



KnowINNO



Making the most of knowledge

COORDINATION AND SUPPORT ACTIONS

FP7-Adhoc-2007-13

MAKING THE MOST OF KNOWLEDGE

(KNOWINNO)

**KEY FINDINGS OF THE OECD-KNOWINNO PROJECT ON THE CAREERS OF
DOCTORATE HOLDERS**

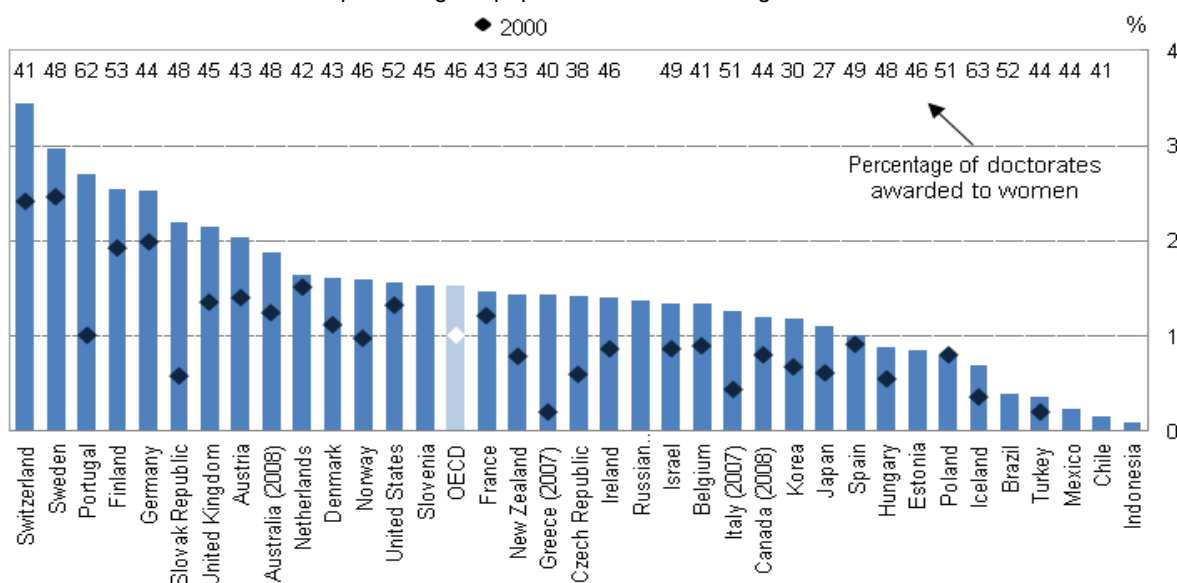
SUMMARY OF KEY FINDINGS

- The project highlights the potential of CDH data to inform policy questions that bear on the labour market and careers of doctorate holders and researchers. Beyond descriptive analysis of tabulations, the project makes use of econometric analysis based on micro-data to identify systematic patterns in the data which underpin overall differences.
- The past decade has witnessed a steady increase in the number of doctoral degrees being awarded across the OECD, rising by 38% from 154 000 new doctoral graduates in 2000 to 213 000 in 2009.
- There is only a weak association between the proportion of doctor graduates in the labour force and a country's R&D intensity. Switzerland has the highest workforce share of doctorates, close to 2.8 per cent.
- Despite the growing supply of doctorates, the available evidence points to a sustained -possibly increasing- labour market premium on individuals holding doctoral qualifications, relative to other highly qualified individuals.
- Although female and younger doctorate holders fare relatively worse in terms of employment rates and earnings than their older and male counterparts, these biases are less marked for doctorate holders than for individuals with lower levels of educational attainment. The gender bias persists but is lower in size after controlling for other differences.
- Employment rates for recent doctorates are also high, but figures for 2009 still do not account for the wave of fiscal adjustment in many countries and its potential impact on the public funding of R&D. Temporary positions are increasingly common in the academic sector, but less so in business.
- Although the higher education sector is the main sector of employment for doctorates, demand for doctorates is apparent across other knowledge intensive sectors. The take up of jobs outside higher education is not necessarily, but often related to take-up of non research occupations. Work as a researcher becomes less likely as careers progress and other competencies are acquired.
- Natural scientists and engineers are more likely to be engaged in research while social scientists find more opportunities in non-research occupations that are nevertheless related to their degree.
- Job mobility patterns differ markedly across countries but mobility is more frequent among doctorates not working in research. Very few countries have more mobility from the higher education to the business sector than vice versa.
- Earnings in agricultural sciences and humanities are below the overall median in most countries, whereas doctorate holders in medical and health sciences tend to be paid above. Doctorates in the business sector are typically better paid than in other sectors, but surprisingly not in all countries.
- International mobility is a widespread and increasingly important phenomenon, although less common than it might be assumed for researchers. It has positive impacts on knowledge exchange and diffusion, but surprisingly it is not systematically associated with higher earnings.
- Individuals who have already experienced an episode of international mobility are more likely to report an intention to move abroad.
- Even when not in research, jobs are in most cases related to the subject of doctoral degrees and doctoral graduates are satisfied with their employment situation. A wide range of monetary and non pecuniary factors contribute to explaining the reported attractiveness of research careers. Satisfaction levels on aspects other than pay are particularly high for individuals working in the higher education sector.

Developing a statistical evidence base on doctorate holders

Doctoral graduates account for a relatively small proportion of the overall population but their importance is widely appreciated.¹ Having benefitted from highly specialised research training and produced an original contribution to science, doctoral holders are expected to play a key role in the knowledge economy as they stand in a position to drive forward advances in science, technology and knowledge about society. Evidence on the careers of doctorate holders (CDH) and their contribution to science, innovation and the economy is of high relevance not only to policy decision makers and governments who finance the training of this group of individuals and support their integration in the innovation system; but also to prospective employers in search of specific skills for their workforce; and the individuals themselves who consider whether to pursue doctorate studies and proceed with research or unrelated careers. Unfortunately, evidence is limited and sparse owing, for example, to the fact that standard statistical sources are typically far too small to produce statistically robust results for this population. The CDH-KNOWINNO project stems from a relatively recent initiative initiated by the OECD, the UNESCO Institute for Statistics and Eurostat under which internationally co-ordinated data collections have been carried out among participating countries to obtain statistically reliable data on doctorate holders and their professional careers. This document² provides an overview of the key statistical and analytical findings that draw on data from the second international CDH data collection conducted in 2010, as well as some complementary sources. **Box 1** provides further details on this project.

Figure 1. Graduation rates at doctoral level, 2000 and 2009
As a percentage of population in reference age cohort



Source: OECD, Education at a Glance 2011: OECD Indicators and Education at a Glance 2009: OECD Indicators.

The flow of new graduates has increased, raising the share of doctorates in the population.

The past decade has witnessed the continued development of higher education and research systems worldwide. The expansion of higher education has resulted in not only a massive increase of tertiary level graduates but also marked increases in the number of individuals with postgraduate degrees, including doctorate awards. In 2009, around 213 000 new doctoral graduates graduated from universities in OECD

1. See 'Skills for Innovation and Research', *OECD Innovation Strategy*, OECD 2010.
2. The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

countries, an increase of 38% with respect to the 154 000 who graduated in 2000. **Figure 1** shows that nearly 1.5 per cent of individuals in a comparable age cohort received a doctoral degree, a figure as high as 3.4% in Switzerland and 3% in Sweden. The increasing presence of women in doctoral programmes partly explains the overall increase in doctorates over the past decade. Women were awarded on average almost half (46%) of OECD's new doctorate degrees.

Box 1. The Careers of Doctorate Holders project

Evidence gaps and the development of a dedicated global data source on doctorate holders:

The OECD, in coordination with the UNESCO Institute for Statistics and Eurostat, launched in 2004 a new project on the Careers of Doctorate Holders (CDH) aimed at addressing evidence gaps on this population which other generic statistical sources were not able to deal with. Methodological guidelines, a model questionnaire and a set of reference output tables (key indicators) were developed for collecting data on doctorate graduates on an international basis. A pilot data collection was also conducted involving a reduced number of countries. A first large-scale data collection was launched in 2007 in which 25 countries participated. This collection provided a rich set of data but also highlighted a number of technical challenges which a further data collection in 2010 sought to address. Belgium, Bulgaria, Croatia, Denmark, Finland, Germany, Hungary, Iceland, Israel, Latvia, Lithuania, Malta, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Slovenia, Spain, Sweden, Switzerland, Chinese Taipei, Turkey and the United States, collected information on the situation of doctorate holders as of 1 December 2009.

The CDH-KNOWINNO project:

Over the 2011-2012 biennium, the OECD activity on CDH has been partly sponsored by the European Union's Seventh Framework Programme as part of the broad OECD KNOWINNO project. This supported the development of the CDH database by the OECD and has helped produce a set of internationally-comparable indicators based on the results from the 2010 CDH data collection. In order to address a number of policy and analytical questions, four key areas of work were identified for detailed investigation: 1) early career of doctorate holders; 2) job-to-job mobility; 3) international mobility and 4) competences and skills of doctorate holders. Each topic was led by a participant organisation: NISTEP/Japan for early careers, DGEEC/Portugal for job-to-job mobility, CSIC/Spain for international mobility and ECOOM/University of Ghent/Belgium for competences and skills.

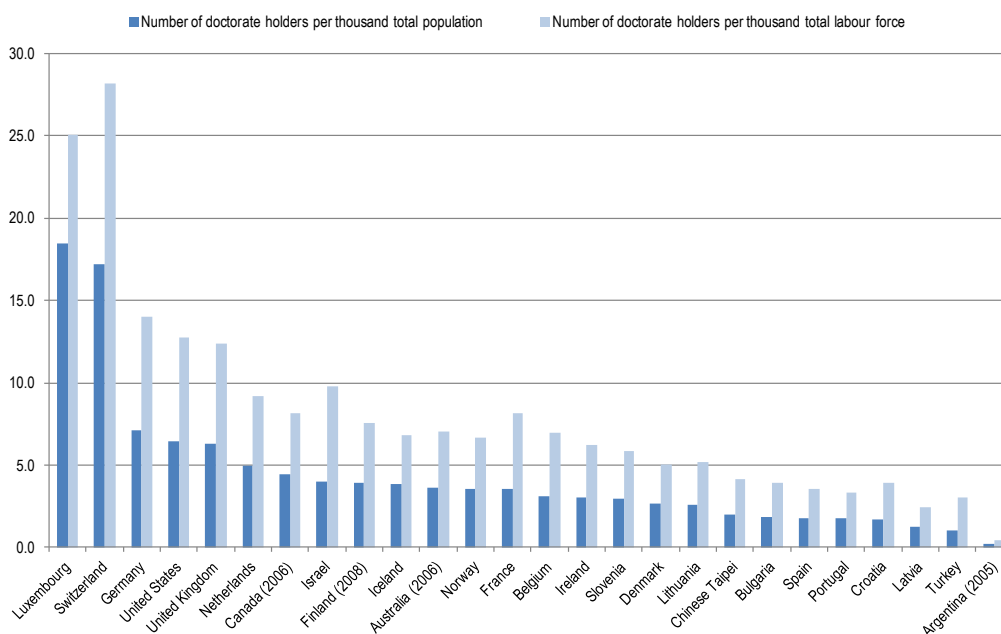
In order to extend the number of countries for which comparisons could be carried out, a special effort was made to define common populations of doctorate holders among surveys of university graduates available for France, Japan and the United Kingdom, and subsamples within CDH surveys carried out in other countries. Access to and use of micro data has been instrumental in facilitating these comparisons that were carried out under the "early career module" of the project. Using a data coding guide provided by the OECD, ten volunteer countries harmonised their micro data sets in order to implement tabulations and econometric analyses using a common programming code developed by CSIC and NISTEP. The OECD secretariat also carried out for demonstration purposes a comparative analysis of micro data on doctorate holders and individuals holding other postgraduate qualifications for the United States and the United Kingdom.

The future:

The results of past CDH data collections, related documents and new reports arising from this project can be found in a dedicated website: www.oecd.org/sti/cdh. The project has also resulted in the production of updated methodological guidelines, comprising a revised model questionnaire –which includes new questions on competencies mainly developed by Belgium and the Russian Federation– for countries to use when collecting statistics on doctorate holders and thus ensure the internationally comparability of the results. The outlook for future CDH data collection differs across countries as some will be collecting data for the first time in 2012/2013; some will re-conduct a survey; while others have indicated they lack the resources to carry out new surveys. The OECD intends to continue to play an active role in collecting and disseminating statistics on doctorate holders as a key dimension of human resources for science and technology. The OECD is also keen to raise the profile of CDH as an additional evidence resource to decision makers and to encourage statistical agencies to make the CDH micro-data available for wider research and analytical purposes, which are to date relatively underexploited and remain difficult to access by potential users.

There are rather marked differences in the doctorate intensity of labour markets across countries. The high performance of Switzerland in terms of doctoral training is reflected in estimates of the stock of doctorate holders in the total population and labour force (**Figure 2**). Luxembourg shows a similar pattern due the presence of a large share of foreign doctoral graduates. Germany, the United States and the United Kingdom also display particularly high shares of doctoral graduates, with doctorates respectively accounting for 1.4, 1.3 and 1.2 per cent of the total labour force.

Figure 2. The relative importance of doctorate holders in the population
2009 or most recent year, doctorates per thousand



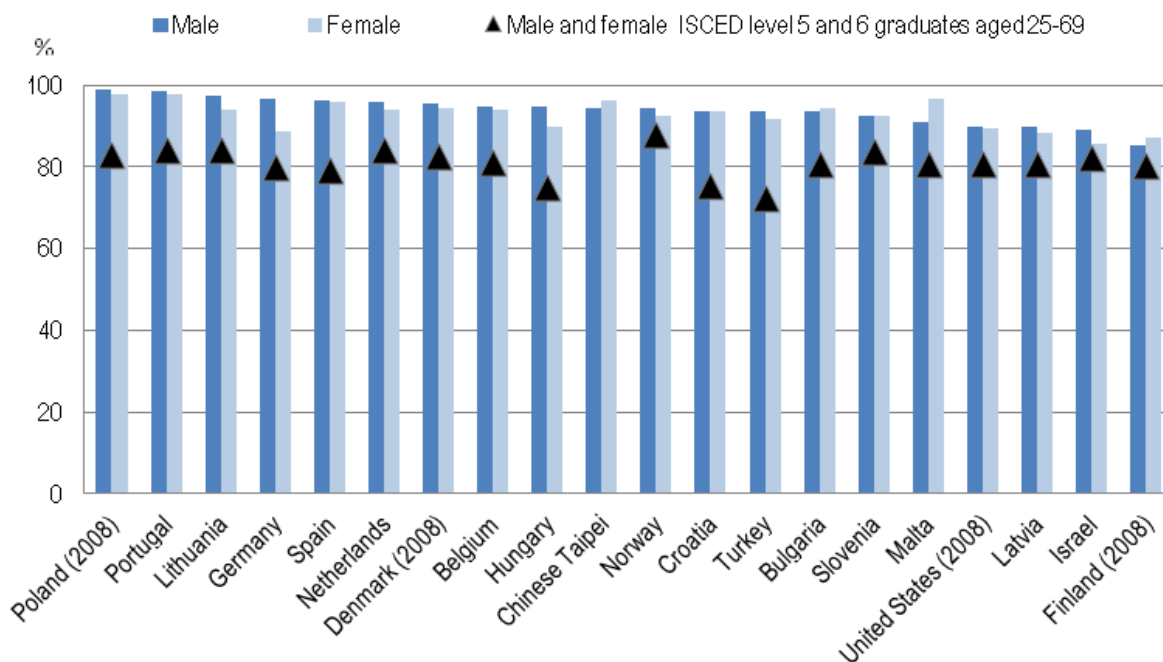
Source: OECD, based on OECD/UNESCO Institute for Statistics/Eurostat data collection on careers of doctorate holders 2010; OECD Main science and technology indicators, OECD Education attainment database, US Census Bureau (ACS, 2009).

Notes: Data for the Netherlands and Spain refer to graduation years 1990 onwards. For Spain, there is limited coverage of individuals who graduated over the years 2007 to 2009. Data for Chinese Taipei only include those doctorates in National Profiles of Human Resources in Science and Technology (NPHRST) made by STPI, NARL, Chinese Taipei.

Notwithstanding the increased supply of doctorates, overall demand has remained strong, as revealed by evidence of a continued employment and earnings “premium”.

Despite reported concerns in the media about excessive graduation rates and claims that advanced skills are being underutilised, there is no evidence to suggest that the growth in the number of individuals at the highest level of qualification has resulted in some form of excess supply that the labour market struggles to accommodate. Most indicators point to a sustained, if not increasing premium on doctorate skills, which is consistent with rising demand for individuals with such skills. A considerable body of literature has shown that labour market outcomes improve with the level of education. Comparisons between doctorate holders and other individuals at the upper end of the educational attainment distribution should always take into account possible differences in competencies and skills that are not attributable to the pursuit of additional education and the role these play in driving education and future labour market participation decisions. Comparing CDH statistics with standard labour force statistics, individuals with doctoral degrees had higher employment rates than the average higher education graduates in 2009 (**Figure 3**), which confirms the findings based on the first CDH data collection back in 2006, prior to the onset of the economic crisis. Due to differences in survey design, comparisons across different databases are hazardous and therefore differences may not be as large as implied by the chart. However, this result is replicated across countries with surveys that cover the broad set of higher education graduates. Given the very similar employment rates found for men and women at the doctorate level, there is some reason to believe that the “premium” effect is driven by the latter’s relatively increased attachment to the labour market.

Figure 3. Employment rate of doctorate holders by gender, 2009
As a percentage of total doctorate holders

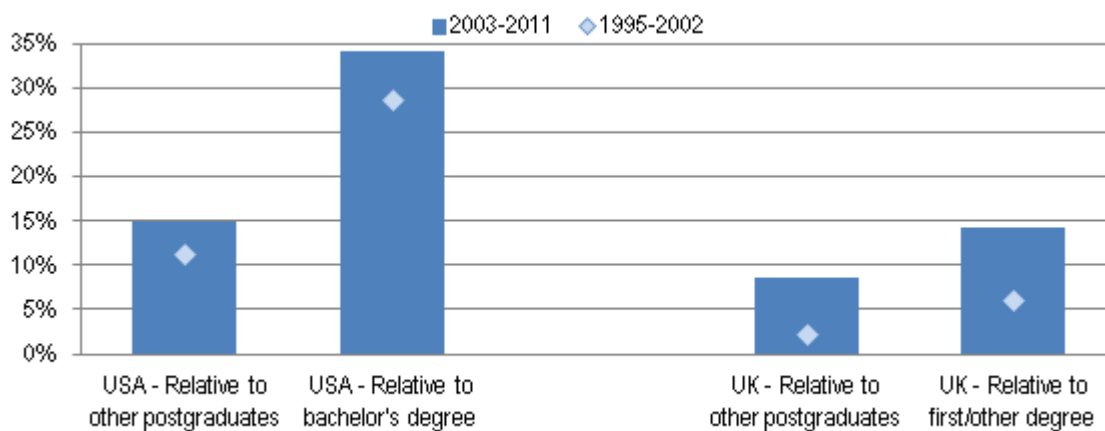


Notes: Data for Belgium, Germany, Hungary, the Netherlands and Spain refer to graduation years 1990 onwards. *For Belgium and Malta, data for the 65-69 age class include doctorate holders aged 70 years and above. For Spain, there is limited coverage of doctorate holders for the years 2007 to 2009. Data for Chinese Taipei only include those PhD in National Profiles of Human Resources in Science and Technology made by STPI, NARL, Chinese Taipei: <http://hrst.stpi.narl.org.tw/index.htm#noticeChinese>. Data for Turkey exclude foreign citizens. For the United States, data exclude doctorate holders who received their degree abroad and who received a doctorate in humanities.

Source: OECD, based on OECD/UNESCO Institute for Statistics/Eurostat data collection on careers of doctorate holders 2010; Eurostat 2012; Education at a Glance 2012.

Labour force survey data for the United States and the United Kingdom allow for comparing doctorates and other education groups across a number of labour market dimensions. These data show that the proportion of doctorate holders in the labour force aged 25 and above increased steadily between 1995 and 2011. Over this period, doctorate holders went from representing 1.3 per cent of the labour force to 2 per cent in the United States, and from 0.7 per cent to 1.2 per cent in the United Kingdom.

Figure 4. Doctorate wage premium in the United States and the United Kingdom
Estimated differences in log hourly earnings



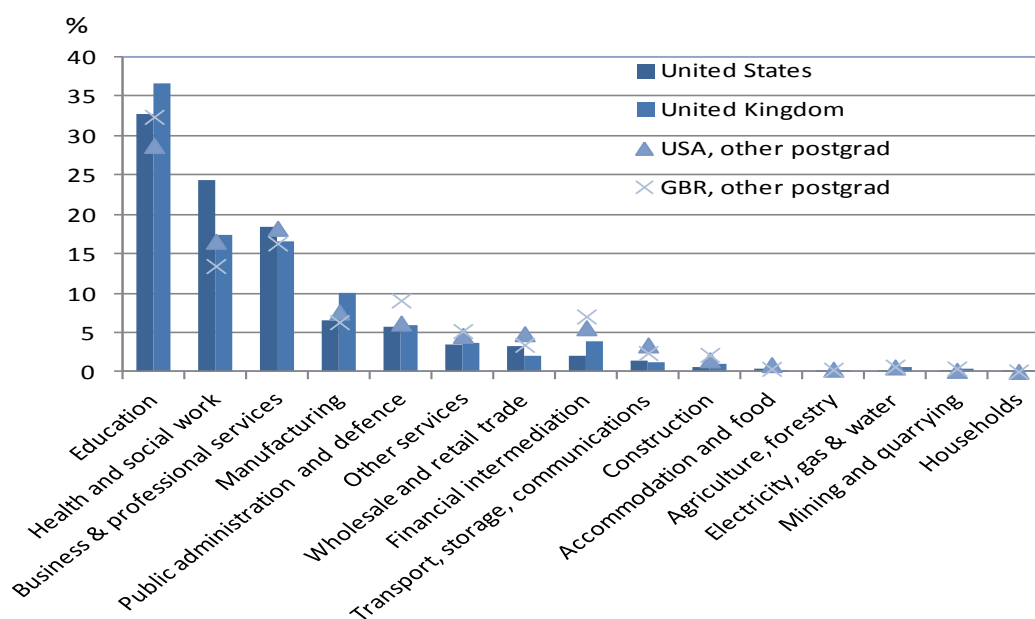
Notes: Based on ordinary least square regressions of log hourly earnings, controlling for other personal and job characteristics. Source: OECD calculations based on the US Current Population Survey and the UK Labour Force Survey.

Despite this near doubling in the share of the workforce, **Figure 4** shows that, in the United States, the earnings premium relative to other postgraduates (which includes masters' graduates and MBAs) increased from 11 percent in 1995-2002 to 15 percent 2003-2011, and from 28 to 34 per cent relative to those with bachelor's degrees. The estimated earnings premium in the United Kingdom was lower to start with, especially compared to first degree holders, although the same upward trend is apparent. The estimated premium increased from around 2 per cent to 9 per cent with respect to other postgraduates, and from 6 to 14 per cent with respect to first and other degree holders.

Although higher education and academic careers are the main destination of doctorate holders, their presence in other sectors is becoming more visible, particularly in countries with higher R&D intensity.

CDH data indicate that the education sector is indeed the main institutional sector³ of employment for individuals with a doctorate degree, accounting for a rather variable proportion of doctorates, from around one-third of the total in the Netherlands, Denmark and Belgium, to nearly four-fifths in Poland and Portugal. Government and business sectors alternate as the second most important destination. In Belgium, Denmark and the United States, at least one out of three employed doctorate holders works in the business sector. This sector primarily attracts those specialised in engineering as well as chemical scientists. The results from early destination surveys of the United Kingdom and Japan indicate a similar pattern.

Figure 5. The sector of economic activity for UK and US doctorates, 2003-2011
As a proportion of total doctorates or "other postgraduate" qualification group



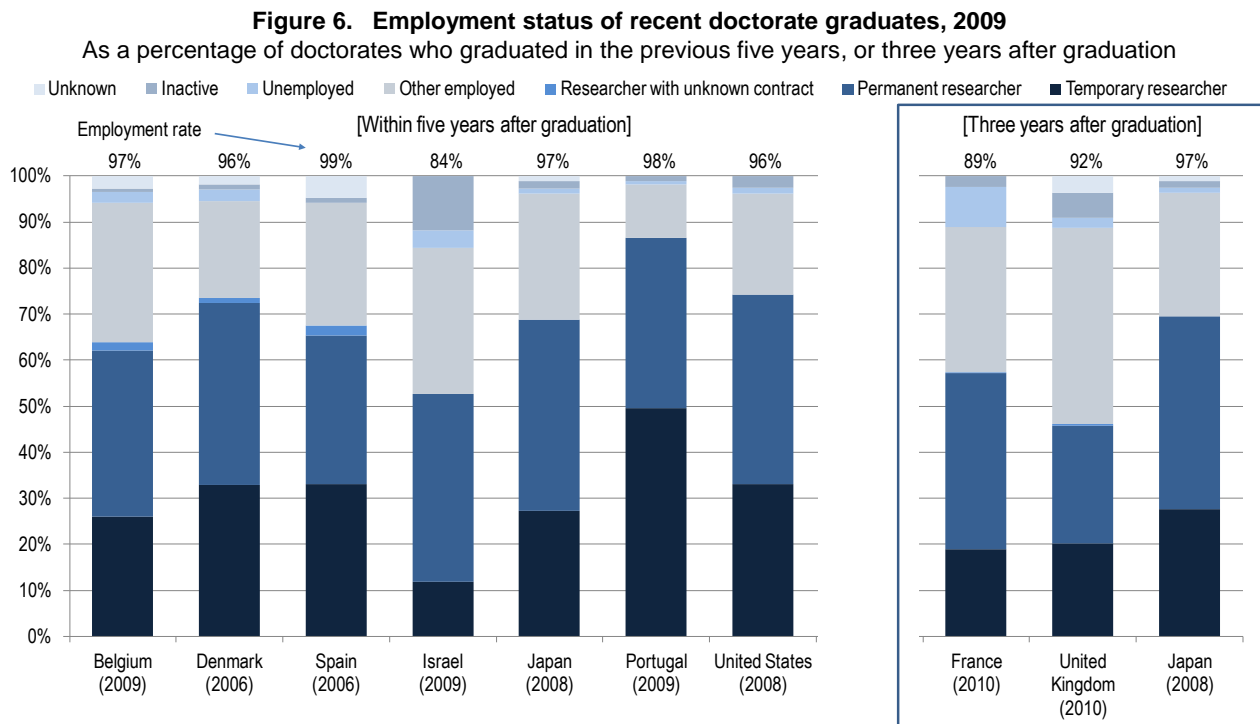
Source: OECD, estimates based on US Current Population Study and UK Labour Force Survey micro-data.

Detailed breakdowns by main activity, as opposed to broad, institutional sector, are not yet available for CDH dedicated data but should be in the future following revised guidelines. In the case of the United Kingdom and the United States, labour force survey data (**Figure 5**) show that the education sector employs above a third of the total population of doctorates, followed by the health and business and professional services sectors. Manufacturing is the fourth largest destination for the doctorate population, followed by public administration. Further analysis shows that doctorates are not only employed in professional but also in management occupations.

3. Based on the sectoral classification for R&D performing units in the OECD *Frascati Manual* (OECD, 2002), which includes Higher Education, Business Enterprise, Government and Other Private non-Profit.

Data on the labour market performance of recent doctorate graduates - which do not yet incorporate the impact of fiscal adjustment on academic research funding - reflect some potential challenges.

While the situation for doctorate holders looked rather benign in 2009, given the prevalent economic conditions, there is a perception that new cohorts of graduates are facing very different circumstances to those faced by their older peers at similar stages of their careers, raising concerns about what this may imply for motivations to embark on doctorate careers. The available data suggest that the employment rates of recent doctoral graduates were still high (96 per cent) compared to the broad population, but not as high as for those who earned their doctorates previously. Three years after graduation, the employment rate of doctoral graduates was estimated to be 89% in 2010 in France. In Israel, the employment rate was 84% in 2009 for those individuals who received their doctoral degree in the previous five years (**Figure 6**).



Notes: Only doctorate holders who obtained an advanced degree from the reporting country are considered for better comparability. "Other employed" includes those with unknown research status. For France, only those graduates aged 35 years old or less were surveyed. Data for Japan contain information of all recent doctoral graduates (census) with imputation and some higher education teaching personnel, such as part-time lecturers, are also classified as researchers. Non-EU domiciled students are outside the scope of the survey for the United Kingdom. The research status was derived using a combination of information on employment sector and occupation and is not exactly the same as the *Frascati* definition for the United Kingdom. Data for Belgium and UK data not weighted.

Source: OECD, based on ad hoc tabulations of data from CDH and early destination surveys (EDS) from France, the United Kingdom and Japan, November 2012.

These high employment rates, however, may mask relatively precarious working conditions. CDH data confirms that while employment rates may not differ substantially between cohorts of doctorates, temporary contracts are far more prevalent among those who received their degree less than five years ago. These figures are relevant to the analysis of the 'postdoc' phenomenon, a hard-to-measure concept in an international context given the diversity of arrangements for positions which are in principle aimed at consolidating or improving the research training of new doctorate recipients and preparing them for a research career.⁴ The CDH results may be consistent with claims that young doctoral graduates wishing to pursue academic careers have to undertake an increasing number of postdoctoral positions before

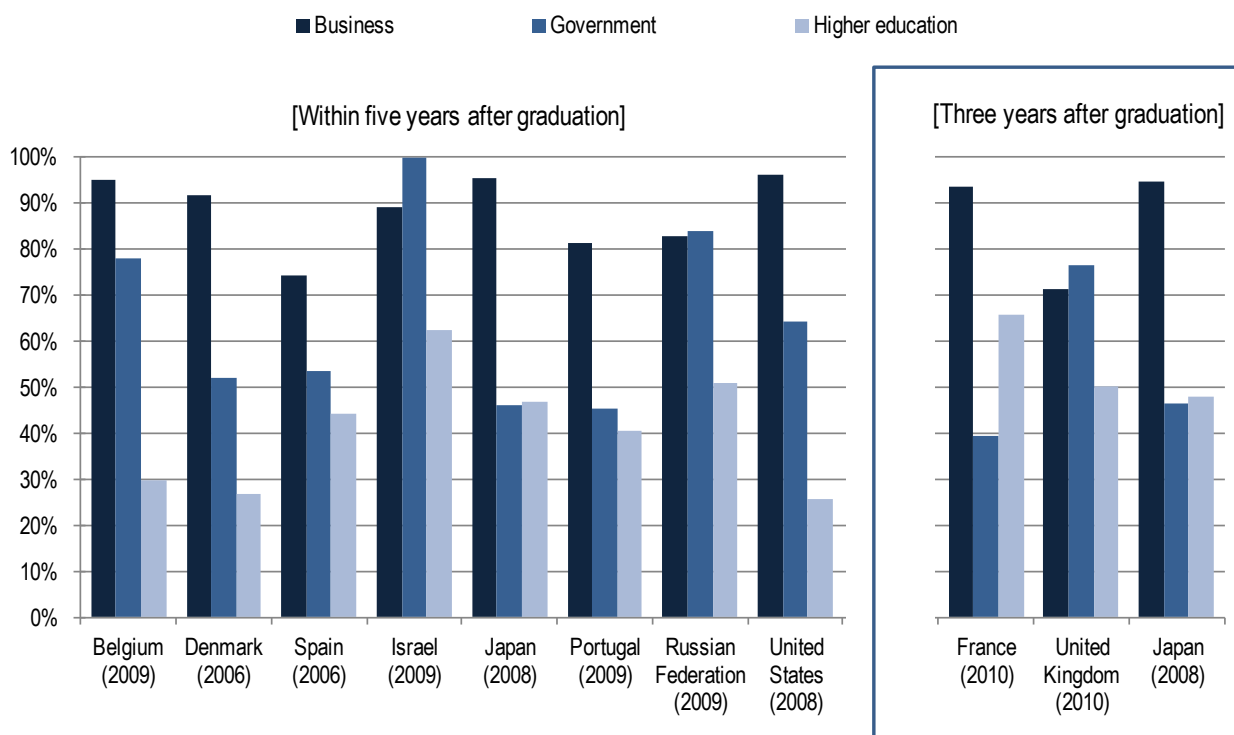
4. The terms of indefinite contracts differ across countries depending on the existence of employment protection laws.

achieving a tenured research position at a university or public laboratory.⁵ This could lead to concerns about a potential deterrent effect on the take up of research careers.

However, the incidence of indefinite contracts among recent doctorates in the business sector has been more robust and this sector may have become an increasingly attractive destination.

In most countries, the concern about temporary positions for new doctorates appears to be mostly concentrated within the higher education sector, as seen in **Figure 7** below. For the majority of countries, the share of recent doctoral recipients engaged in research in the higher education sector who have permanent/indefinite contracts is below 50%. The share of researchers with permanent/indefinite contracts in the business sector is higher in all cases and is over 90% in Belgium, Denmark, France, Japan and the United States. This finding could be potentially interpreted as evidence that younger doctorates in the higher education sector are willing to forego some benefits, such as indefinite employment terms, for the prospective opportunity of securing a tenured position and other non-pecuniary benefits, as will be discussed below.

Figure 7. The incidence of indefinite contracts among recent doctoral graduates engaged in research
Percentage with indefinite / permanent contracts, by sector of employment



Notes: Estimates calculated for those whose contract types are known. Only doctorate holders who obtained an advanced degree from the reporting country are considered for better comparability. For France, only those graduates aged 35 years old or less were surveyed. For the United Kingdom, the *Frascati*-based sectoral classification has been approximated: all R&D firms are assigned to "business". For Japan, some higher education teaching personnel such as part-time lectures are also classified as researchers. Non-EU domiciled students are outside the scope of the survey for the United Kingdom. The research status was derived using a combination of information on employment sector and occupation, and the business sector combines 'Finance business and IT', 'Manufacturing', 'R&D' and 'Other sectors' and the government sector corresponds to 'Health and social work' and 'public administration and defense' for the United Kingdom. Belgian and the UK data are not weighted.

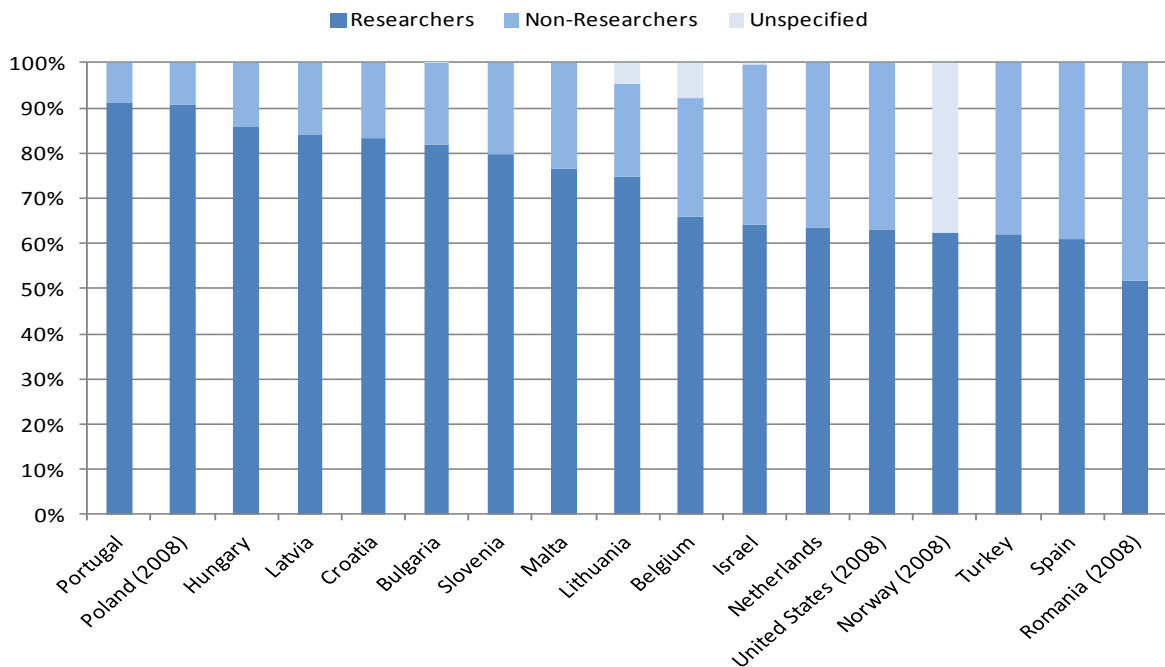
Source: OECD, based on ad hoc tabulations of CDH surveys and early destination surveys (EDS) from France, the United Kingdom and Japan, October 2012.

5. See for example: http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2012_07_06/credit.a1200075

A majority of doctorates work as researchers...

The structure of labour markets and the organisation of research systems have undergone significant changes which have contributed to traditional linear research career paths giving way to a more diverse range of career experiences. In the run-up to the economic and financial crisis, “job hopping” among the highly skilled had become more common and tenured positions in the academic sector declined in importance relative to temporary ones. With the high growth in new doctoral awards, some observers have wondered whether innovation systems are mature enough to create research positions that fully utilise the skills of the doctorate population. Considering these questions requires a better understanding of differences between doctorates employed as researchers and those who are not, evaluating for example to what extent occupations are related to the doctoral studies, satisfaction, pay and their evolution in the short to longer term. Across countries for which data are available, at least 50% of doctorate holders are working in research. In Portugal and Poland, more than 80% of doctorate holders work as researchers, whereas the shares are lower (close to 60%) in Belgium, the Netherlands and the United States (**Figure 8**).

Figure 8. Doctorates employed as researchers
As a percentage of employed doctorate holders

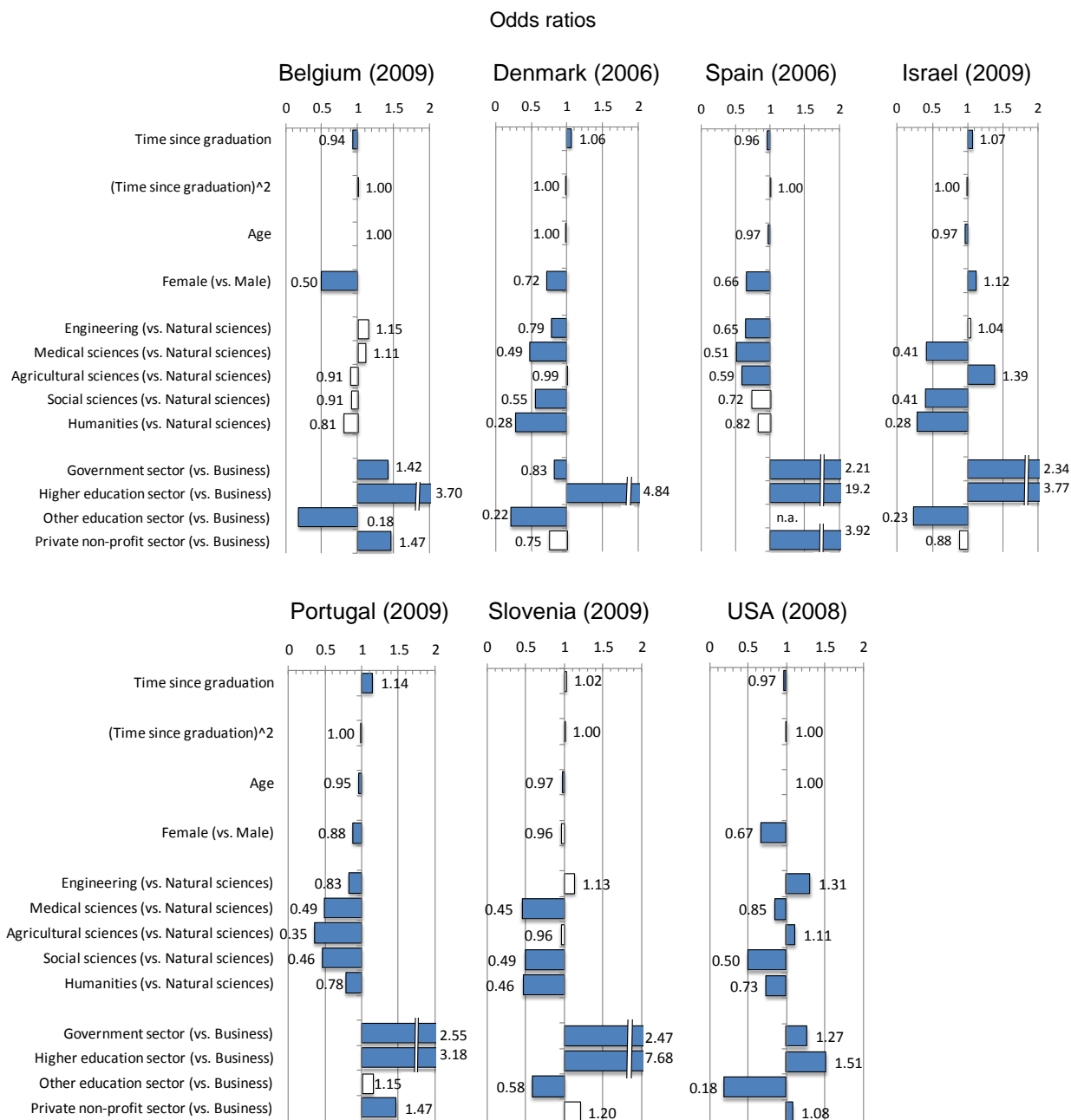


Source: OECD, based on OECD/UNESCO Institute for Statistics/Eurostat data collection on careers of doctorate holders 2010.
Notes: Data for Belgium, Hungary, the Netherlands and Spain refer to graduation years 1990 onwards. For Belgium, Malta and the Russian Federation, data for the 65-69 age class include doctorate holders aged 70 years and above. For Spain, there is limited coverage of doctorate holders for the years 2007 to 2009. Data for Turkey exclude foreign citizens. For the United States, data exclude doctorate holders who received their degree abroad and who received a doctorate in humanities.

... but there are significant differences across types of doctorate holder, particularly according to gender and field of study.

Doctorate holders in the natural sciences and engineering are the most frequently employed as researchers, except in Portugal and Poland where there are no obvious differences across fields and the share of researchers is high. By contrast, large deviations across fields of study exist in countries where a non-research career is more common.

Figure 9. Factors determining the probability of working as a researcher



Notes:

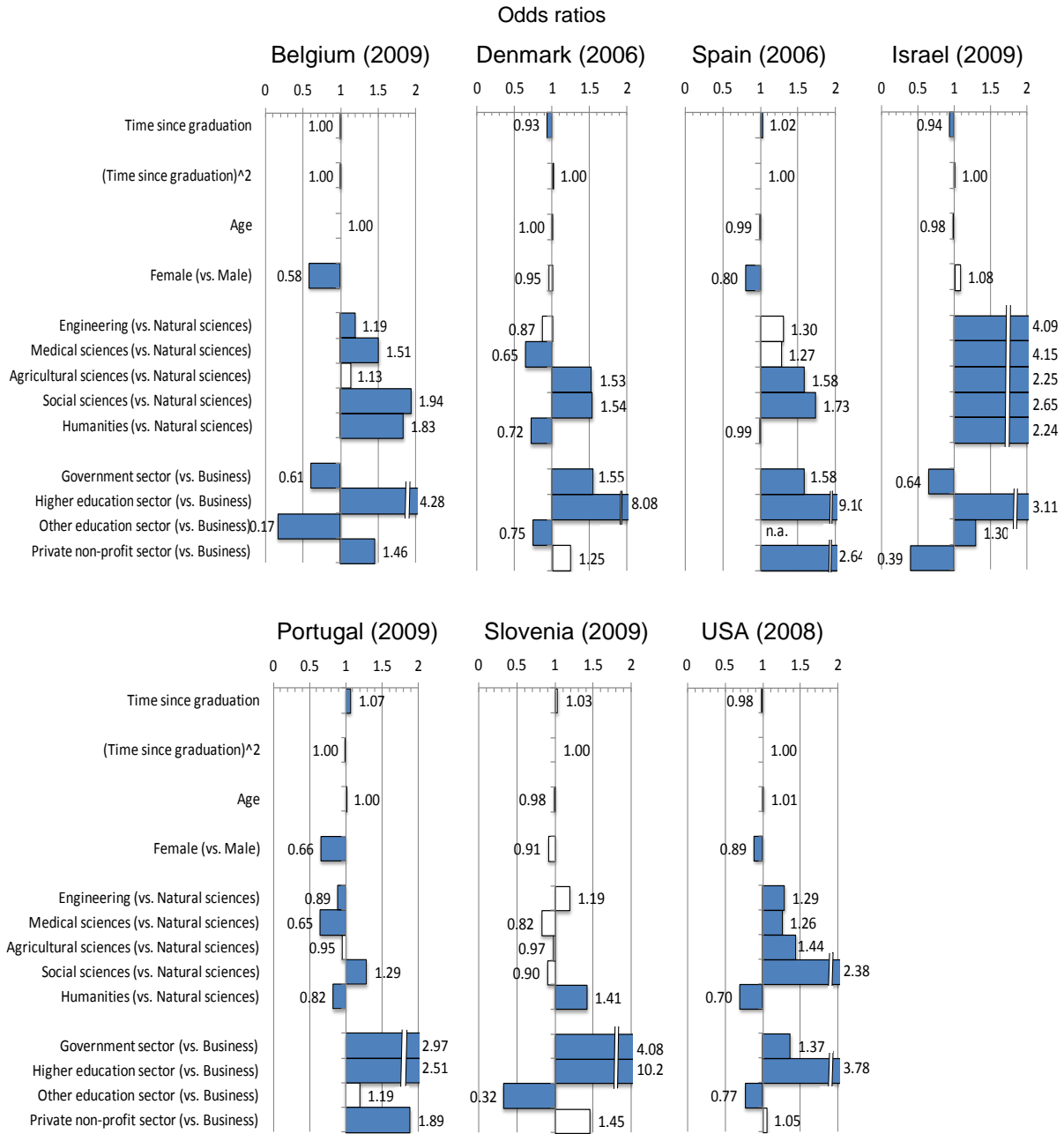
* The odds ratios from logistic regression analysis are shown and illustrate the odds of corresponding group of being a researcher relative to those of reference group, controlling for the other variables. For instance, for Belgium, the odds of being a researcher among doctorates employed in the higher education sector are 3.70 times higher than for those employed in the business sector.

* Filled boxes correspond to estimates that are statistically significantly different from one, with p-values less than 5 percent.

* For the United States, most individuals specialised in humanities are outside the scope of the survey.

Source: OECD, based on ad hoc analysis of CDH micro data, October 2012.

Figure 10. Factors determining the probability of holding a job related to doctoral study



Notes:

* Based on answers to question: "To what extent was your work on your principal job held on 1 December 2009 related to your advanced research qualification degree?"

* The odds ratios from logistic regression analysis are shown and illustrate the odds of corresponding group of holding a job related to doctoral study relative to those of reference group after controlling for other variables. For instance, the odds of social scientists getting a job related to doctoral study are 2.38 times higher than natural scientists in the United States.

* Filled boxes correspond to estimates that are statistically significantly different from one, with p-values less than 5 percent.

* For the United States, most of those specialized in the humanities are outside the scope of the survey.

Source: OECD, based on ad hoc analysis using the CDH micro data, October 2012.

Taking into account the various observed factors that relate to the probability of working as a researcher among those individuals in employment, it is apparent that as careers progress after graduation, individuals become more likely to do non-research jobs (**Figure 9**). In general, the share of research positions is higher for recent doctorate recipients in natural sciences and engineering and lower for those who studied humanities. However, differences by field of study become less marked after controlling for the sector of employment, with only a slight hint that graduates in the natural sciences are more likely to work as researchers. The analysis also confirms that individuals who work in the higher education sector are significantly more likely to work as researchers and that it is individuals in the business sector that are least likely to do so.

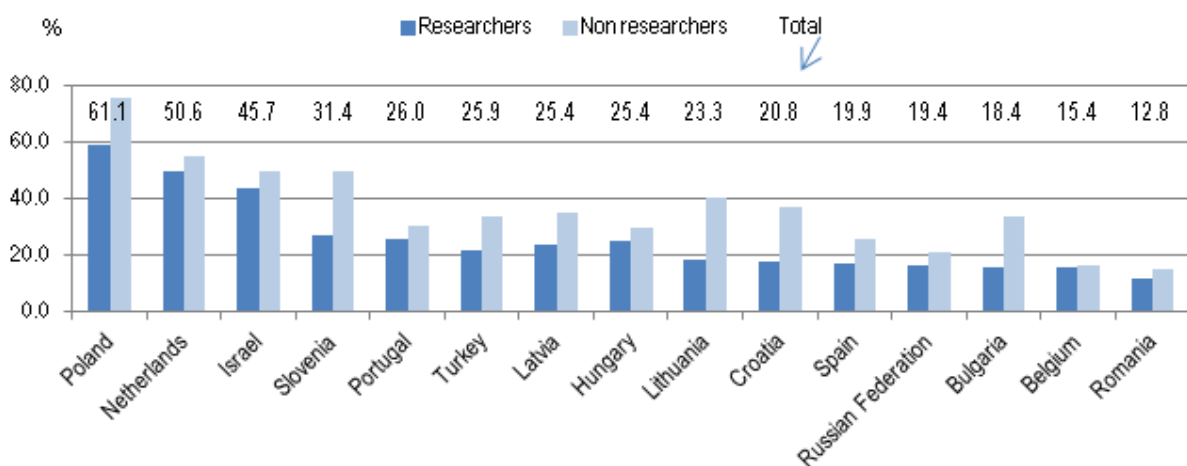
Many doctorates who do not work as researchers have jobs that relate to their studies, suggesting that doctorate degrees may be valuable in the marketplace for purposes other than research.

Female doctorate holders are systematically less likely to work on research, a finding that is also replicated when looking at whether one’s job is related to one’s doctoral studies, even if it does not involve research. Denmark is a notable exception, with women being just as likely as men to hold a job related to their study. Graduates in the social sciences, although less likely to work as researchers, are the group whose job is most likely to be closely related to their study topic. This suggests that skills and knowledge acquired through doctorate studies are used for activities other than research (**Figure 10**).

Job mobility patterns differ markedly across countries, potentially reflecting differences in their research and innovation systems and labour market conditions.

CDH data can be used to document the mobility of individuals with doctorate degrees, a priority question from the perspective of sponsors of PhD programmes whose objective is to maximise the social and economic benefit of their public investment in training researchers. Voluntary mobility can be expected to improve the quality of the match between doctorate holder and employee and promote knowledge transfer. However, mobility may also be the outcome of unintended separations and represent the breakdown of a stable match, for example as a result of a business closure, or reflect career instability and low attachment.

Figure 11. The job mobility of doctorate holders
Percentage of doctorate holders who changed jobs in the last 10 years, 2009

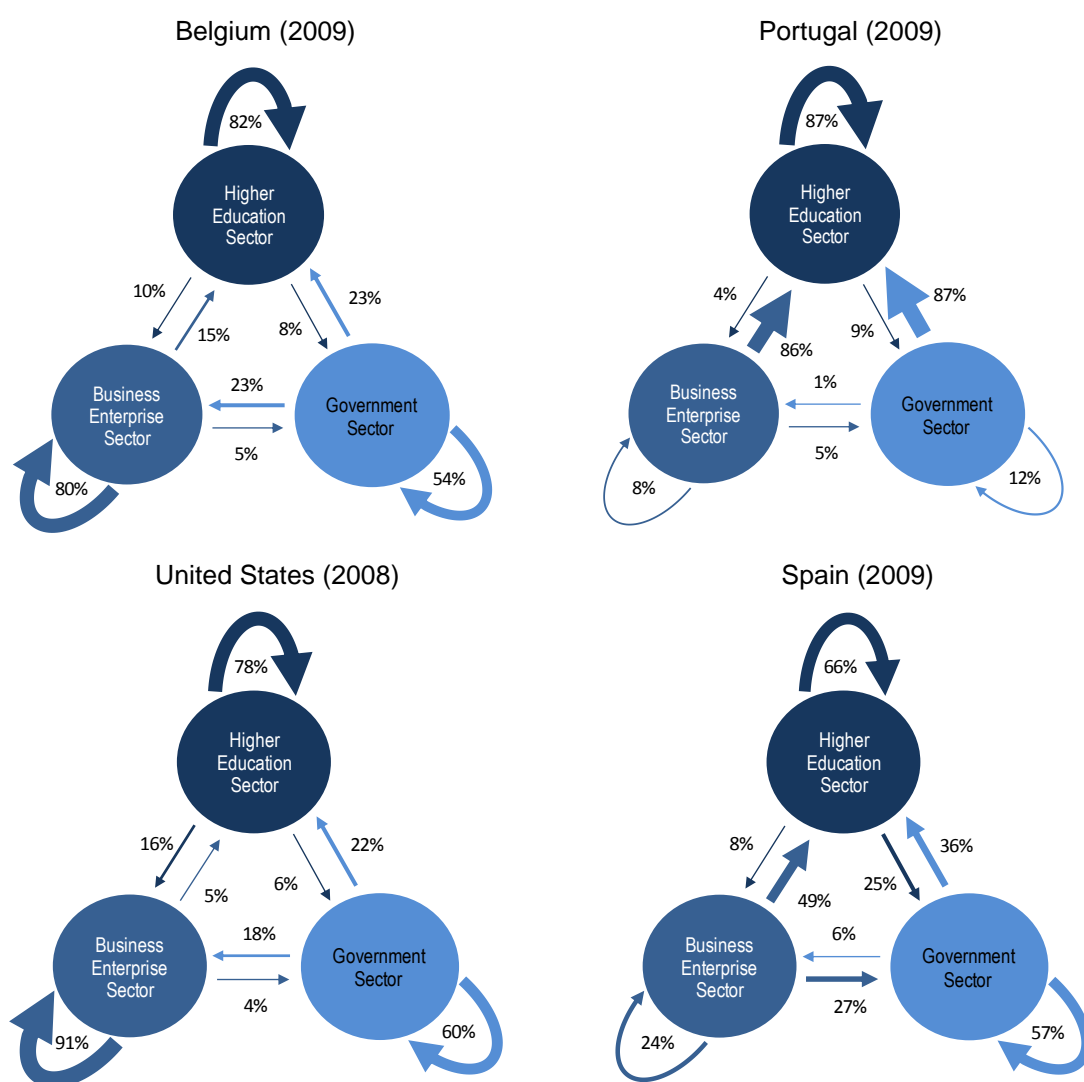


Notes: Data for Belgium, Germany, Hungary, the Netherlands and Spain refer to graduation years 1990 onwards. For the Russian Federation, data relate only to those doctoral graduates employed as researchers and teachers. For Spain, there is limited coverage of individuals who graduated between 2007 and 2009. Data for Turkey exclude foreign citizens.

Source: OECD, based on OECD/UNESCO Institute for Statistics/Eurostat data collection on careers of doctorate holders 2010.

CDH data show that, on average, one out of four doctorate holders have changed jobs over the past ten years. Doctorate holders from Denmark, Poland, Netherlands, Israel and Slovenia rank amongst the most mobile, and Belgium, Russian Federation and Spain amongst the least mobile. Doctorate holders who work as researchers are found to have been less mobile than their counterparts who do other types of jobs (**Figure 11**). As careers progress and available opportunities, circumstances and personal preferences change, individuals are likely to drift away from research into other types of occupations. For those doctorate holders who have changed jobs, the evidence points to major differences in the nature of job moves across countries.

Figure 12. Patterns of past job mobility of doctorate holders working as researchers, by sector of activity
Percentage of intra and inter-sectoral job moves, for those having moved jobs in last ten years



Notes: For the United States, as a proportion of job moves in the previous two years. Inter- and intra-sectoral mobility rates are calculated for those engaged in research activity in December 2009 and employed in three main sectors at both periods (current and previous employment). Job moves within sector and flows out of one's sector add up to 100%.

Source: OECD, based on DGEEC calculations using CDH OUTPUT tables, October 2012.

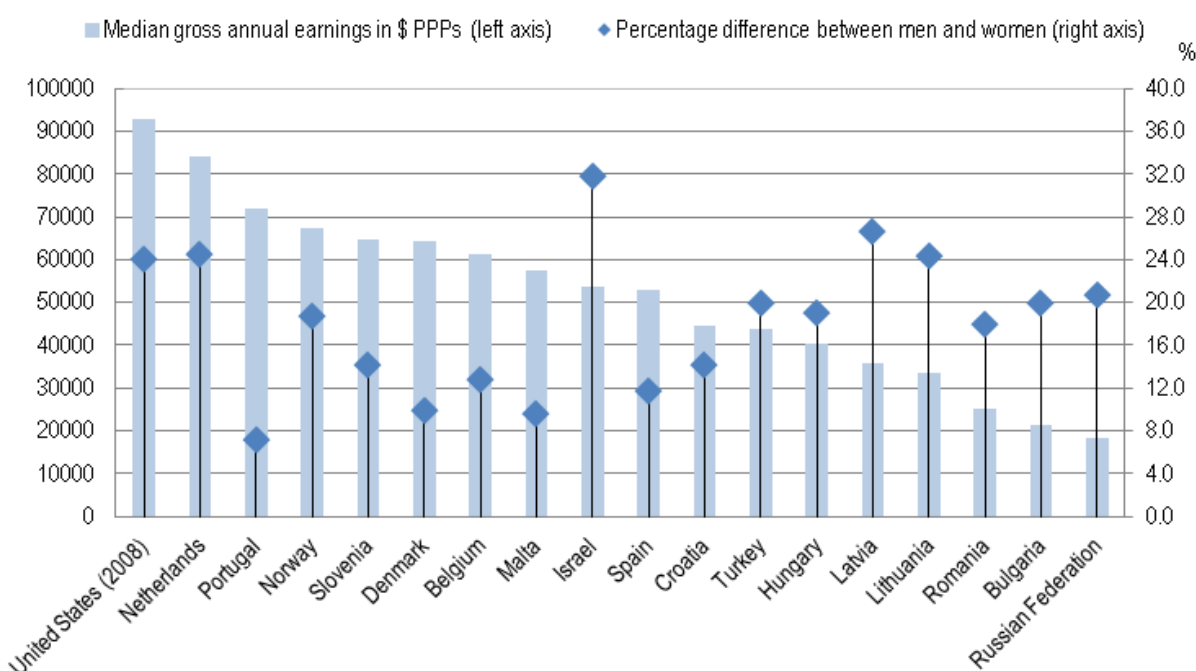
Although most mobility occurs within sectors, among job movers, this is far more likely to be the case in countries like Belgium and the United States than in others like in Spain and Portugal, particularly outside the higher education sector (**Figure 12**). Mobility also appears to be more prominent from the business

enterprise sector to the higher education than the other way around, with the exception of the United States and the Netherlands.

Earnings levels vary across countries and may incentivise international mobility.

The expected level of earnings may be a key determinant in the choice of a particular career path prior to and after completing doctorate studies. Earnings differentials between sectors of employment and between countries may also influence preferences for specific occupations or where to reside.

Figure 13. Median gross annual earnings of doctorate holders
USD PPPs, 2009



Notes: Figures are in US dollars adjusted for differences in purchasing power (parity) (PPP). Data for Hungary, the Netherlands and Spain refer to graduation years 1990 onwards. For the Russian Federation, data relate only to those doctoral graduates employed as researchers and teachers. In this case, earnings for doctorates working as managers would be excluded for example. For Spain, there is limited coverage of doctorate holders who graduated between 2007 and 2009. Data for the United States exclude doctorate holders who received degree abroad and who received a doctorate in humanities. Source: OECD, based on OECD/UNESCO Institute for Statistics/Eurostat data collection on careers of doctorate holders 2010.

Data on earnings show that wide variations exist in the level of median gross annual earnings of doctorate holders across countries, ranging from 18 306 US dollar PPPs in the Russian Federation to 93 000 in the United States, i.e. a factor of 1 to 5. The least paid doctorate holders can be found in Central and Eastern European countries (with the exception of Slovenia), while the highest median gross annual earnings are found in the United States and the Netherlands (Figure 13).⁶ International differences can be expected to act as drivers of international mobility. It is therefore unsurprising to find that the United States continues to be a major focus of attraction for internationally mobile doctorate holders. The United States has been for several decades a magnet for the research community worldwide, offering particularly attractive infrastructure and working conditions. Complementary data on migration to the United States reveal that there were around 610 000 foreign-born doctorate holders in this country in 2005-2009 representing 27%

6. These headline figures are not adjusted by differences in hours worked, which could push down the average earnings for countries with higher shares of part-time employees, nor differences in the experience or skills of the doctorate population.

of the total population of doctorate holders and an increase of 38% compared to 2000. Half of these were born in Asia and 28% in Europe. Close to 100 000 doctorate holders were born in China, of which 40% have US citizenship. The Russian Federation, Bulgaria, Australia and New Zealand have seen their number of native citizens acquiring US citizenship double over this period. The share of native-born who acquired US citizenship has remained stable for Canada, Germany and South Africa and has decreased for two out of five countries, indicating that doctorate holders originating from these countries come essentially for temporary mobility reasons.

Descriptive statistics also show that women earn less than men and in some countries the difference is close or above 25%. At the sectoral level, the difference between male and female median gross annual earnings is most marked in the business enterprise and government sectors. The differential exceeds 20% for the Netherlands Turkey, Bulgaria, Hungary, Slovenia, Malta and Portugal in the business enterprise sector, and Latvia, the Netherlands, Lithuania, Russian Federation and Malta in the government sector. These earnings differences become smaller but remain statistically significant after controlling for observable characteristics, as revealed by the coefficient on female doctorate holders in **Figure 14**.

Multivariate analysis of wage differences reveals a number of interesting patterns and country differences, relating to gender and research premia, experience, sector pay, field of study, part time and temporary work...

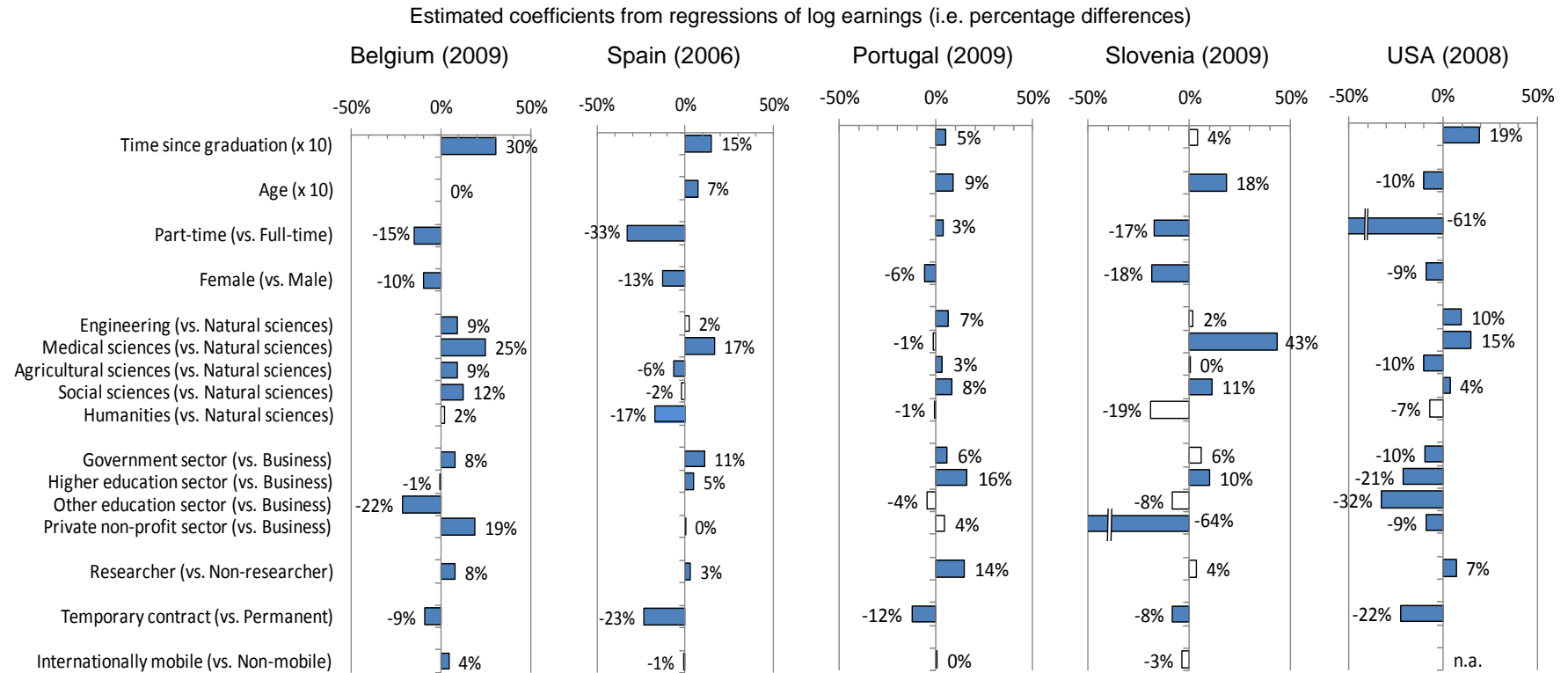
A number of regularities have been identified in the data, both in descriptive statistics and through regression analysis carried out for selected countries (**Figure 14**), controlling simultaneously for a wide range of individual and job characteristics, including time elapsed since graduation. Gross annual earnings of doctorate holders employed as researchers systematically exceed those of non-researchers, although this “premium” varies across countries. For example, the United States and Belgium appear to place a higher premium on being a researcher than Spain and Portugal. Conforming to expectations, doctoral researchers are typically better paid in the business sector than in higher education. After controlling for other characteristics, the gap is nearly 25% for the United States, a country where academic pay is considered to be large, while in Spain and Portugal, pay appears to be higher in the higher education sector. This would be consistent with the earlier findings concerning inter-sectoral mobility into the higher education sector. Further analysis would be required to understand whether the public sector pay levels are leading to crowding-out or whether demand for doctorates in their business sector lags the demand levels found in other countries.

There are also variations by fields of science. For example, median earnings of doctoral graduates in agricultural sciences and humanities are below the overall median in most countries, whereas doctorate holders in medical and health sciences are generally paid above the overall median. As expected, doctoral graduates on part-time and temporary positions are likely to earn less than those who have indefinite/permanent contracts.

... and international mobility.

The experience of international mobility appears to be positively associated with higher earnings in the case of Belgium, while that is not the case of Spain and Portugal. This lack of an effect is surprising after controlling for other factors, as it reveals that the investment in international mobility are not compensated by higher pay in these countries.

Figure 14. Differences in annual earnings



Notes:

* Results based on ordinary least square regressions of log annual earnings on individual and job characteristics.

* Filled boxes correspond to statistically significant estimates with p-values less than 0.05.

* For the United States, most of those specialised in humanities are outside the scope of the survey.

Source: OECD, based on analysis of CDH micro data, November 2012.

The international mobility of doctorate holders has been increasing but remains low, reflecting potential barriers. Mobility facilitates research collaboration but is not necessarily reflected in higher earnings.

In a world in which research is carried out on a truly global basis and personal transport is more affordable than ever, it might be expected that most researcher doctorates should have been exposed to an episode of international mobility in order to draw upon expertise in leading research organisations.⁷ CDH data reveal that, on average, 14% of national citizens with a doctorate degree have had at least one experience of international mobility of three months or longer over the previous ten years. Individuals in countries that host world-leading research organisations may perceive a lesser need to move abroad. However, a number of barriers, including economic and personal costs, language differences and lack incentives may explain this apparently low mobility rate.

The main destinations reported in the data refer to the United States and large European countries as the main destinations of internationally mobile doctorate holders. In most cases, this mobility has been a “one-off” event.⁸ CDH data show that academic reasons are typically cited as the main reason for having gone abroad. Results from the analysis of CDH micro-data show that, for Belgium, Portugal, Spain and the Russian Federation, doctorate holders employed in the higher education sector, those engaged in research, those specialised in natural sciences and those with temporary contracts exhibit the highest levels of international mobility. The same holds true for those who recently received their doctoral degree, except in the cases of the Russian Federation and Spain.

Further evidence is needed to understand the relationship between career promotion and international mobility, for example the extent to which academic tenure decision processes encourage mobility. Mobility can have personal, economic and transaction costs which should be in principle compensated by improved career prospects from increased interaction with centres of research excellence found elsewhere, but mechanisms may not be in place to fully facilitate the exploitation of the benefits of mobility. For example, by moving abroad, individuals may lose the right to opt for jobs in their home institutions, relative to those who stay. Some institutions address this problem by precluding the hiring of incumbents or by including the requirement of mobility as a requirement for hiring.

CDH data from Belgium indicate that international mobility experience is related to the propensity to engage in international research collaboration. Unfortunately, this finding cannot be currently corroborated for other countries but could be evaluated in the future by (confidentially) linking survey and scientific publication data for researcher doctorates.

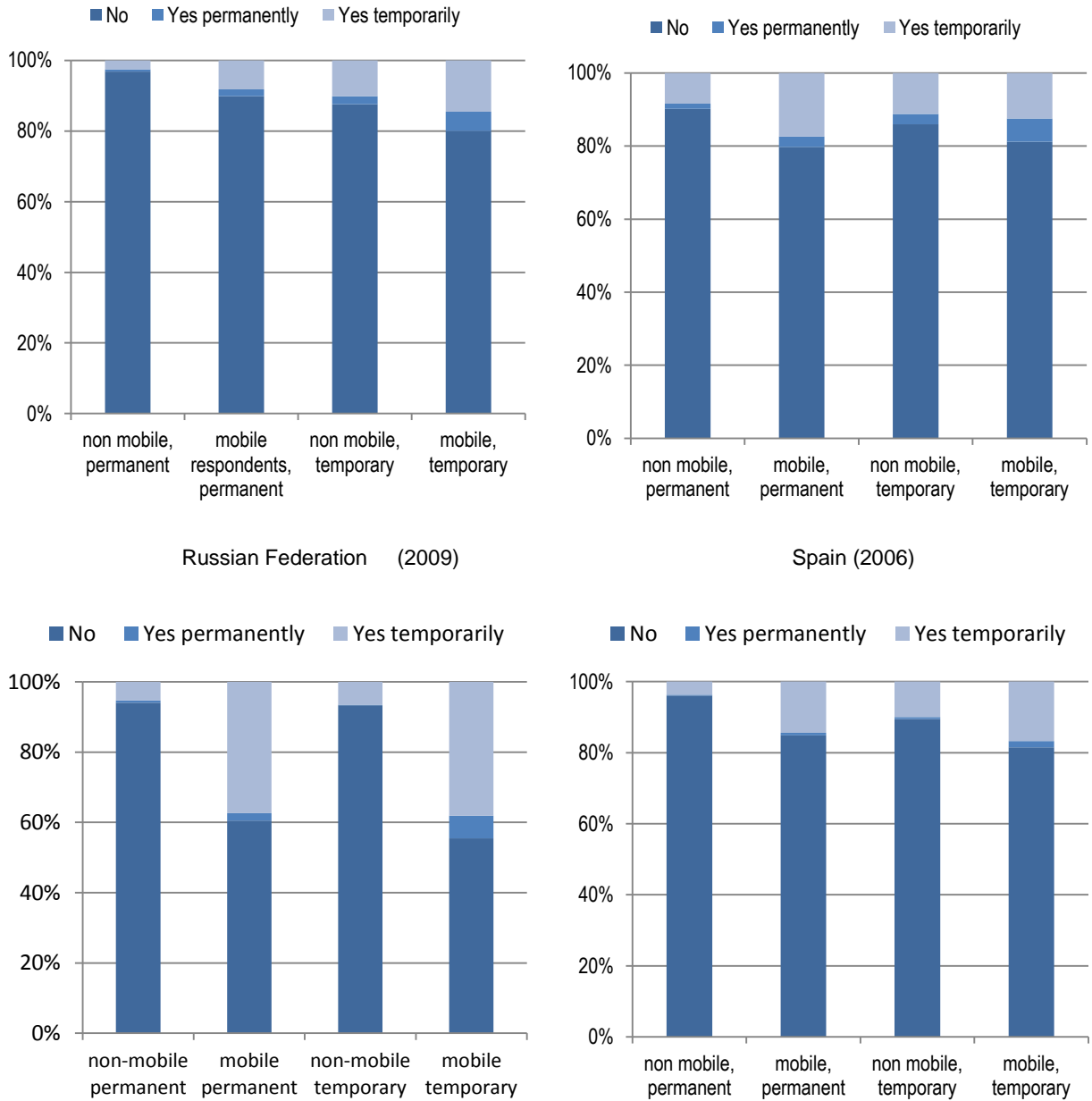
International mobility begets further mobility, and is primarily intended for a limited period of time.

Micro data analysis shows that, across all countries, temporary contract holders are more likely to report an intention to move abroad (**Figure 14**). Interestingly, it appears that those with past mobility experience are more likely to consider going abroad another time, which could indicate an idiosyncratic preference for mobility within this group, or the possibility that a prior experience demonstrates benefits of mobility. This finding is consistently found for all countries for which data are available, it applies to those on temporary and permanent contracts and it is confirmed by multivariate analysis, controlling for other personal characteristics.

7. A recent OECD report shows that one third of all recent immigrants to the OECD were tertiary-educated (<http://www.oecd.org/migration/49205584.pdf>).

8. This type of finding needs to be interpreted with some caution, as it could be a consequence of limitations in the registers from which survey respondents are drawn. Permanent movers would cease to be captured in surveys carried out in the origin country, while these may fall outside the sample frame for the receiving country’s survey if for example registers are based on domestic graduation records. By design, the number and length of spells abroad are truncated by the length of individual careers and the fact that these figures are conditional on doctorates having returned.

Figure 15. Doctorate holders' intentions to move abroad in the following year
 Percentage intending to move, by past mobility and type of contract



Notes: Data for Belgium and Spain refer to graduation years 1990 onwards. For the Russian Federation, data relate only to those doctoral graduates employed as researchers and teachers. For Spain, there is limited coverage of doctorate holders who graduated between 2007 and 2009.

Source: OECD and CSIC, Spain, based on ad hoc tabulations from careers of doctorate holders surveys, November 2012.

In Belgium, Portugal and Spain, these results also show that the likelihood of reporting an intention to move abroad is higher for men and recent doctorate graduates. In Portugal and Spain, intentions to move abroad diminish when income levels increase, potentially reflecting a higher opportunity cost of mobility.

In general, the share of doctorate holders planning to move abroad on a temporary basis is higher than that of those planning to move out permanently, which is another indication of the temporary aspect of international mobility.

Doctoral graduates are generally satisfied with their employment situation.

In addition to previously-reported information on salaries, research occupations and relatedness to study, responses to CDH survey questions on job perception and satisfaction can also be used to evaluate how the experiences of doctoral graduates differ according to personal and job characteristics. Overall, doctorate holders are satisfied with their employment situation. Satisfaction levels with intellectual challenges and with opportunities for advancement are markedly higher for those working as researchers. On the other hand, satisfaction levels with regards to salaries and benefits are lower than with other criteria, suggesting that a significant number of doctorate holders are foregoing some economic benefits in return for doing jobs they find otherwise more rewarding.

The research skills of doctorate holders are those that are most valued on the labour market

In Belgium, an additional module on researchers' competencies was added to the standard CDH questionnaire and its findings were compared to different kinds of data collected elsewhere in OECD countries. The results confirm the findings of other studies: assets directly related to research rank high, as do self-management skills and personal attitudes such as working independently, taking initiative and being eager to learn. Possible explanations for the discrepancy between what PhD graduates learned during the doctoral programme and their experience in the job were addressed. PhD graduates in Belgium from various disciplines and employed in sectors in or outside academia perceived their experiences and needs differently. Perhaps surprisingly, the type of competencies identified by doctorate holders as highly required in their jobs, does not differ very much across sectors of employment, in particular not when asked about team skills, communication skills and personal effectiveness. The largest variation between sectors can be observed in management skills, which seem to be most important in industry. With regard to research skills, the demands of a university environment are obviously larger than those in other sectors.

Concluding remarks

The CDH initiative has been continuously evolving and learning from previous experiences over its relatively short history. The international comparability of CDH results hinges on the practical solutions adopted on a country-by-country basis to address survey resource limitations, gaps in doctorate registers and the challenges in tracing doctorate graduates, a highly mobile population. This note has attempted to put the project's key findings in a broader context and highlight where the evidence is stronger and where the results need qualifying for such methodological differences.

Most importantly, the results presented in this document aim to showcase the potential of CDH data to inform policy questions that bear on the labour market and careers of doctorate holders and researchers. This potential goes beyond the mere analysis of tabular results, but also involves the use of micro-data based econometric methods to identify systematic patterns in the data which underpin overall differences. This type of analysis has shown, for example, that only part of the gender bias found for earnings can be explained by observable characteristics, or that the impact of international mobility on earnings greatly varies across countries and may reveal some fundamental, structural differences.

By demonstrating the feasibility of carrying out a wider range of possible analyses among a reduced set of countries, this project has also attempted to make a strong case for improving researchers' access to data on doctorate holders with a view to promoting the coordinated use of micro-data across countries and

conduct more in-depth analyses of the factors shaping career choices, labour market mobility and individual performance, linking whenever possible to other available databases.

Carrying out the analyses summarised in this note and in a future report has required extensive efforts by participating experts to overcome a wide range of barriers to render the data accessible and suitable for analysis. This would not have been possible without the goodwill and relentless efforts made by partnering organisations. Some best practices have also been identified, for example cases in which the data has been anonymised and made publicly available. Future survey collections should foresee the future analytical and research intended uses of the data, secure the necessary consents and provide the necessary infrastructure. In their absence, data collected at a high expense to taxpayers could be left unused, a luxury that countries can ill-afford.

CDH data should be considered as a critical but not exclusive source of evidence on the policy questions of interest regarding doctorates and research careers. This note has equally outlined the importance of utilising mainstream household data sources such as census and labour force data. This requires an explicit effort to capture information on the educational attainment of individuals at a sufficiently detailed level. In many countries, there is room for using employment registers to trace mobility with much higher accuracy than at present. Business surveys could potentially inquire about the employment of individuals at the doctorate level to help inform the analysis of the demand for doctorates. The emergence of the internet and the wealth of information available from social networks of professionals should also provide an additional, much needed tool for improving the quality of registers upon which CDH surveys are based. More hypothetically, they could also provide complementary and timely information on key phenomena of interest. Further work should be carried out to assess the statistical properties of such sources.

Throughout the project, a number of topics have raised particular interest among the participating research teams, pointing to future areas of survey development for testing. Indeed, the changing economic environment, the increasing diversity of career patterns and the changes in the organisation of the research landscape may require the use of a different and broader set of skills. This dimension needs to be measured and analysed with the appropriate tools. The revised methodological guidelines and model questionnaire include proposals for capturing information that is relevant to these questions. CDH data can also provide a useful tool for analysing the contribution of doctorate holders to entrepreneurship. There is increase interest in the phenomenon of academic entrepreneurship; and observers have also noted the importance of doctorate training for individuals who started, but never completed their doctoral studies as they chose to develop their inventions by starting up new businesses. .

In conclusion, existing CDH data should be made more openly available for analysts and decision makers in order to judge which analysis, findings and recommendations can be supported by evidence. It is only through continued effort, drawing from best practices in the compilation of labour, STI and skills statistics that a robust evidence base will ultimately facilitate an improved understanding of the role played by doctorates in the innovation system and the broad knowledge economy.

CDH-KNOWINNO PROJECT CONTRIBUTORS

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FOR FURTHER INFORMATION

For more information about the OECD's work on statistics on human resources for science and technology and the careers of doctorate holders, please contact:

Laudeline Auriol, Tel.: + 33145249205, e-mail: Laudeline.Auriol@oecd.org or visit: www.oecd.org/sti/cdh