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WHY DO WE NEED INDICATORS ON CAREERS OF DOCTORATE HOLDERS?

WORKSHOP ON USER NEEDS FOR INDICATORS ON CAREERS OF DOCTORATE HOLDERS
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WHY DO WE NEED INDICATORS ON CAREERS OF DOCTORATE HOLDERS?

Introduction

1. The question of human resources is currently at the forefront of policy discussions in the area of science and technology, as recently demonstrated at the meeting of OECD Ministers in charge of scientific affairs. In the last few years many aspects affecting the supply and demand of researchers and of highly skilled people have drawn the attention of a wider circle of analysts such as the ageing of the scientific work force, the declining interest of young people for science studies, the role of women in science or the increasing mobility of highly skilled people across borders. This interest is closely linked to the growing recognition of the role played by knowledge and research in the innovation process and the economic performance of nations.

2. Acknowledging the importance of human resources in science and technology, while not new, is also becoming more universal with the globalisation of higher education and research networks and the emergence of new competing economies, such as China, India and Brazil. Attention of national governments to the issue of human resources however differs according to their stage of scientific and technological development. China has for many years sent large numbers of young people to study abroad and has only recently implemented policy measures to attract them back. India is known for massively training computer engineers and hosting delocalised service companies. OECD countries are confronted by an ageing population and seek to secure their advance in science and technology by increasing human and financial resources in these areas as shown by the 3% of GDP R&D investment targeted by the European Union for 2010.

3. Yet, understanding the patterns affecting the scientific and technical workforce is not simple and many analysts have pointed out the lack of relevant statistical data in this area. The OECD Secretariat has for several years engaged efforts aimed at improving the statistical information base. Some progress has been made, but there is still a long way to go before reaching an integrated and comprehensive information system. One direction of work for which the Secretariat has opted is to develop a harmonised survey instrument that could follow the career paths of doctorate holders in different countries with special attention to emerging patterns such as the development of post-doctoral positions or the increasing international mobility of PhD holders. This paper, prepared for the *Workshop on User Needs for Indicators on Careers of Doctorate Holders*, explores the issues that have led to the formulation of this project. We first summarise the work on human resources in science and technology (HRST) conducted by the OECD Secretariat in the latest years and how it has led to the selection of an harmonised survey on careers of doctorate holders (CDH) as a direction for further development work. We then position the role of doctorate holders on the labour market and highlight some of the policy issues at stake that indicators produced by a survey on CDH should address.

From the Canberra Manual to the surveys on careers of doctorate holders

4. In 1995 the OECD, jointly with Eurostat, released a methodological manual, the *Canberra Manual* on *the Measurement of Human Resources devoted to Science and Technology* (OECD, 1995). This work built on intensive consultations with member countries and an in-depth inventory of relevant data sources. It was a first attempt of its kind and was followed by a data collection effort in the form of a

questionnaire to the OECD Group of National Experts on Science and Technology Indicators (NESTI). The results of the data collection were however limited because of the heterogeneity of the national data sources and their lack of comparability (Hardy, 1997). Further methodological and data compilation work was then conducted by Eurostat drawing on the European labour force survey and education statistics.

5. The OECD Secretariat re-launched the work on HRST in 2001 after a period of resource constraints. An assessment and better use was made of the different existing international data sources (notably censuses, education statistics and labour force surveys), data on human resources in R&D were improved and knowledge gained in the measurement of international mobility (OECD, 2002). This work has resulted in the compilation of new indicators that were published in the *2003 OECD Science, Technology and Industry Scoreboard* (OECD, 2003) and the *2004 Science and Technology Statistical compendium* (OECDa, 2004).

6. Better insight was also gained on the limits of the current statistical system and in particular the links between the training of highly skilled professionals and the fact that their careers on the labour market are ill-captured. While measures of educational performance exist through the numbers of enrolments and graduates at the different levels of education, as well as measures of the characteristics of the labour market through employment status and occupations, characterising the links between supply from the education system and demand on the labour market is difficult. There is a crucial lack of information on the school to work transition of graduates, the compatibility of their educational background with their occupation, their trajectories on the labour market and their domestic and international mobility. This type of information is crucial for the understanding of the patterns that affect the scientific work force as demonstrated by the current policy debate.

7. One frequently cited example and data source used to map the characteristics, mobility and trajectories of scientists and engineers on the labour market is the National Science Foundation (NSF) system of statistical surveys – i.e. SESTAT -- that follows, amongst others, recipients of doctorates in science and engineering in the US.

8. Taking this into account, the OECD with the help of a consultant explored the availability, characteristics and comparability of existing surveys on the destination of doctorate recipients in OECD countries (Recotillet, 2003). It appeared that many such surveys existed at national level (some of which target the wider population of tertiary graduates) and that they were producing comprehensive information relevant to the understanding of HRST issues. However, they are conducted with different objectives, perspectives and methodologies that limit their use and comparability, notably as concerns the international dimension of graduates' experiences and careers. The OECD is therefore launching a project aimed at coordinating these efforts in order to set up a common survey instrument that would permit the collection of data in a harmonised way and perform international comparisons. The focus of the project will be on doctorate holders who are considered crucial to the production of knowledge and conduct of research activities.

Why doctorate holders?

9. Those who are familiar with the Canberra manual may question the choice of narrowing the population targeted to doctorate holders vs. all tertiary level graduates. Indeed the Canberra manual defines the HRST population as *"people who fulfil one or other of the following conditions: a) successfully completed education at the third level in an S&T field of study; b) not formally qualified as above, but employed in a S&T occupation where the above qualifications are normally required"* (OECD, 1995). Note that S&T is understood here in the wide sense of "knowledge" or "knowing" and therefore encompasses all fields of education. Three reasons may be put forward for this choice. The first one is a question of practicability: surveys are extremely costly to conduct and it is therefore recommended to limit

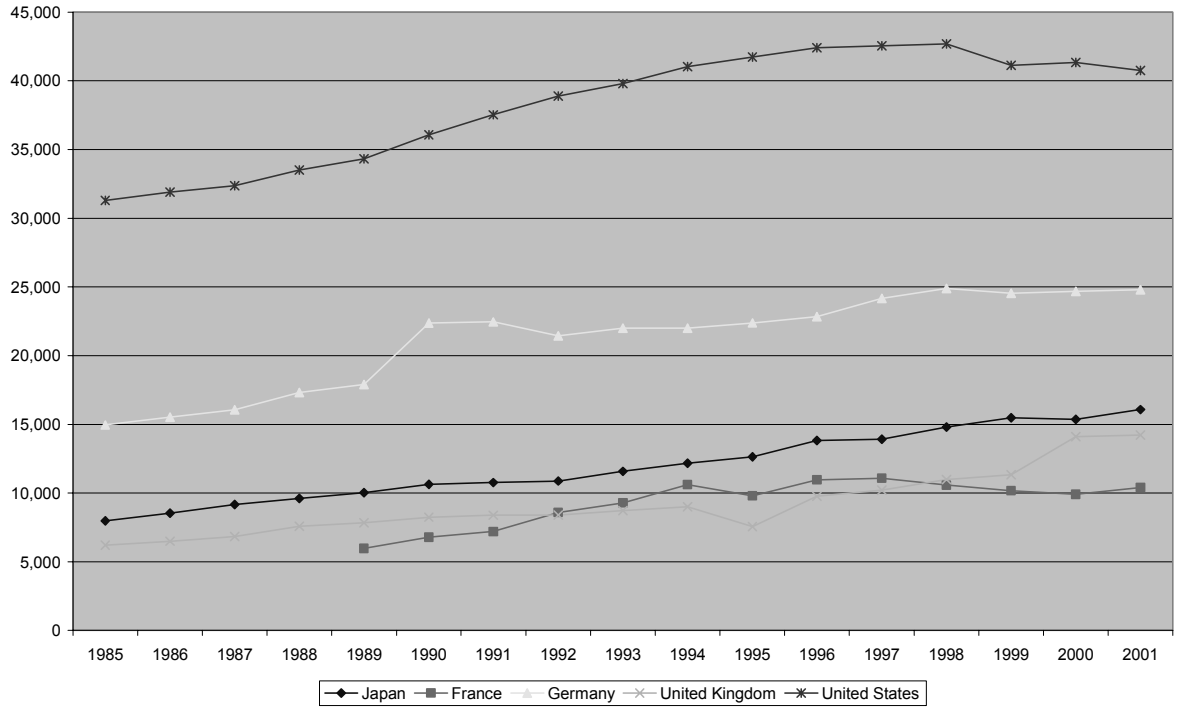
the scope, at least at the initial stage. If surveys on careers of doctorate holders prove to be efficient tools, their extension to other graduates could be envisaged. Second, although the Canberra manual definition is broad, it is recognised that narrowing the scope to different sub-populations is necessary from analytical points of view. The labour market of PhD holders differs from that of other graduates. Finally, holders of doctorate degrees are a key component of the population of researchers and much of the policy debate on HRST has to do with PhD holders, post-docs and researchers.

General policy and labour market context affecting doctorate holders

10. Another important reason that can explain the specific interest for PhD holders is their expected contribution to innovation and growth. They constitute indeed the most educated portion of the population and those who are considered most likely to contribute to the advancement and diffusion of knowledge and technologies, notably in the form of publications and patents. However, as we will see below they are in competition with other cadre of talents in this respect: not all researchers and engineers hold PhD degrees. And as Boothby (2004) points out in the Canadian case, "*the key documents of the Innovation Strategy do not single out doctoral degree-holders as the crucial element in improving productivity growth and innovation performance*". This seems to be also the case in other countries. PhD holders are often cited in the wider list of the highly skilled but not necessarily seen as a prime or single policy target.

11. With a growing number of young people acceding tertiary education in OECD countries the number of doctoral degrees awarded has steadily increased over the last twenty years. Japan, France and the United-Kingdom, for example, have doubled their number of new PhD degrees over the period shown on chart 1. OECD countries delivered around 160 000 PhDs in 2001, an increase of 6.5% compared to 1998, just three years before. It is worthwhile noting that despite the fact that women receive more university degrees than men in two thirds of the OECD countries, they are under-represented at the doctoral level and only capture 25% to 30% of PhD degrees. This gender gap has been pointed out by OECD Science Ministers at their meeting in January 2004. While the need to increase the number of researchers is widely recognised, not all PhD holders become researchers or follow an academic career and some analysts even question the labour market absorption capacity for these very highly educated and specialised talents.

Chart 1: Number of new doctoral degrees[1] – 1985-2001



1. German doctoral degrees include those of former East Germany from 1990 and thereafter.

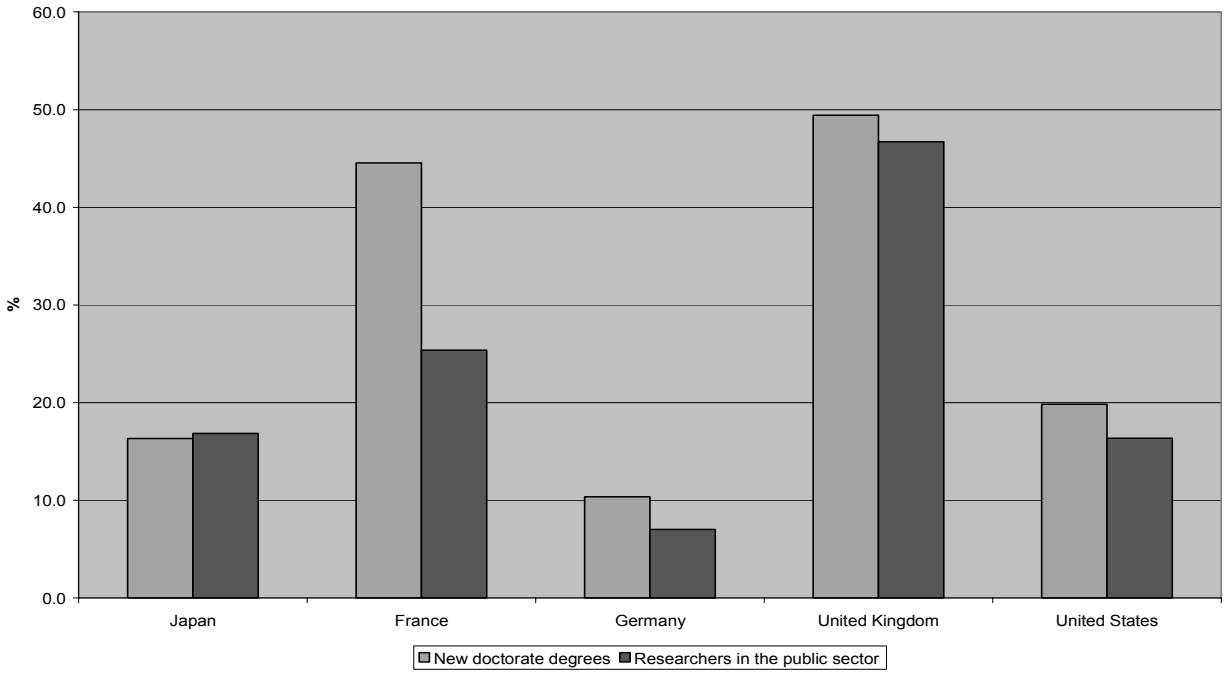
Source: NSF, Science and Engineering Indicators 2004 and OECD S&T databases.

Employment of doctorate holders

12. There are a number of pending and recurrent questions about the supply and demand of PhD holders: do we train too many or too few of them? Why do some remain unemployed? Are they operational or not when they arrive on the labour market? And in a business environment? Are there shortages or mismatches on the labour market? What factors influence the choice for certain type of careers: research vs. non research, public vs. private?

13. The most natural and common career choice for doctorate holders is to go into research. A look at the number of researchers in public research labs of OECD countries however shows that it does not grow at the same rate as the number of new PhD holders except in Japan (Chart 2). This general trend should not however mask the fact that in a number of countries, of which France and Germany, many researchers in the public sector will retire in the next years and that an important number of research positions are therefore expected to become available. The situation is inverted in business enterprises (except in the United States) where the number of researchers is growing faster and may absorb a higher number of doctorates (Chart 3).

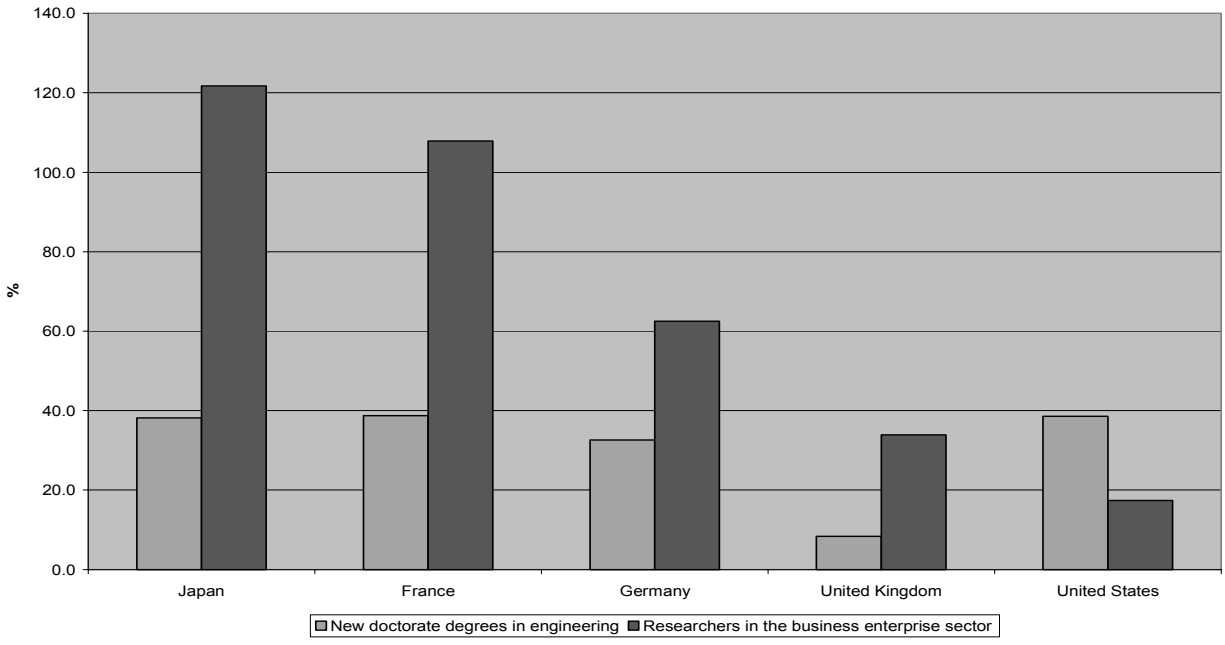
Chart 2: Growth of new doctoral degrees and of researchers in the public sector in the 1990's[1]



1. Growth rates over the following periods: Japan: 1996-2001; France and Germany: 1991-2001; United Kingdom: 1987-1997; United Sates: 1989-1999.

Source: NSF, Science and Engineering Indicators 2004 and OECD S&T databases.

Chart 3: Growth of new doctoral degrees in engineering and of researchers in the business enterprises in the 1990's[1]



1. 1989-1999 growth rates.

Source: NSF, Science and Engineering Indicators 2004 and OECD S&T databases.

14. Yet the question of the attractiveness of the research careers is also much debated. In their final communiqué OECD Ministers concluded in January 2004 that "*complementary efforts are needed to improve mobility and the attractiveness of research careers in the public and private sectors*". One may expect two criteria to play an important role in respect of attractiveness: the level of salaries and the type of contract (permanent vs. non permanent). No comparable statistics exist on salaries of researchers at the OECD level, but some data show that researchers, at least at the upper level, are better paid in the United States than in Canada or the United Kingdom (Table 1). The contractual situation of researchers is even more difficult to compare and is a complex issue, much dependent of the organisation of the research system at national level. While sometimes criticised in France, the civil servant status of French researchers in the public sector is much envied by their foreign counterparts for the security and intellectual independence it provides. A tenure position occurs at a further stage of a researcher's career in the United States. In addition, the recent NSF *Science and Engineering indicators* report (NSF, 2004) shows that in the last 25 years, "*full-time faculty positions increased more slowly than postdoc and other full- and part-time positions*". And Sir Gareth Roberts (2002) in his review reports that up to 55% researchers (post-docs for the most part) in the biosciences and 54% in physics are on temporary contracts in university labs of the United Kingdom. The Science and Technology Committee of the House of Commons (2001) has even denounced this situation in another report. The contractual situation of researchers is thus further complicated by the development of post-doctoral positions.

Table 1: Salaries of scientists in life sciences

(median salary in 2003 – current US dollar purchasing power parities)

Canada		United Kingdom		United States	
Research director	86066	University professor	80000	Distinguished researcher	126000
Senior researcher	50410	Senior researcher	44484	Senior researcher	75350
Intermediate researcher	37705	Intermediate researcher	34673	Intermediate researcher	36366
Postdoc	31148	Postdoc	36753	Postdoc	35000
Research technician	27869	Lab technician	29297	Research technician	23600
High school teacher	37295			High school teacher	44200

Source: OECD calculations based on data from *The Scientist* 2003 Salary Survey.

15. The status of researchers is different in the private sector, where in many instances research will only be a temporary function in the career development of an engineer in the enterprise. Mangematin (2000) reports that *"in engineering science, PhD graduates begin their career in research and then change to a managerial job"*. It is also worth noting that many researchers, especially in the business enterprise sector, are not holders of doctoral degrees (Table 2). The value attached to PhD degrees, varies from one country to another although it is increasingly recognised as a standard at international level.

Table 2: Percentage of researchers having a doctoral degree in selected OECD countries

	Hungary 2002	Korea 1998	Norway 2001	Portugal 2001	Slovak Republic 2002
Business enterprises	10.4	6.1	10.8	2.4	16.6
Government sector	33.4	38.9	29.0	18.4	56.0
Higher education sector	33.1	62.0	32.8	43.0	53.5
Private non-profit sector		32.2		39.6	0.0
National total	29.1	31.3	22.5	32.4	47.8

Source: OECD S&T database.

16. Besides, in some fields of study, doctorate holders will be tempted by other types of careers. The 2004 NSF *Science and Engineering indicators* report reveals that "*long-term growth of doctoral scientists employed at U.S. universities and colleges was slower than that in business, government and other segments of the economy*". Likewise, Béret et al. (2002) report that the percentage of PhD holders choosing non-R&D engineering jobs has significantly increased in France from less than 8% in 1999 to 13% in 2001 and that these jobs go chiefly to doctors in mathematics and physics for whom they represent 16% of their total jobs. This situation may reveal a mismatch between expectations of young PhD holders and the offers of the research system in terms of salaries and job status and may represent a threat for these areas of research when combined with a declining interest for study in these fields.

17. Finally, the quality of doctoral training is also much questioned and some argue that PhD holders are not trained in a way that makes them operational in an enterprise environment. A large range of qualities is now expected from individuals at work (e.g. oral and written communication and presentation skills, networking abilities, management capabilities). This, combined with the fact that doctorate holders reach the labour market at a relative advanced age, may explain why some remain unemployed. A growing number of countries and universities are for this reason reforming their PhD curricula. This may also explain the important development of post-doctoral training.

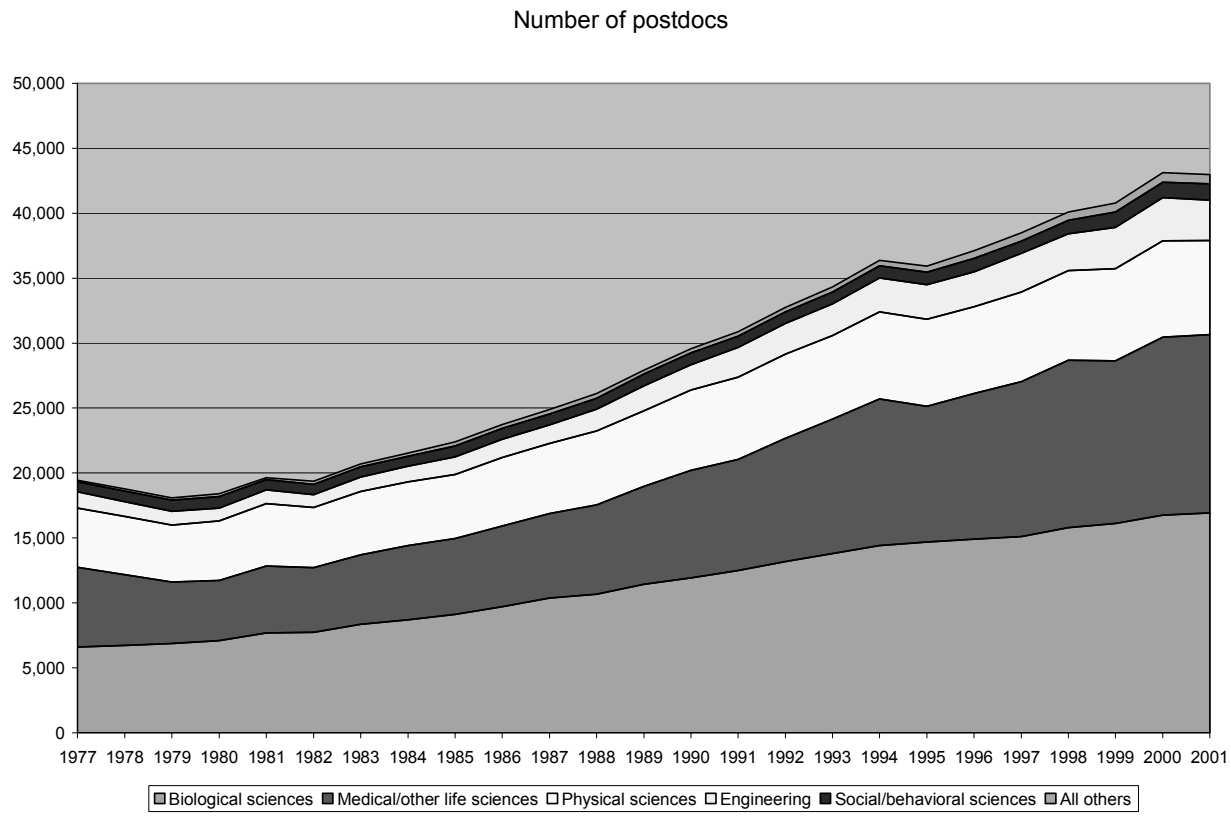
Postdoctoral positions

18. In the case of doctorate holders pursuing their career into research, post-doctoral training is a typical step in the transition from education to work that differentiates them from other graduates. Post-doctoral training and funding is also increasingly becoming a target of science policy makers in OECD countries as has recently been the case in Australia, Austria, France, Japan, Hungary or Luxembourg (OECDb, 2004).

19. Post-doctoral training has indeed dramatically increased over the last fifteen years, although relevant statistical information is limited on this. It is currently impossible to know precisely the number of postdoctoral positions in a country. While the question of postdoctoral training and the working conditions of postdoctoral fellows are much debated, available information principally originates from *ad hoc* surveys conducted by postdoc associations or funding institutions. Many of these exist but fail to give a comprehensive and coherent picture of the situation. The only systematic collection on postdoctoral data is by the NSF in the framework of its Survey of Recent Doctorate Recipients, which only goes to recipients of doctorate at US universities. Even so, the latest publication of *Science and Engineering Indicators* (NSF, 2004) states that the "*definition of postdocs differs among the academic disciplines, universities, and sectors that employ them, and these differences in usage probably affect self-reporting of postdoc status in the Survey of Recent Doctorate Recipients*". It can be expected that definitions also differ among surveys, postdoc associations, funding or employing institutions and across countries. Several countries have in fact made attempts to develop definitions of postdocs but without much success to date.

20. Chart 4 depicts the increase of postdocs from US universities by field of doctoral degree over the last 25 years. While postdoctoral training is the normal step into research career in some fields, its occurrence varies across disciplines. It is for example systematic in the life sciences and very common in physics, but less frequent in the social sciences and rare in the humanities. The NSF report also shows that much of the increase in postdocs is due to non US citizens on temporary visas. While most postdoctoral fellows claim reasons consistent with the need for additional research training, 11.5% of them report "other employment not available" as a reason for taking up a postdoctoral position. There are also suspicions that young doctorate holders remain longer than before in post-doctoral positions where conditions of work, salaries and social benefits are less advantageous than in other types of employment. Some argue that this has a negative impact on the attractiveness of research careers.

Chart 4: Postdocs at US universities, by field of doctoral degree: 1977-2001



Note: Data for 1978 are interpolated.

Source: National Science Foundation, Division of Science Resources Statistics, WebCASPAR database system, http://caspar.nsf.gov. See appendix table 2-30. Science & Engineering Indicators – 2004.

Mobility of doctorate holders

21. Doctorate holders and researchers are highly mobile populations at least internationally and in some fields of research. Much of the policy debate focuses on how best to measure and monitor this mobility not only internationally but also between institutions and the public and private sectors. The interface between the innovation and science systems, the development of public-private partnerships and the mobility of researchers between public and private labs was one of the themes discussed by Ministers at the meeting of the OECD Committee for science and technology policy in January 2004. Yet, the mobility of researchers between public labs and businesses seems to be generally limited and it is in any case difficult to measure.

22. Some attempts however have been made as is the case in France (Béret and al. 2003) for example. Drawing on the results of the French surveys, the authors were able to design a table showing the mobility patterns of doctorate holders in the three years following the award of their PhD degree (table 3) as well as developing a typology of PhD trajectories on the labour market.

Table 3: Mobility of French PhD graduates in the three years following their PhD degree

	PhD graduates in natural sciences	PhD graduates in social sciences and humanties	All PhD graduates
All jobs in the private sector	40.5	29.2	37.4
All jobs in the public sector	39.2	58.4	44.4
Mobility from the private to the public sector	5.5	12.3	5.7
Mobility from the public to the private sector	9.4		8.0
More than one mobility between the two sectors	5.4		4.5
Total	100.0	100.0	100.0

Source: CEREQ, France.

23. International mobility of PhD holders is even more difficult to seize, first because it is a multi-faceted phenomenon and second because of the inherent complication of capturing international flows. To begin with, it is important to acknowledge that international mobility in many instances already occurs at the time of the thesis preparation. Education statistics show that the percentage of foreigners among PhD students is higher than in lower degree levels (Table 4). Second, these foreign PhD students tend to stay longer for postdoctoral training in the country where they obtained their PhD. Third, for those having earned their doctoral degree "at home", postdoctoral training abroad is in many fields becoming a pre-requisite to a research career. Fourth, research always had an international dimension and, as it is becoming increasingly global, researchers and PhD holders tend to be even more mobile. Finally, mobility is often not limited to a one time move but may take the form of multiple exchanges with and visits to foreign laboratories.

Table 4. Percentage of foreign students in total enrolment of selected OECD countries – 2001

	Advanced research programmes	Total tertiary education
Australia	22.6	13.9
Austria	14.2	12.0
Belgium	33.9	10.6
Czech Republic	6.5	3.0
Finland	6.0	2.2
Iceland	12.0	4.1
Italy	0.8	1.6
Korea	1.5	0.1
Mexico	1.1	0.1
New Zealand	8.7	6.2
Norway	14.9	4.7
Slovak Republic	1.6	1.2
Spain	10.9	2.2
Sweden	19.2	7.3
Switzerland	37.5	17.0
United Kingdom	34.7	10.9
United States	26.3	3.5

Source: OECD, Education database.

24. Such a complex pattern is difficult to measure: people change status (from students to post-docs to researchers), cannot be traced easily across borders and may cross borders several times. Limited

information is available on the length of stay of researchers abroad and on returns to their home country. This lack of solid information does not support the recurrent discourse on "brain drain". While the threat of "brain drain", especially from developing to developed countries should not be underestimated, recent analysis by the OECD has instead highlighted a scheme of "brain circulation" (OECD, 2002) across its member countries. The need for solid and reliable statistical data to confirm this trend is cited by numerous analysts.

Implications in terms of indicators

25. In the above section, we have identified a number of policy issues at stake regarding the labour market of doctorate degree-holders. What are the indicators that could help informing policy makers? In the table below, we try to link a number of policy research questions that have emerged from the above discussion with the types of indicators that would be needed to answer them. Although we are aware that doctoral studies differ across countries and that the funding and conditions of doctoral training may have an impact on the quality of the degree and the outcome of the doctorate holder of the labour market, we have deliberately limited our focus to what happens after obtaining the PhD. Besides, the purpose of this exercise is not to go into a detailed list of questions but to highlight the main topics that should be covered. This is a first attempt and will need to be modified following the discussions at the workshop.

Table 5. Possible links between policy research questions and data needs

Policy research questions	Data needs
Role in innovation, knowledge economy Where do PhD holders work as compared to other tertiary graduates, what is their productivity?	PhD holders by type of employment (research, non-research), sector (industry, government, higher education), field of research; data on scientific productivity of PhD personnel (publications, co-authorship, patents, citations).
Labour market supply and demand Do we train too many or too few PhDs? Are there mismatches on the labour market? Why do PhD holders choose a research career in the public sector or one in the private sector or leave research?	Employment status broken down by age, gender, country of origin, sector of employment, occupation, field of study vs. field of research. Statistics on wages, type of contract, unemployment rates, job conditions in S&T occupations; data on perceptions of career opportunities in S&T in public versus private sector, satisfaction.
Education to work	Time of transition to employment and post doctoral experience statistics.
Mobility How mobile are PhD holders (among sectors and across countries)?	PhD mobility between sectors (industry, government, higher education). PhD mobility across countries: PhD holders by country of birth, citizenship, residency status, type of visa. Data on permanent vs. non permanent, length of stay, returns to country of origin.

The potential of surveys on careers of doctorate holders

26. Until a few years ago, international education statistics did not even specifically identify students at the doctoral or PhD level. It is only with the introduction of the 1997 version of the International Standard Classification of Education (ISCED-97) that a specific class – i.e. level 6: second stage of tertiary education (leading to an advanced research qualification) – makes it possible to identify PhD students and graduates separately (UNESCO, 1997). Statistics at this level of education however existed at national

level in numerous countries. Internationally comparable long-term data series are nevertheless still not available and there are remaining difficulties and differences across countries on the type of degrees that should be included in ISCED-97 level 6. In addition, ISCED-97 level 6 data are not systematically collected in other statistical sources such as censuses or labour force surveys.

27. Surveys of PhD holders have in the same way been predominantly developed at national level. In 2003, the OECD Secretariat has released a working paper on the availability and characteristics of surveys on the destination of doctorate recipients in OECD countries (Recotillet, 2003). This paper reveals that many such surveys exist in the member countries but that they cannot be used in their current shape for meaningful international comparisons.

28. The above mentioned inventory identifies two main types of surveys in addition to register or administrative data sources specific to some Nordics countries. The first type includes snapshot surveys and the second type longitudinal surveys that can be retrospective or panel-based. Some countries like the United States have in fact a combination of both, the Survey of Earned Doctorates (SED), which is snapshot, serving as the sample frame for the Survey of doctorate recipients (SDR), the panelised survey. The author of the inventory notes that longitudinal surveys, whether retrospective or panelised are the ones that provide the most comprehensive information about the situation of doctorate recipients on the labour market and that they are a highly appropriate tool for the conduct of research and innovation policies and for steering higher education flows. In the conclusion, the author makes an interesting proposal to conduct several rounds of snapshot surveys in order to harmonise the time frame for data collection across countries and as a way to panelise the surveys. The survey questionnaire could in addition contain retrospective questions so as to get a maximum of historical information from the doctorate recipients.

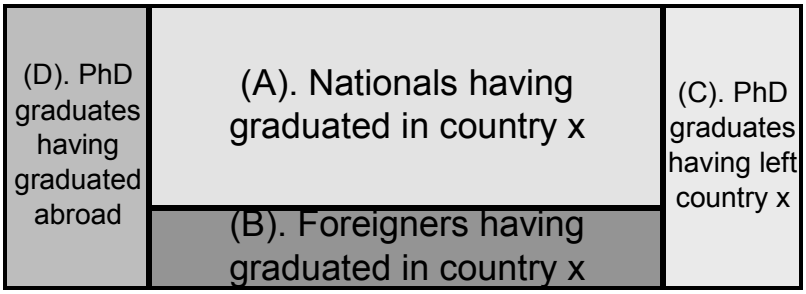
29. The advantage of such a proposal is that it could accommodate, with a minimum of adjustment, the different types of survey systems already existing in different countries. It would however be necessary to find agreement on, at least the following elements: the content of the questionnaire, the population/cohorts surveyed, the frequency and time-periods of the survey.

30. The type of information collected by the surveys, although it varies from country to country and according to the type of survey (snapshot or longitudinal), generally covers the following components: demographic characteristics, information on the doctorate degree itself (field of research, year of completion, funding), post-doctoral training and description of successive jobs (occupation, type of contract, duration, salary, satisfaction).

31. The choice of the population/cohorts surveyed and the survey frequency are important. The easiest and most frequent approach is to survey doctorate recipients of a given year xx years after the doctorate award. If the survey is then repeated and panelised on a regular basis, it will eventually cover a large portion of the doctorate holders in the country although this will take a long period. It will however fail to provide information on those doctorate holders in non-survey years (although their characteristics could probably be estimated from the benchmark years), which highlights the importance of consolidating the timing and frequency of the surveys across countries in order to get the international picture. An important question is also to determine when doctorate holders should be surveyed for the first time, knowing that the time needed for entering the labour market may vary from country to country and overtime. Surveying just after the completion of the degree as is done in the United-States and the Canada through the SED is seen as a good way to ensure the traceability of doctorate holders in these countries. But the nature of a survey to new PhD graduates differs from one aimed at capturing a career trajectory and it is unlikely that many countries have the resources for engaging in both types of survey. It also appears that countries have other means of locating their PhD holders through administrative or special registers, alumni, postdoc, fellowship or professional associations and these sources could probably be usefully combined if needed.

32. Surveying on a national graduate cohort basis fails to capture PhD holders having graduated abroad as demonstrated by the system in place in the United States. One deficiency that the inventory has highlighted is indeed the lack of information on the international experience or mobility of doctorate holders. These are only ill-captured by the surveys. This is not surprising in light of the difficulty of tracing individuals across borders. Should the OECD launch a new survey instrument on careers of doctorate holders, it is of utmost importance that an improved measurement of international mobility be implemented. Some thoughts are given below on possible approaches. Although none of them is entirely satisfactory in the sense that it would give an ideal solution, their combination could probably help getting a better picture of international flows.

Chart 5. Breakdown of all PhDs holders in country X



Note: the size of boxes (A), (B), (C) and (D) is expected to vary from one country to another; box (C) includes both nationals and foreigners having obtained their PhD in country X; in addition, among foreigners having left, some may have returned to their country of origin; similarly, box (D) includes both nationals and foreigners having obtained their PhD abroad.

Source: OECD.

33. It is necessary to devise ways enabling the coverage of the emigrate population – i.e. (C) in chart 5 below -- and of the immigrate population – i.e. (D) in chart 5 below. Several avenues could be explored for that. One approach for example consists in making an effort to survey the people who are emigrated. This has been tried in a number of countries like France or Germany. The difficulty resides in locating the person abroad, i.e. identifying his or her address. An investigation of the methods used by the countries having experience with this technique and an evaluation of the results (in particular in terms of representativeness) would be necessary to decide whether this is a sustainable approach. New estimation techniques of the people having left and/or new surveying methodologies could also be tested.

34. An approach which has been adopted by the United States to identify the immigrate population, consists in using complementary statistical data sources (census, household or labour force surveys). See table 5. This approach could however be limited by the fact that in certain countries ISCED-97 level 6 information is not yet systematically collected in large scale population surveys as mentioned earlier.

Table 6. Comparison between NSF and Census estimates of foreign-born individuals in S&E occupations, by level of education: 1999 and 2000 (percent)

Level of education	1999 NSF/SRS SESTAT	2000 Census 5-Percent PUMS
All college educated	15.0	22.4
Bachelor's	11.3	16.5
Master's	19.4	29.0
Professional degree	10.0	35.8
Doctorate	28.7	37.6

NSF/SRS National Science Foundation, Division of Science Resources Statistics
SESTAT Scientists and Engineers Statistical Data System
PUMS Public Use Microdata Sample

Note: Includes all S&E occupations other than postsecondary teachers because field of instruction was not included in occupation coding for the 2000 Census.

Sources: NSF/SRS, SESTAT, 1999; and U.S. Bureau of the Census, PUMS, 2000.

35. Another approach could be called that of the "mirror statistics" and consists at estimating the numbers and getting information on the PhD holders having migrated from the numbers and the information reported by the other countries. This approach is used in trade statistics and also in the education statistics and although it is not perfect – i.e. the "export" numbers rarely equal the "import" numbers – it could give a reasonable picture of the population having migrated. It requires however that all countries participate in the survey to ensure a full coverage of the people having crossed borders. This approach, would consist in considering (D) as a sum of (C)s originating from other countries, in other words in reconciling (D) from mirror (C) data, insofar as the countries are able to survey their own graduates abroad, which in the current situation is uncertain as mentioned earlier. Similarly box (C) of chart 5 could be approximated by nationals registered as (D) in foreign countries. The fact that none of the boxes (C) and (D) can actually be properly estimated complicates the implementation of such an approach, unless important methodological breakthrough are devised.

36. The situation is furthermore complicated by the fact that migration flows may be of very different nature: permanent or temporary, long term or short term, single or multiple. The characterisation of these flows should also be taken into account in measurement efforts since it is crucial to the understanding of international mobility patterns. Collecting detailed information on visas, citizenship and residency status of individuals can help in this regard.

37. Another avenue that could be envisaged is of a more selective and/or qualitative nature. If the main interest is for example to gauge the research career of doctorate holders, be they from national or foreign origin, one could envisage a survey of researchers who are holders of PhDs from research institutions. Research institutions, at least in the government and higher education sectors, probably hold detailed information on the individual characteristics of their research staff. Efforts are already conducted by the OECD to collect basic statistics on R&D personnel according to the level of education, including doctorate level, and citizenship from its member countries. Surveys to researchers who hold a PhD degree could also include questions of a more qualitative or sociological nature, though interviews for example, so as to determine personal motivation factors that influence career and mobility choices of doctorate holders. An interesting study of this kind has for example been conducted in France (Dedieu & Musselin, 2004).

CONCLUSIONS

38. In this paper, we have raised a number of questions related to the labour market of PhD holders in OECD countries and discussed the possibility of using data generated by an international survey on CDH to inform these questions. This approach is based on the assumption that doctorate holders make a specific contribution to the knowledge economy, an assumption that needs to be substantiated by hard data. PhD holders are often cited as an important component of the wider population of tertiary graduates or of human resources in science and technology, but they are not necessarily retained as a prime or single target for policy. Building indicators on careers of doctorate holders should help knowing more on how they fare compared with other graduates on the labour market. There exists one career path which is certainly specific to PhD holders that is that leading to a research career through the occupation of post-doctoral positions. Previous OECD work has however highlighted the lack of comprehensive information on this aspect of the doctorate holders' careers. More also needs to be learned on the other segments of doctorate holders' labour market. Furthermore, while a good body of analytical studies exists at national level, it does not always enable comparisons across countries and drawing an international picture of the labour market of doctorate holders.

39. In table 5 above, we have made an attempt to link some of the most important research questions with the type of indicators that could help informing them. Although we are aware that doctoral studies differ across countries and that the funding and conditions of doctoral training may have an impact on the

quality of the degree and the outcome of the doctorate holder of the labour market, we have deliberately limited our focus to what happens after obtaining the PhD.

40. In order to stimulate the discussion, we wish to raise the following questions:

- Is the coverage of the research questions outlined in table 5 sufficient or should it be extended and how?
- Do these research questions need to be prioritised and how? Or do we need information on all aspects in order to get a global view of the doctorate holders' labour market?
- Are the indicators proposed relevant to inform the research questions proposed in table 5?
- Is an internationally coordinated survey on CDH viewed as a useful tool for producing these indicators?
- How complementary data sources should be used or organised to get the most comprehensive set of indicators?

41. Participants to the workshop are invited to make their suggestions to the Secretariat.

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