodata@haver.com

**ITALIA – Roma**
ISTAT
Centro di Informazione Statistica
Sede di Roma, Eurostat Data Shop
Via Cesare Balbo, 11a
00186 ROMA
Tel. (06-6) 46 73 31 02 06
Fax (06-6) 46 73 31 01 07
E-Mail: dps@istat.it

**SWISS/SUISSE/SVIZZERA**
Statistisches Amt des Kantons Zürich, Eurostat Data Shop
Bleicherweg 5
CH-8001 Zürich
Tel. (41-1) 225 12 12
Fax (41-1) 225 12 09
E-Mail: datashop@zh.ch

TO ORDER:

**For the Data Shop and sales office addresses see above**

Internet Address: http://eur-op.eu.int/rf/academic/s-ad.htm

Please visit our website at www.europa.eu.int/comm/eurostat for further information!

Order form

I would like to subscribe to Statistics in focus (from 1.1.2000 to 31.12.2000):

For the Data Shop and sales office addresses see above

**Formula 1:** All 9 themes (approximately 140 issues)

- Paper: EUR 360
- PDF: EUR 264
- Paper + PDF: EUR 432

Language required: [ ] DE [ ] EN [ ] FR

**Formula 2:** One or more of the following seven themes:

- Theme 1 'General statistics'
- Theme 2 'Economy, trade and services'
- Theme 3 'Population and social conditions'
- Theme 4 'Industry, trade and services'
- Theme 5 'Agriculture and fisheries'
- Theme 6 'External trade'
- Theme 8 'Environment and energy'

- Paper: EUR 84 PDF: EUR 60
- Combined: EUR 114

Language required: [ ] DE [ ] EN [ ] FR

Please send me a free copy of Eurostat Mini-Guide (catalogue containing a selection of Eurostat products and services)

Language required: [ ] DE [ ] EN [ ] FR

I would like a free subscription to 'Statistical References', the information letter on Eurostat products and services

Language required: [ ] DE [ ] EN [ ] FR

Mr [ ] Mrs [ ] Ms

(Please use block capitals)

Surname: 
Forename: 

Company: 
Department: 

Function: 

Address: 

Post code: Town: Country: 

Tel.: Fax: 

E-mail: Payment on receipt of invoice, preferably by:

- Bank transfer
- Visa 
- Eurocard

Card No: Expires on: 

Please confirm your Intra-Community VAT number:

If no number is entered, VAT will be automatically applied. Subsequent reimbursement will not be possible.