

## **E. HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY IN SPAIN: A REVIEW OF THE INFORMATION SOURCES**

*by*

Ms. Carolina Cañibano, Assistant Professor, *Alfonso X University of Madrid*  
Dr. Paloma Sánchez, Professor of Applied Economic, *Autonomous University of Madrid*

### **Overview**

This paper attempts to make a methodological analysis of the Spanish statistical data that may provide information about the human resources in science and technology labour markets. A thorough review is made of the questionnaires in different surveys and the results. One of the main findings is that although none of the sources has been created with the purpose of providing information about these human resources, the information is quite extensive and its analysis could lead to important improvements in policy design. Some suggestions are provided in the paper to ameliorate the analytical capacity of the data sources, first by making additional use of the existing raw material in the questionnaires, and second by suggesting further issues to be incorporated.

### **Introduction**

The object of this paper is to review the existing statistical sources in Spain that may provide information on the human resources in science and technology. The analysis of these sources will be made allowing for possible use of existing data to explain the characteristics of the labour markets of that portion of population in order to better define policy measures.

The rationale of this analysis is very clear. We live in a knowledge-based economy, which means that knowledge has become an important factor of production, completely changing the characteristics of the production process. In this new situation competitiveness and growth are increasingly based more on brains than on material resources. To determine the level, qualifications, dynamics, etc. of human resources, the brain-intensity of a country, is without doubt a key political issue. Future wealth will be largely based on the existence of sectors of population which are well trained with the appropriate skills to undertake the challenges of the new millennium.

The remainder of this paper is organised as follows. The point of departure is the concepts and definitions of the Canberra Manual (OECD, 1994). Section 2 is devoted to defining the scope of the analysis taking into account the different categories established by the Manual. A detailed description of all existing data sources in Spain is made in Section 3. All of them are enumerated and described, distinguishing between primary and secondary sources. The following information is provided for every source:

- Institution responsible for the data.
- Date of first and last data available.
- Data frequency.
- Main information provided.

Particular attention is paid to the following:

- Existence of detailed raw data related to S&T human resources (included in the questionnaires) but not yet used in the tables. Additional analysis of existing data that would supply further information on such resources.
- Need for more raw data and therefore a redefinition of the questionnaires.

Some of the methodological and factual difficulties in addressing mobility are addressed in Section 4. Section 5 is devoted to highlighting the main advantages and shortcomings of the existing data to build adequate indicators for policy making, and finally, Section 6 presents some conclusions.

### **Scope of the analysis on the Canberra Manual bases**

As is well known, the OECD Group of National Experts on Science and Technology Indicators (NESTI) finished in November 1994 a Manual on the Measurement of Human Resources devoted to Science and Technology, referred to hereafter as the Canberra Manual. This Manual is an important attempt to provide useful international guidelines to measure a crucial subgroup of all human resources, which is in one way or another connected to scientific and technological activities.

The Manual takes a broad view considering Human Resources devoted to Science and Technology (HRST) as those who fulfil one or other of the following conditions:

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

We will keep closely to these definitions in this paper and will therefore use the two following categories:

- Human resources with a third level education in Science and Technology studies: HRSTE.
- Human resources occupied in Science and Technology activities: HRSTO.

The intersection of these two groups will be the main category of human resources and refers to people with third level education *and* employed in an S&T occupation. It is one of the important groups for policy purposes (see Figure 1).

According to the above definitions two issues have to be defined:

- Science and technology studies.
- Science and technology activities.

In the first case the Canberra Manual distinguishes between Core Coverage, Extended Coverage and Complete Coverage. Table 1 below shows how they are defined.

**Table 1. Coverage for data collection, by field of study and level of education**

Field of Study	ISCED-76 Level		ISCED-97 Level	
	6/7	5	5A/6	5B
Natural sciences	Core	Extended	Core	Extended
Engineering and technology	Core	Extended	Core	Extended
Medical sciences	Core	Extended	Core	Extended
Agricultural sciences	Core	Extended	Core	Extended
Social sciences	Core	Extended	Core	Extended
Humanities	Extended	Complete	Extended	Complete
Other fields	Extended	Complete	Extended	Complete

Source: OECD, 1994; 25 and OECD, 1999b; 14.

Levels 5, 6 and 7 are all within the third level of education (technical plus university level qualifications) according to the International Standard Classification of Education (ISCED-76), which is the classification followed by the Manual. However, Table 1 shows also the coverage for data collection following the new ISCED-97 classification, which will be implemented in OECD countries in the coming years.

In principle, we are going to consider all suggested coverage. Thus HRSTE are all human resources with third level education in whatever field of study. This approach is taken mainly for practical reasons. As we will see in the next Section, some sources reveal the level of education a person has achieved (and therefore permit us to place them above or under the third level), but not the field of study in which that level has been attained.

However, for political purposes we believe that humanities and other fields at any educational level should be left out, otherwise data gathering and analysing would increase without providing a useful tool for policy. The fact is that the number of humanities graduates in Spain is larger than the number of graduates in sciences and engineering, which is probably a shortcoming if the innovative capacities of the country are to be increased.

In relation to coverage in terms of occupation, the Manual follows the International Standard Classification of Occupations (ISCO). We will adhere to the coverage suggested, considering as S&T occupations Professional Technicians and Associate Professionals, and Managers. Recent reviews suggest excluding the Manager's group (OECD, 1999) but as this is just a methodological analysis of the sources we prefer to have the broadest possible perspective. When actually gathering the data to build indicators a selection of those with more explanatory capability and usefulness for policy may be made.

Table 2 shows clearly the equivalence between ISCO classification and the Spanish definitions. Two important ideas from the Manual are kept in mind in particular when analysing the Spanish data sources. The first one is that there are a number of data sets that contain information about HRST, but they have neither been collected nor used for S&T policy. In fact S&T policy makers do not take these data into consideration. The second is that the Manual itself has yet to be implemented in practice. It is necessary to see whether it is sufficiently utilitarian and relevant to policy and analytical needs.

Taking these two ideas together, the main objective of this paper is to: analyse the data sets in Spain which, although not built for that purpose, provide information about HRST, and to assess whether the categories and concepts established in the Manual can be found in the Spanish statistical data and whether they are useful in terms of shaping S&T policy.

On the basis of the Canberra Manual, in 1995 the OECD produced a very important paper: *Basic Indicators for describing the stock of Human Resources in Science and Technology* (OECD, 1995). In the

paper a set of 10 main indicators to be calculated by all countries is suggested. The availability of these indicators would allow interesting international comparisons.

In this paper, we consider whether the Spanish data permits the construction of such indicators, and in some cases, additional ones are suggested.

### Description of the data sources

The following sections describe in detail the data sources analysed.

#### *Active Population Survey (Encuesta de Población Activa – EPA) (INE, 1998a.)*

- Institution responsible for the data set: National Institute of Statistics (INE).
- Date of first and last data: 1987/third quarter 1998.
- Publication frequency: Quarterly.
- Sample: 64 000 family units<sup>12</sup> surveyed every quarter.

The Spanish Active Population Survey (EPA) provides useful information about the conditions of the labour market. The data are classified in four main categories: 1) Occupied; 2) Unemployed; 3) Active (Occupied + Unemployed), and 4) Inactive. All of them are analysed below.

The classification of occupations used in the two first categories follows the National Classification of Occupations (CNO-94), which is the most recent Spanish adaptation of the International Standard Classification of Occupations (ISCO-88). Thus the EPA provides HRST data, in terms of occupation according to the definitions outlined in the Canberra Manual.<sup>13</sup>

The equivalence between ISCO-88 and Spanish CNO-94 is shown in Table 2.

**Table 2. ISCO-88 and CNO-94 Equivalence for S & T Occupations**

ISCO-88	CNO-94
Major Group 2: Professionals	Major Group 2: Technicians, Professionals, Scientists and Intellectuals.
Major Group 3: Technicians and Associate Professionals	Major Group 3: Support Technicians and Professionals.
Major Group 1; Subgroup 122: Production and Operations Department Managers and subgroup 123: Other Department Managers	Major Group 1; Subgroup 11: Executive Managers of companies with 10 or more employees.
Major Group 1; Subgroup 131: General Managers	Major Group 1; Subgroups 12, 13, 14, 15, 16 and 17: Managers

Source: Authors.

12. The unit of analysis is the group of people living in the same house.

13. “All people employed in occupations which are classified in ISCO-88 major groups 2 or 3, or in the management subgroups 122, 123, or 131 are considered to be employed in an S&T occupation” (OECD, 1994; 27).

*Information about the active population*

The EPA section, which corresponds to the employment survey, provides substantial information on the stock of HRST employed in an S&T occupation (HRSTO). The quarterly publication of the INE includes the following breakdowns for each one of the major groups mentioned above:

- Gender.
- Age.
- National Origin (grouped by large geographical or political areas, i.e. European Union, America, etc.).
- Economic Sector of Employment.
- Labour force status: Full time or part time permanent staff, short-term contract staff, etc.
- Time spent in the present employment.
- Type of working conditions (work on weekends, work at home, work by night, etc.).
- Level of education (classification comparable to ISCED).
- Current studies.

As the level of education is provided for all HRSTO, the EPA allows for differentiating between two of the three main categories of HRST defined by the Canberra Manual. Thus:

- HRST without third level education but employed in an S&T occupation.
- HRST with third level education and employed in an S&T occupation.

It should be noted, however, that the source we are analysing here allows for breakdowns only for the different occupation levels and disregards the different educational levels. So, for example, a gender analysis here can be made for HRSTO, but not for HRSTE.

Moreover, using the information on the Current Studies of HRSTO, we obtain the flow of HRST going from a) to b), which represents people employed in an S&T occupation who are now receiving third level education. The EPA results are only published at aggregated level. This means that only data about the major groups of occupations are disclosed, even though raw data exists on the subgroups and could be obtained and analysed on request. In summary, the Spanish Survey of the Active Population allows for the preparation of a well defined profile of those employed in an S&T occupation, according to the definitions and analysis of the Canberra Manual.

*Information about the unemployed and inactive population*

Unemployment figures broken down into major groups of occupations provide information about people who are unemployed at the time of the survey, but who held an S&T occupation in the past. The different analyses show how long these people have been unemployed, their gender, age and the reason for leaving their last employment.

The source also provides information on those HRST who are inactive, and in this case the duration of their last employment is also provided.

The EPA then permits us to determine the profile of the stock of human resources who had an S&T occupation in the past and who are, at the time of the survey, unemployed or inactive. This profile,

according to the published data, is not as detailed as that of the employed, although the raw data exists and analysis could be made as thorough as that related to the occupied population. In addition, a follow up to the quarterly results of the EPA would enable us to obtain information about the flows of HRSTO from employment to unemployment and inactivity. The reasons for leaving an S&T occupation could also be studied, as well as other aspects concerning the dynamics of HRSTO. Thus we have a very useful source of information which can be better exploited. As most OECD countries produce something similar, comparisons between countries could be made.

***Population Census (Censo de Población) (INE, 1996)***

- Institution responsible for the data: National Institute of Statistics (INE).
- Date of first and last data set: 1857/1991.
- Publication frequency: Every 10 years.
- Sample: Exhaustive.

The population census can be a very useful instrument to measure the stock of HRST both in terms of education and occupation. It provides information on the level of education for the whole Spanish population and specific details about the occupations of the employed population.

However, the latter are classified following the National Classification of Occupations of 1979 (CNO-79), which presents differences with CNO-94 used for more recent surveys like the EPA. Besides this, the classification breakdown is made only into major groups, which do not permit us to distinguish the subgroups of major group 1 as suggested by the Canberra Manual.

The INE publication of the National Results (INE - 1996) of the Census presents the following relevant breakdown:

- Total population with third level education broken down into age groups, gender, level of completed education and occupation.
- Active and Inactive Population with third level education.
- Employed broken down into level of education, economic sector of activity, age and labour situation (paid or self-employed, permanent versus short-term contract, full time versus part time, etc.).
- Unemployed by level of education, gender and age groups.
- Migration between regions (Autonomous Communities), broken down into level of education.
- Foreign population analysed by the level of education, gender and age groups.
- Foreign studying population.
- Immigrants during the last decade broken down into level of education, gender, age and size of arrival city.

As the Census is related to the entire population and not to a sample it provides exhaustive information about the HRST stock. The data allow the analysis of different HRST subgroups as well. The specification of the completed education level makes it possible to separately analyse the situation of those included in the different ISCED categories. The data, for example, would determine the number of working women holding a postgraduate degree as a proportion of all graduates. Even if the publication analysed does not

present a classification in terms of fields of study, the Census questionnaire contains a specific question related to it. Thus, a conclusion concerning the stock of HRST to be highlighted at this stage is that the Population Census gathers enough data to study in detail both HRSTE and HRSTO.

With regard to the flows, the breakdowns mentioned show that the Census contains information on the internal mobility of HRSTE, general data on the inflows of foreign HRSTE and special data on inflows of foreign students who may be HRSTE in the future. This means that some indicators describing the mobility of HRSTE could be produced.

The population Census appears thus to be a useful instrument for gathering statistical information on HRST. However, it is important to underline that the survey is conducted every ten years and that the methodology used to prepare each census usually changes, which makes dynamic analysis more difficult. The last Census produced in Spain dates back to 1991 making the data obsolete. For any future studies of the Spanish HRST, the 2001 Census should be taken into account (INE, 1998-d.).

***Social-demographic survey (Encuesta Sociodemográfica) (INE, 1994-b.)***

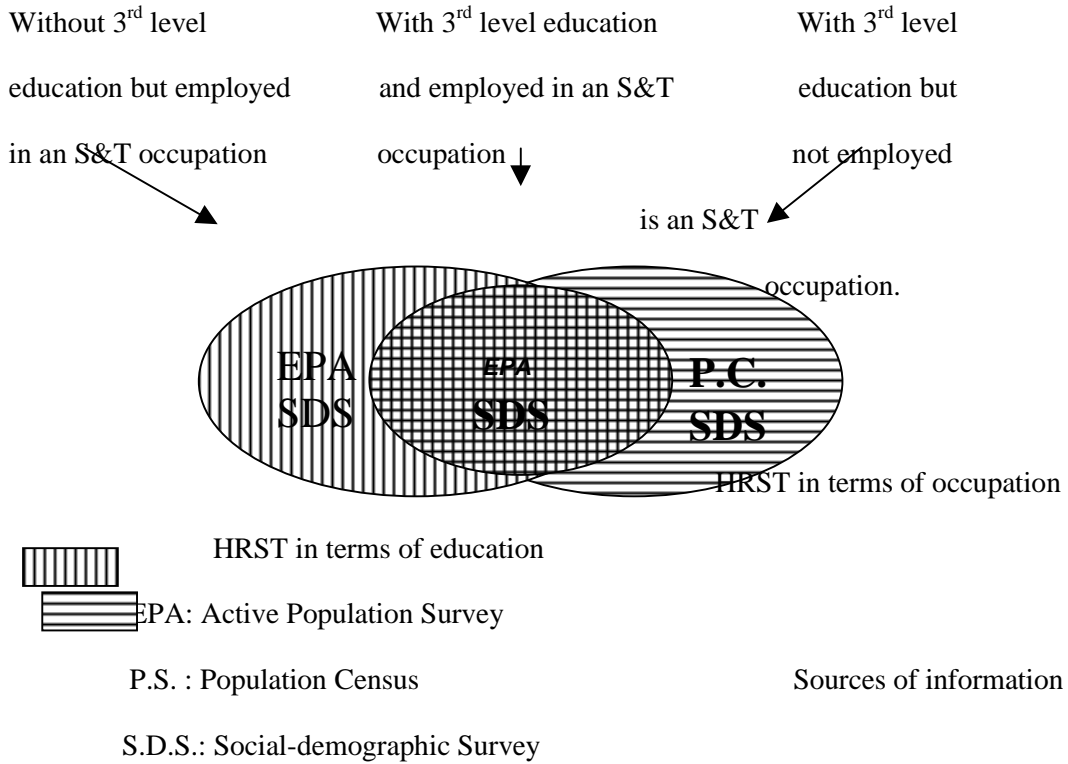
- Institution responsible for the data: National Institute of Statistics (INE).
- Date of first and last data set: 1991.
- Publication frequency: Singular source.
- Sample: Population aged 10 or over, living in family units and registered in the 1991 Population Census.

This source is the result of an exhaustive and very detailed data collection made in 1991 in order to increase knowledge of the individual characteristics of Spanish residents provided by the Population Census. The statistical survey focuses on the changes which have occurred in individuals' lives. For example, the reasons for changes in occupation and type of work, as well as changes of residence and their cause. Special attention is also paid to the particular family circumstances of the surveyed person, providing detailed information on their social and cultural origins.

In relation to the educational level, the survey provides an in depth analysis of the "education life" highlighting, for example, the reasons for interrupting and adjourning studies. It also provides information on the labour activities: all the occupations held, the reason for changes, unemployment spells, etc. The classification of occupations follows the CNO-79, the same as the Population Census, and the educational levels may be classified in the ISCED categories (see Table 3). Thus, this source of information contains data on all the HRST stock, making it possible to distinguish between HRSTE and HRSTO. Besides giving special attention to trends and changes, the information on flows and mobility is also relevant. It is important to notice that a specific questionnaire was produced for foreigners living in Spain, providing many details concerning their education and labour characteristics. The list of breakdowns provided by this source, which are useful to the HRST study, would be too large. Therefore we advise the interested reader to go to the original source (INE, 1993). The social-demographic survey has been an extremely useful source to produce monographs concerning different characteristics of Spanish society since its publication. In our opinion a special one on HRST could also be made, especially if new surveys with similar characteristics are going to take place.

As the three above-mentioned sources are probably the main ones which may be used for the analysis of HRST, they could be integrated in order to achieve what the Canberra Manual calls "principal categories of HRST", which may be represented by the following figure:

Figure 1: Principal categories of HRST



**Third level education**

There are two sources for third level education statistics, the first is the annual survey on higher education provided by the National Institute of Statistics (INE) and the second a special annual report from the University Council. We shall analyse both of them separately.

*Higher education statistics (INE) (INE, 1998-c.)*

- Institution responsible for the data: National Institute of Statistics (INE).
- Date of first and last data: 1989/1990 and 1995/1996.
- Publication frequency: Annual.
- Sample: Exhaustive.

The information presented in this annual publication is related to HRST covered in terms of education (HRSTE); it provides an exhaustive survey of higher education centres. Before analysing in detail the information provided by the data, it is important to establish the equivalence between the categories of the ISCED (International Standard Classification of Education used by the Canberra Manual) and the third level Spanish diplomas. Table 3 summarises such equivalence:

**Tables 3A and 3B. Allocation of Spanish education levels to ISCED-76 and ISCED-97****Table 3A**

ISCED-76	Spanish Diplomas
Category 5: First stage, does not lead to an award equivalent to a first university degree.	- High level Technician. High level professional training.
Category 6: First stage, leads to a first university degree.	- University Diploma. First cycle University education (2 to 3 years). - University Graduate. Second cycle University education (4 to 6 years).
Category 7: Second stage, leads to a postgraduate university degree or equivalent.	- Postgraduate: Doctoral and master studies.

**Table 3B**

ISCED-97	Spanish Diplomas
Category 5B: Practical/technical/occupationally oriented programmes, minimum two year programmes.	- High level Technician. High professional training.
Category 5A: more theoretically oriented programmes than level 5B; minimum three year programmes, usually lead to a university degree.	- University Diploma. First cycle University education (2 to 3 years). - University Graduate. Second cycle University education (4 to 6 years). - Postgraduate: Master studies.
Category 6: Programmes devoted to advanced study and original research, usually three year theoretical programmes.	- Postgraduate: doctoral studies.

Source: Authors and OECD, 1999b: 107.

The survey provides detailed information on the development of the stock of HRSTE indicating the number of students graduating each year in the different categories described above. In addition, the data on the students enrolled in the different categories every year enables us to predict what the HRSTE stock will be in future.

The data are classified according to the ISCED classification with the following breakdowns:

*Higher non-university education; ISCED category 5*

- Students enrolled in centres of higher education analysed according to:
  - Type and field of study.
  - Autonomous Community and province.
  - Character of the centre: public/private.
  - Gender.
- Students who finished their studies the year before the survey, and categorised in the same way as enrolled students.
  - There are also annual series available concerning these two categories which show enrolment and graduation trends since 1986 broken down by field of study.

*University education, first stage, 1<sup>st</sup> and 2<sup>nd</sup> cycle; ISCED-76 category 6*

- Students enrolled at Spanish universities analysed according to:
  - University.
  - Field of study.
  - Gender.
- Students who finished their studies the previous year and categorised according to the same variables as enrolled students.
  - Similarly, there are also annual series available concerning these two categories which reflect enrolment and graduation trends since 1986 broken down by field of study.

*University education, second stage, 3<sup>rd</sup> cycle; ISCED-76 category 7*

- Students enrolled in doctoral programmes at Spanish universities broken down by:
  - University.
  - Field of study.
  - Gender.
- Doctoral thesis approved during the last year and categorised in the same way as enrolled students.
  - Information on annual series for graduate students and approved thesis broken down by field of study from 1986/87 is also available.

One of the first conclusions to be highlighted at this stage is that this source of data will permit us to differentiate, when analysing the HRSTE stock, between the three coverage levels (Core Coverage, Extended Coverage and Complete Coverage (see Table 1). These were established by the Canberra Manual (1994; 25) for data collection by field of study and level of education.

In addition to the distinction between the Core and the Extended Coverage, the information provided by the Education Statistics facilitates a detailed study of a crucial subgroup within the HRST: the PhD

holders. The Canberra Manual states that the proposal to create a third category, PhD level HRST, was in fact only abandoned on practical grounds (OECD 1994; 12). In our opinion this subgroup should be analysed whenever possible and its labour market be taken into consideration for policy purposes. The availability of Spanish data concerning postgraduates allows us to be more optimistic about overcoming the practical problems.

The source contains the following information concerning doctoral studies:

- Stock of doctors and dynamic trends since 1986 broken down by field of study.
- Number of doctoral dissertations read during the year, classified by field of study, universities and gender of the reader.
- Number of PhD students broken down by university and gender.

As a consequence, the following indicators concerning PhD Spanish holders could be made up as follows:

- Stock of doctors as a proportion of all the HRSTE.
- Stock of doctors as a proportion of the Core HRSTE; broken down by fields of study.
- Number of doctoral dissertations read in the year as a proportion of enrolled PhD students. This indicator would give an idea of the efficiency of Spanish universities when generating highly qualified HRST.

The survey also provides information about teachers, which corresponds to HRSTO. There are for example annual series for the number of teachers, broken down by fields of study. Nevertheless, it should be borne in mind that the useful information from this source refers mainly to education (HRSTE) and not occupation (HRSTO). As can be gathered from the above, this statistical source provides information not only about the HRSTE stock but also about its flows, as it contains annual series over a period of years. In conclusion, this source of data provides useful information about PhD holders in Spain and about the dynamic generation of new HRSTE every year. This information is crucial for education policy design.

#### *University statistics (University Council, 1995)*

- Institution responsible for the data: University Council General Secretary.
- Date of first and last data set: 1989/1990 and 1993/1994.
- Publication frequency: annual.
- Sample: Exhaustive.

The information contained in this annual publication is also related to HRST covered in terms of education (HRSTE); it provides an exhaustive survey of university statistics.

Although it is a primary source, the information is very similar to that contained in the Statistics of Higher Education described earlier. Thus, this section only analyses the difference between both sources, rather than making a review similar to the one contained in the preceding paragraphs.

The Annual Report on University Statistics naturally contains no data on non-University Higher Education and so excludes students enrolled and graduates in ISCED level 5. As a consequence the information in this Annual Report only covers Core Coverage in terms of education. The data concerning students at ISCED level 6, which includes university students of 1<sup>st</sup> and 2<sup>nd</sup> cycle, is provided in more detail than those contained in the Higher Education Statistics provided by the INE. All analysis of the information presented

for the latter is also presented in the Annual Report. In addition it also breaks down data concerning enrolled students and graduates according to the following categories:

- Age.
- Duration of studies (1<sup>st</sup> or 2<sup>nd</sup> cycle).

Concerning the enrolled students there are three breakdown categories that provide certain information on mobility:

- Nationality: Distinction between Spanish students and foreign students.
- Province of the family residence.
- Province of the university of enrolment.

Other distinctions make it possible to determine the social origin of the students:

- Educational level of the student's father.
- Occupation of the student's father.
- Occupation of the student's mother.

The three latter categories concern social rather than regional mobility. This could be an interesting point, since certain analysis could be made to see whether children of the no HRST population become part of the HRST population. Similarly, the likely hypothesis that children of the HRST population also tend to be part of such a population at least in respect to the educational level could be verified.

The Annual Report also goes further than the INE report in the analysis on graduates, providing information about their labour market situation as follows:

- Graduates in the active population during the year before the survey, broken down according to duration of studies, gender and age.
- Graduates in the active unemployed population the year before the survey, broken down according to duration of the studies, gender and age.

The above-mentioned differences between the two sources (INE and University Council) refer only to students and graduates at ISCED-76 level 6, while data concerning postgraduate studies (ISCED-76 level 7) are basically the same in both sources.

Finally the Annual Report also gives more detailed information on R&D personnel at universities broken down into fields of study. The 1994 Report provides information on this stock since 1985, indicating the percentage of women and scholarships in the total stock. This is clearly related to HRSTO (employed in an S&T occupation) and it is the only information concerning HRSTO contained in the document.

As a conclusion Table 4 summarises the advantages and shortcomings of the last two analysed sources in order to build a profile of Spanish HRSTE:

**Table 4. Advantages and shortcomings of education statistics sources**

	<b>Advantages</b>	<b>Shortcomings</b>
Source: INE	Earlier availability. Last data = 1995/96 Data about all HRSTE, including ISCED level 5	Less detail concerning ISCED level 6.
Source: University Council	More detailed information concerning ISCED level 6. Data on: Age / Nationality / Social Origin / Regional Mobility / Labour market situation.	Data for years 94/95 and 95/96 are not yet available. No information on ISCED level 5.

Source: Authors.

## **R&D Statistics**

### *National level (INE, 1998-b.)*

- Institution responsible for the data: National Institute of Statistics (INE).
- Date of first and last data set: 1973/1996.
- Publication frequency: annual.
- Sample: approximately 5 000 statistical units: 4 000 companies; 500 governmental institutions; 45 universities; 200 private non-profit institutions.

This source provides HRST information covered in terms of occupation (HRSTO). One of the objectives of the survey is to record the number of working hours devoted to Research and Development activities in Spain. The methodology used follows the OECD Frascati Manual and takes the Full Time Equivalence (FTE) approach to prepare the data. This leads to difficulties when comparing these data to those extracted from other sources. The R&D statistics provide the only analysed Spanish source using this approach.

The R&D personnel (FTE) information is broken down into occupation according to the three following categories: researchers; technicians and other support staff.

The following breakdowns are also provided concerning R&D personnel:

- Sectors: Business Enterprise, Government, and Higher Education Institutions.
- Occupation according to the classification mentioned above: researchers, technicians and other support staff.
- For the Business Enterprise Sector, there is also a breakdown of economic activity, which is in accordance with the National Classification of Economic Activities (CNAE), the Spanish equivalent of the International Standard Industrial Classification.
- For the Governmental Sector the survey provides a breakdown of the field of study.

Although it is not specifically stated in the document, it is very likely that those in the researchers' category have an education level equivalent to ISCED categories 6 and 7. As a result, findings contained in the survey provide information on the total number of people with 6 and 7 education levels who are effectively working as researchers in companies, research institutions and governmental agencies.

The problem, once again, is that data are provided in FTE. This Full Time Equivalence has to be calculated by taking into consideration first the total number of people related to research independently of the number of hours each one devotes to such activity. Therefore, the problem would be solved by asking for a head count of researchers, technicians and other support staff.

Once the head count data is available, the statistics could be crossed with the data from other sources to obtain indicators such as:

- Researchers working in companies as a proportion of all HRSTE with ISCED 6 and 7 education levels.
- Researchers working at universities as a proportion of all HRSTE with ISCED 6 and 7 education levels.
- Researchers working for the Government as a proportion of all HRSTE with ISCED 6 and 7 education levels.

Nevertheless, the survey would be much more useful if it indicated the education level of the employees. We must insist that it has been assumed that researchers have 6 and 7 education levels but that this information is not stated in the document. Were the information about the educational level of R&D support staff available, we would know, for example, the number of people who are not HRSTE but who have an S&T occupation and where they work.

It is interesting to recall that the Active Population Survey also gives information about HRSTO who are not HRSTE but does not specify the sector (company, university, Government). Once such problems are solved, the information concerning HRST from this source would be useful in analysing a large part of the Spanish HRST labour market, that of people actually working on S&T activities.

## **Regional level sources**

### ***Basque Country (EUSTAT, 1997)***

- Institution responsible for the data: EUSTAT (Basque Country Institute of Statistics).
- Date of first and last data set: 1990/1995.
- Publication frequency: annual.
- Sample: No information available.

This source provides HRST information covered in terms of occupation (HRSTO). The information contained in the document concerns the same subjects as those dealt with in the previous section. The difference lies in the geographical scope of the analysis. The present source provides R&D statistics, which concern only the Basque Country, an Autonomous Community in northern Spain.

The reason this document is interesting is that its HRST data are more precise than those contained in the national R&D Survey. The presentation of the information follows the same schema. There are different tables devoted to R&D personnel, which are classified as before into three categories: researchers, technicians and other support staff. The sector classification is also the same.

However, it is important to stress that all data concerning personnel are presented both in Full Time Equivalence and in Head Counts. The breakdowns provided by the tables concerning R&D personnel are as follows. The words in bold correspond to the categories which are not available in the national survey.

*Business enterprise sector*

R&D personnel broken down into:

- Economic activity (i.e. very precise information), broken down according to occupation (researcher, technician) and gender.
- Field of study (Natural sciences; Engineering and technology; Health sciences; Agricultural sciences, Social sciences and Humanities) and occupation.
- Size of the company, by occupation and gender.
- Total “in-house” R&D expenditure broken down into the total number employed in R&D and by the nature of expenditure (researchers’ salaries, other personnel’s salaries).
- Total “in-house” R&D expenditure broken down into the total number of researchers and by the nature of the expenditures.

The information concerning companies also provides the following annual series:

- Number of companies broken down according to the number of R&D personnel from 1989 to 1995 (only available in FTE).
- Number of companies broken down according to the number of researchers employed from 1989 to 1995 (only available in FTE).
- R&D personnel broken down by sector of economic activity from 1993 to 1995 (available in FTE and Head Count).
- R&D personnel broken down by occupation from 1989 to 1995 (FTE and Head Count).

*Governmental institutions*

R&D personnel broken down into:

- Field of study (same classification as for companies), occupation and gender.
- Full or part time occupation, broken down by field of study, occupation and gender.
- Education level: Doctor, graduate, engineer, high school level, others; broken down by field of study.

*Higher Education Sector*

R&D personnel broken down by:

- Field of study, occupation and gender.
- R&D expenditure, broken down according to type.

As a consequence the breakdowns described allow for a much more detailed analysis than the national survey and could prove most useful if used at a national level as well.

**Madrid (Comunidad de Madrid, 1998)**

- Institution responsible for the data: Madrid Autonomous Community Government.

- Date of first and last data set: A monograph produced in 1998.
- Sample: Exhaustive.

It is important to mention this survey because it is the only recent study we have found that contains a special analysis on Human Resources in Science and Technology. Its second chapter is devoted to HRST in the Madrid Autonomous Community, analysing the human resources employed in Madrid Universities, and Research Institutions. For each institution the document presents the proportion of doctors, graduates, scholars, and “others” employed. There is also a breakdown of human resources by field of study, university and education level. The analysis is not very detailed, but it represents a first step towards the study of HRST as being of public interest.

### **Other sources**

*Annual Summary of the Occupation Observatory. Labour Market Information (Resumen Anual de los Datos del Observatorio Ocupacional. Información sobre el mercado de trabajo) (INEM, 1996).*

- Institution responsible for the data: INEM (National Institute of Employment).
- Date of first and last data: Unknown/1995.
- Publication frequency: annual.
- Sample: Exhaustive.

This source covers a subgroup of HRST made up of people who register themselves at the INEM (National Employment Office) as unemployed. In Spain, anyone receiving an unemployment subsidy has to be registered at this office. Registration is also useful for those not receiving a subsidy since INEM is an intermediary between labour supply and demand. It also provides training courses for re-skilling and specialisation for the unemployed.

One of the main objectives of the publication is to show how these training courses help the unemployed to obtain a new job. With regard to HRST, the information that this source provides is, firstly, unemployed educated at the third level as a proportion of all those registered throughout the year, broken down by age and gender. In 1995 this proportion was 8%, which was the smallest category registered at the INEM.

The publication also contains information on the new contracts for people registered during the year, broken down into “professional families”. Only two of these categories require an education level above ISCED level 5, which are Teaching and Research and Health related occupations. Nevertheless the Teaching and Research category takes in only a few occupations, and some of these which are not related to HRST such as driving instructors. As mentioned, most of the information from this source is related to the results of the training courses. It should be noted however that most courses correspond to a low skill level.

In summary, this source is only useful to measure the HRSTE who are registered at the INEM as a proportion of all unemployed HRSTE. It is very likely this proportion is very small. The rest of the INEM information concerning unemployed HRST will not be very relevant for our purposes.

*Analysis of the University Graduate Women Labour Market (Estudio sobre la Inserción laboral de las tituladas universitarias en el mercado de trabajo) (INEM, 1993).*

- Institution responsible for the data: INEM (National Institute of Employment).
- Date of first and last data set: A monograph made in 1993.

- Sample: 2 100 women in 14 different provinces.

This publication presents the results of a survey made to a sample of women who graduated in humanities from different Spanish universities in the period 1988-91. The most useful information concerns the proportion of employed and unemployed woman and their contribution to the university teaching staff.

However, this source is of little interest when analysing Spanish HRST as it concerns only humanities, which do not belong to the core HRST and is a relatively small sample. Nevertheless it would be interesting to see the proportion of these 2 100 women graduates on the total new HRSTE women for the surveyed year.

### **Differences between S&T stocks and flows: the problems of assessing mobility**

According to the Canberra Manual two types of HRST mobility may be analysed: the external mobility, which takes in the inflows and outflows of the HRST stock, and the internal mobility, which reflects changes within the stock.

All the sources described in the previous section focus mainly on information on stocks. However as we have mentioned at different points, some information about mobility can also be obtained. Apart from this there are other sources that, without giving much information on the characteristics of the persons involved, provide specific information on mobility, for example as to the scholarships granted from different institutions or the Governmental international agreements that support mobility.

The mobility programmes could be structured into two groups:

- Mobility to and from foreign countries.
- Mobility within Spain.

In relation to the first group, scholarships are provided mainly by the Ministry of Education and Culture, some Autonomous Community Governments and some private institutions. Information concerning the participants in these mobility programmes is not easily available. We have only obtained some statistics from the Ministry of Education, which provide information on the following issues, for years 1994-1998:

- Spanish researchers abroad.
- Foreign researchers in Spain.
- Spanish professors abroad.
- Incoming researcher contracts: this data concern researchers who received a scholarship for research abroad and are engaged by a research institution on return.
- Short stays and congresses attended by Spanish researchers.
- Sabbaticals abroad.

This information is broken down by province, gender and age (over or under 25). Other important details for the analysis such as field of study, duration, country of origin or destination, are not included in the information provided which does not mean that it does not exist. These additional aspects are probably known by the Ministry and may be used for policy purposes.

Additional details about migration abroad can be found at the Ministry of Foreign Affairs. The Government has signed agreements for scientific and technological co-operation with several countries, which encourage the flows of researchers. Every agreement names a Joint Commission to supervise and

follow up on the results. Although unpublished, these Joint Commissions may have data about the actual movements.

Another governmental initiative to promote mobility is led by the R&D National Plan: in the goal of the programmes is internal mobility. There is a specific measure to foster hiring of PhDs by companies (*Acción IDE*) and another one to encourage young researchers to carry out their research in companies and technological centres (*Acción MIT- Becas*). The information concerning the participants is not published, and therefore not easily available.

The different mobility categories could be structured in the way shown in Table 5. The left-hand side of the table defines the categories and the right-hand side indicates the sources where information about them may be found.

**Table 5. Available information sources for the study of HRST mobility**

MOBILITY CATEGORIES	INFORMATION SOURCES
<b>HRST EXTERNAL FLOWS:</b>	
<b>HRST inflows<sup>14</sup></b>	
a) Persons qualifying at ISCED level 5 or above for the first time.	a) Higher education statistics (INE).
b) Persons without a qualification at ISCED level 5 or above being employed in an S&T occupation.	b) Not much information available. The INEM registers only some of them.
c) Qualified immigrants.	c) Census and Social-demographic survey for the general population; University Council for students.
<b>HRST outflows</b>	
d) Persons without a qualification at ISCED level 5 or above leaving their S&T occupation.	d) EPA and Social-demographic survey.
e) Emigrants.	e) Ministries of Education and Foreign Affairs for temporary movements.
f) Deaths.	f) Not available.
<b>HRST INTERNAL FLOWS</b>	
g) Persons with a qualification at ISCED level 5 or above leaving their S&T occupation (going unemployed or inactive).	g) EPA.
h) Persons with a qualification at ISCED level 5 or above, unemployed or inactive, finding an S&T occupation	h) Very little information at the INEM and Ministry of Education and Culture (incoming researchers' contracts.
i) Persons with a qualification at ISCED level 5 or above, changing their occupation	i) Available for 1991: Social-demographic survey.
j) Persons without a qualification at ISCED level 5 or above, moving from one S&T occupation to another.	j) Available for 1991: Social-demographic survey.
k) Persons with an S&T occupation who increase their qualification level.	k) Social-demographic survey and EPA.
l) Persons within the HRST stock that move from one region to another.	l) Some information in Education Statistics and in Social-demographic statistics for 1991.
<b>INTERNAL/EXTERNAL FLOWS<sup>15</sup></b>	
m) HRST persons moving temporarily to another country.	m) Ministry of Education and Culture and Ministry of Foreign Affairs.

Source: Authors.

14. OECD (1995; 9).

15. The international temporary mobility could be considered both an external and an internal movement. If considered external the immigrant/emigrant notion could be extended to include not only those people who change their residence but also those who move for a few months (training courses, exchange programmes, etc.). On the contrary if considered internal the underlined hypothesis would be that maintaining their own residence keeps them within the national stock of HRST.

Several general conclusions can be drawn from the available information on mobility. First, the information is rather dispersed. Different institutions and programmes are involved, each one with different procedures. Second, the information is not published. The institutions do not prepare it for distribution and it has to be obtained on request. It is heterogeneous as the different programmes provide different data and for some of the sources on flows the data needed to compare them with those of the stocks do not exist. Third, the information does not seem to be used in a coherent manner for policy purposes. Nevertheless the mere existence of mobility programmes suggests that there is a political concern about mobility, particularly when it affects the mobility of highly educated people. Most of the programmes are targeted for graduates and PhDs.

It is worth mentioning that geographical mobility in Spain has little social support. The attachment to the place of origin is high and students prefer, in general terms, to study in the area where their family lives, and workers seldom move during their working lives. This situation is not desirable for a global competitive economy where jobs appear in some activities and regions and disappear in others. Therefore, mobility is an important political issue at the moment and new programmes and activities are likely to be launched in the near future. In our opinion, these activities should be launched in parallel with the corresponding evaluation designs. This implies defining a certain degree of homogeneity in the data to be gathered, and taking stock of all the information related to those programmes in a particular place, to facilitate analysis and feedback into policies. It could also be useful to gather the information corresponding to private institutions, to allow public policy to act on a subsidiary or complementary basis.

### **Usefulness of existing data to build indicators**

The OECD document entitled *Basic Indicators for describing the stock of Human Resources in Science and Technology* (OECD, 1995) suggested a list of ten main HRST stock indicators. One of the objectives of this section is to develop a set of the different suggested indicators on the basis of the information provided in the description of the data sources. The following list provides this information, including comments on the cases when data do not permit us to create the proposed indicator but provide enough information to produce a similar one.

*Basic Indicators for describing the stock of HRST which can be drawn from:*

#### **a) The EPA**

Using the published results of the EPA, and the unpublished raw data on ISCO-88 groups 122, 123 and 131, the basic indicators concerning the stock of HRST employed in an S&T occupation which can be calculated are the following:

- *Main indicator 3:* HRST with an S&T occupation as a proportion of the employed; analysed at level of education, occupation, age group, and gender.
- *Main indicator 4:* Core of the HRST stock (equal to people with third level education and employed in an S&T occupation) as a proportion of all employed; broken down by type of third level education. The rest of the breakdowns suggested for this indicator (field of study, occupation and age group and gender) are not directly available. However, considering that respondents surveyed are asked about all these issues, an ad-hoc analysis of the questionnaire would allow us to build the indicator.
- *Main indicator 6:* HRST employed in an S&T occupation without third level education as a proportion of all employed. Producing the suggested breakdowns presents the same difficulties as Main indicator 4.

- Related to *Main indicator 9*: HRSTO potential (unemployed or inactive) as a proportion of all third level HRST. The proportion suggested may not be easily obtained; however the EPA enables us to calculate the HRSTO potential as a proportion of all HRSTO, that is people who had an S&T occupation in the past as a proportion of people who have an S&T occupation at present. A useful breakdown would be to distinguish between unemployed S&T and inactive S&T.

#### **b) The Census**

- *Main indicator 1*: The HRST total stock as a proportion of the population aged 18 years or above; broken down by level of education, age group and gender.
- *Main indicator 2*: The HRST educated at the third level as a proportion of the population aged 18 years or above; broken down by level of education, age group and gender.
- *Main indicator 3*: HRST with an S&T occupation as a proportion of the employed; analysed at level of education, occupation, age group, and gender.
- *Main indicator 4*: Core of the HRST stock (equal to people with third level education and employed in an S&T occupation) as a proportion of all employed; broken down by type of third level education, field of study, age and gender.
- *Main indicator 7*: Unemployed HRST (with third level education) as a proportion of all level educated HRST; broken down by type of third level of education, age group and gender. The Census information does not permit analysis of data regarding the field of study, as suggested in the definition of this indicator by the Canberra Manual.
- *Main indicator 8*: Inactive HRST (with third level of education) as a proportion of all level educated HRST broken down into type of third level of education, age group and gender. As mentioned above the analysis attending the field of study is not possible.
- *Main indicator 9*: HRST potential (unemployed or inactive HRST) as a proportion of all level educated HRST; analysed by type of third level of education, age group and gender. Again, the breakdown by field of study is not possible.

#### **c) The social-demographic survey**

All indicators suggested in the OECD document may be calculated, given the large quantity of data provided by this source.

#### **d) INE statistics on higher education**

- *Main indicator 2*: The HRST educated at the third level as a proportion of the population aged 18 years or over; broken down by level of education, field of study, age group and gender. This source does not enable us to calculate all the proportions proposed in the OECD document (OECD, 1995; 29-30) as it contains no information about the entire Spanish graduate population. Nevertheless, some figures related to this main indicator could be very interesting. Here are some examples:

**Example 1: HRST who obtained a first cycle or 2<sup>nd</sup> degree in 1994**

**Graduates having completed 3<sup>rd</sup> level education in 1994**

= New HRSTE at ISCED level 6 1994

*New HRSTE 1994*

**Example 2: New HRSTE in Natural Sciences in 1994**

- Related to *Main indicator 9*: A new basic indicator could be worked. This indicator may be called HRST future potential. The number of students attending third level education, as a proportion of the population aged 18 or more (Population Census), for example, would give an idea of the HRST who would be available in the future.

**e) University Council Annual Report**

- Related to *Main Indicator 2*: The comment made in relation to this indicator in paragraph c) above could be reproduced here. The examples concerning possible new indicators could be similar in this case.
- Related to *Main Indicator 9* (HRST potential): This source would permit us to make a more dynamic analysis than the analysis allowed by the suggested indicator in OECD (1995). Two interesting indicators to build would be:
  - New active population educated at ISCED levels 6 and 7 in year X, as a proportion of all university graduates in year X.  
This indicator would show the proportion of new graduates who enter the labour market immediately after graduation.
  - New unemployed population graduated at ISCED level 6 and 7 in year X, as a proportion of new active graduates at the same levels and in the same year. This proportion would inform us of the difficulties new graduates encounter in finding employment.

**f) INE R&D Statistics**

The survey does not permit us to calculate the indicators suggested by the OECD document for several reasons. First of all, the categories of HRSTO defined in the publication (researchers, technicians and support staff) do not follow the occupation classification used by the rest of the sources. However, it is easy to deduce that everybody included in the survey as R&D personnel is HRSTO.

Two additional problems when working with this data source have been mentioned before: the data follow the FTE criteria and they provide no information about the educational level of R&D personnel.

Should these two problems be solved (i.e. by adding two questions to the questionnaire) the following indicators could be calculated, related to the subgroup of HRSTO defined as R&D personnel.

- Related to *Main indicator 3*: R&D personnel as a proportion of all employed (source: EPA), broken down by level of education, type of occupation (researcher, technician or support) and place of employment (company, university or Governmental institution).

- Related to *Main indicator 4*: Core of the HRST stock (ISCED level 6 and 7 of education included in R&D personnel) as a proportion of all employed (source: EPA) broken down into level of education, type of occupation and place of employment.
- Related to *Main indicator 6*: HRST employed in an S&T occupation without third level education as a proportion of all employed (source: EPA) broken down into type of occupation and place of employment.

#### **g) EUSTAT R&D statistics**

The comments above are also valid for the present source. However, it is important to insist on the fact that one of the problems faced when working and comparing the R&D data from the INE is solved in this case, and that is that data are presented both following the Full Time Equivalence and the Head Count criteria. In addition, many more indicators could be produced, for example:

- Salaries of researchers as a proportion of all the R&D expenditures by companies.
- The number of companies employing more than X researchers as a proportion of the companies with more than Y employees.
- The number of doctors working in governmental institutions as a proportion of all R&D employees in this sector.
- The number of woman employed as researchers in companies as a proportion of all women researchers employed in the whole economy.

As the reader might conclude, the statistical exploitation that could be made using the data from this source is very wide and would provide in-depth knowledge of the HRSTO in the Basque Country. This methodology might also be applied at national or other regional level.

**Table 6. Sources of statistical information available to build main HRST indicators**

Main Indicators	Sources of data
1: HRST stock proportion	Census EPA
2: HRSTE stock proportion	Social-demographic survey Census Social-demographic survey INE statistics of education University Council
3: HRSTO stock proportion	EPA Census Social-demographic survey INE R&D statistics with the suggested changes + EPA (some problems may also appear when crossing the data).
4: Core of the HRST stock	EUSTAT R&D statistics + EPA: regional indicator. EPA Social-demographic survey INE R&D statistics: reliable source only after adding to the questionnaires questions concerning the level of education of the employees
5: HRSTE employed in a non S&T occupation	Social-demographic survey
6: HRSTO who are not HRSTE	EPA Social-demographic survey INE R&D statistics (after changes: education and head count) + EPA
7: Unemployed HRSTE	Census Social-demographic survey
8: Inactive HRSTE	Census Social-demographic survey
9: HRST potential	Census Social-demographic survey EPA: with some changes INE education statistics University Council
10: HRST reserve	Social-demographic survey

Source: Authors.

Some interesting conclusions are as follows:

- All the indicators can be produced. However, some of them may not be updated because data are obsolete.
- Apart from the indicators suggested by the OECD document others may be calculated on the basis of the information provided by the sources.
- EPA, Census and Social-demographic survey appear as three very useful instruments to provide statistical information about HRST.
- INE R&D statistics could also be a good instrument once minor changes are incorporated.
- According to the table, education statistics do not seem to provide much information. However, their utility lies in the information that they store about flows and future HRST potential.

## Policy conclusions

Bearing in mind that the above discussion is related to methodological issues of the existing Spanish data set, the policy conclusions can only refer to generic and methodological policies. The main characteristic of the current situation is probably lack of awareness. There is no coherent set of data about HRST which would inspire education and labour market policies, or scientific and technological policies. The efforts OECD makes to integrate data so as to give a coherent perspective are not followed up at national level. It would not be wise to undertake the gathering of specific data on HRST. On the contrary our conclusions suggest a better and more effective use of existing ones. The specific suggestions are as follows:

1. Data should be gathered and considered as a whole and not in a dispersed manner as at present. For that purpose an administrative unit could be created, for example, at the National Institute of Statistics (INE) to take into stock the data from all the already existing sources and produce a coherent analysis of all of them. Duplications and shortages will then appear and solutions could be implemented.
2. Studies about the functioning of HRST labour markets are sorely needed. The variables affecting supply and demand of those human resources are almost unknown. If not grounded in true and reliable information the best designed policy can fail.
3. Although the extended and complete coverage in terms of field of studies could be made, our suggestion is to concentrate efforts in the key areas. These are in our opinion: Natural sciences, Engineering and technology, Medical sciences, Agricultural sciences, and Social sciences for educational levels 6 and 7, and Natural sciences and Engineering and technology for level 5. Particular analysis should also be made of PhDs (part of level 7) in all the mentioned fields.
4. To change supply and demand trends in education is a long term and inflexible process. Public efforts to modify those trends and to match supply and demand both in education and labour markets should therefore be well thought out. This means that all actions or programmes undertaken should be accompanied by their own evaluation procedure. The design of any programme should be made together with the evaluation design, so as to continuously feed back into the process.
5. Particular policies to encourage mobility should continue. However, a previous analysis of the results of existing programmes both at public and private level should be made. Again all new action should encompass a permanent evaluation process.
6. In relation to the existing data sources, all questionnaires should be revised for the next survey to be made. As we have explained in the paper, only minor modifications could enormously improve the analytical capacity of the data. In some cases a few additional questions could be included.

### ANNEX. MAIN SUGGESTED INDICATORS

1. The total HRST stock as a proportion of the population aged 18 years or above; broken down by level or education, age, group and gender.
2. The HRST educated at the third level as a proportion of the population aged 18 years or above, broken down by type of third level of education, field of study, age group and gender.
3. HRST with S&T occupation as a proportion of the employed; broken down by level of education occupation, age group and gender.
4. Core of the HRST stock (third level education and employed in an S&T occupation) as a proportion of all employed; broken down by type of third level of education, field of study, occupation, age group and gender.
5. HRST (with third level education) employed in a non-S&T occupation as a proportion of all employed broken down by type of third level of education, field of study, age group and gender.
6. HRST employed in an S&T occupation without third level education as a proportion of all employed broken down by occupation, age group and gender.
7. Unemployed HRST (with third level education) as a proportion of all level educated HRST; broken down by type of education, field of study, age group and gender.
8. Inactive HRST (with third level education) as a proportion of all third level educated HRST: broken down by type of third level of education, field of study, age group and gender.
9. HRST potential (unemployed or inactive HRST) as a proportion of all third level educated HRST; broken down by type of third level of education, field of study, age group and gender.
10. HRST reserve (= unemployed, inactive or HRST employed in a non S&T occupation) as a proportion of all third level educated HRST; broken down by type of third level of education, field of study, age group and gender.

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