Meta-analysis of gender and science research

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Topic report
Science as a labour activity

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Maria Caprile
Núria Vallès

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1. INTRODUCTION

This report deals with the underlying causes of gender segregation in science related with the organisation of work and the difficulties of balancing professional and personal lives. The 'work-life' conflict is one of the most commonly held explanations for the under-representation of women in science, particularly in senior positions. This report intends to provide a critical insight on the literature on this theme.

Women face a conflict between their professional and family roles in all kinds of occupations and this conflict tends to be sharper in the highly skilled professions: they are more time-demanding and the cumulative impact of caring breaks over professional opportunities is higher, in terms of foregone earnings, skill erosion and lost seniority. From this perspective, is science distinct to other highly skilled professional settings? First, gender segregation is higher in science and the engineering professions: they seem less responsive to the social forces that are successfully leading to progress towards gender equality in other professions. And secondly, this trend is clearly at odds with the scientific ethos of universalism and meritocracy: if universalism and meritocracy were the actual rules, gender inequality would be less prevalent than in other professions.

Most studies emphasise that gender differences in scientific careers are decreasing for more recent cohorts. This, nevertheless, does not mean that women have equal opportunities to attain academic status equal to that of men. Literature points to two basic explanations for this fact. One is the role conflict, the other is subtle discrimination. Needless to say, it is comfortable for scientific institutions to deny the existence of any kind of gender discrimination and explain women's under-representation in senior scientific positions in terms of unequal performance – women would be less productive than men because of greater family commitments. However, empirical evidence confirms the existence of discriminatory practices and shows a far more complex picture, in which subtle forms of discrimination are closely connected to time and mobility constraints.

Structural barriers and subtle discrimination

This report tries to distinguish between structural barriers and subtle discrimination. Subtle discrimination is based on prejudice against women, albeit often unintentional and implicit, and leads to the unequal treatment of men and women. It may affect the procedures of selection and recruitment, the relationship with mentors and peers, the distribution of resources, the allocation of tasks or the system of evaluation and promotion (Osborn, et al., 2000). However, the advancement of women in science is also hindered by systematic structural constraints: namely, seemingly neutral practices of recruitment, tenure and promotion that are based on a model of the ideal scientist which is built on the assumption of an unlimited and uninterrupted commitment to science. The model still fits some men but is increasingly unsuitable for both men and women who need or want to participate in other activities (NAS, 2007).

The analytical distinction between subtle discrimination and structural constraints is useful in addressing the role conflict. The paradox of women in science is that they have to face a much more severe conflict between their family and professional roles than their male colleagues – because of structural constraints in the scientific system and the gender division of labour in society. Some of them choose a family: they move away from science, make a halt in their career or pursue a non-conventional path. Others choose science: they remain single or decide not to have children, or rely on external support for care giving. And finally, others choose both, making additional efforts to combine career and family commitments. However, they are not treated and judged like their male colleagues: the playing field is not level – because of prejudice and gender bias.

Box 1 – Promoting excellence through mainstreaming gender equality: ETAN report

"Women constitute half the undergraduate population. However, there is a continuous drop in the numbers of women at each level of the academic ladder and many highly trained women are lost to science. Institutions that employ scientists tend to be behind the times in addressing the life/work balance and need to modernise.
Old-fashioned practices characterise employment and promotion procedures in some of our academic institutions. Reliance on patronage, the 'old boys' network' and personal invitations to fill posts cuts across fair and effective employment procedures. More sophisticated means of assessing merit are recommended".

Osborn, M., Rees, T., Bosch, M., Ebeling, H., Hermann, C., Hilden, J., McLaren, A., Palomba, R., Peltonen, L., Vela, C., Weis, D. and Wolh, A. 2000, *Science policies in the EU: promoting excellence through mainstreaming gender equality. A report from the ETAN Expert Working Group on Women and Science*, Office for Official Publications of the European Communities, Luxembourg, pp. viii-xix.

Leaky pipeline versus life course approach

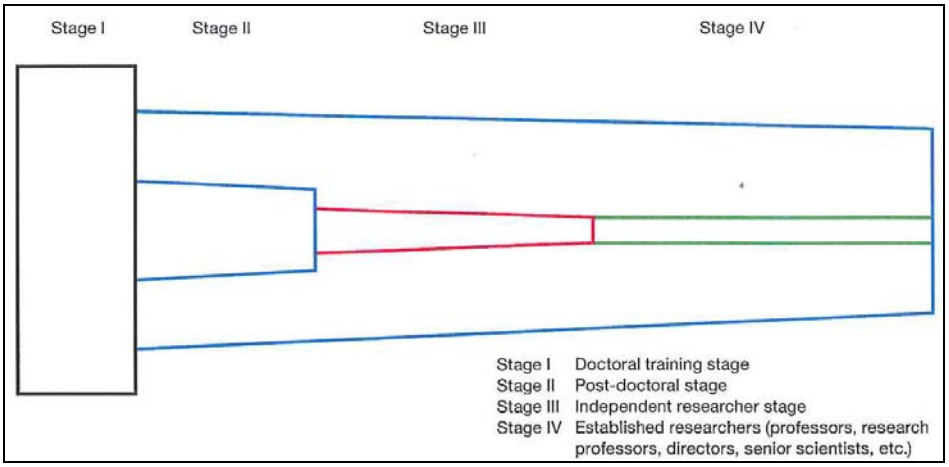
Ever since Berryman (1983) introduced the metaphor of the 'leaky pipeline', this conceptual approach has dominated the scientific literature on women in science. According to this perspective, the process of becoming a scientist can be conceptualised as a 'pipeline'. The science pipeline refers to the normative sequence of educational and employment stages that typically comprise a scientific career. From this point of view, the decreasing proportion of women rising up in the educational/professional hierarchy is attributable to women's higher rates of attrition from the science pipeline: at each moment of transition from one educational/professional stage to another, the pipeline loses more women than men.

The pipeline approach has significantly enhanced empirical research on gender disparities across the whole process of becoming a scientist, instead of focusing on the individual stages. However, the metaphor of the leaky pipeline has been object of criticism in that it is an approach that neither covers the complexity of the educational, professional and vital processes involved in being a scientist, nor those trajectories that move away from the normative linear career (Langberg, 2006; Xie & Shauman, 2003). "Whereas the pipeline perspective assumes the science career to be an exceptionally rigid structure, the life course perspective allows for a more multidimensional and nuanced understanding of career processes and outcomes. In a nutshell, the life course perspective posits that the significant events and transitions in an individual's life are age-dependent, interrelated, and contingent on (but not determined by) earlier experiences and societal forces" (Xie & Shauman, 2003, p. 12). The life course perspective raises new research questions and opens new lines of research in order to analyse how certain configurations of factors lead some individuals, but not others, to believe that the scientist's role is desirable and attainable, to maintain and act on this belief through an extended period of the life course and why this classifying of individuals into science and non-science pools so neatly divides along gender lines.

This report attempts to overcome some of the limitations of the leaky pipeline approach, paying special attention to the interrelation between personal and professional events at each stage of the life course, the cumulative effect of positive and negative effects that shape scientific careers and the existence of professional trajectories that do not follow the normative scientific career.

Academic and non-academic careers

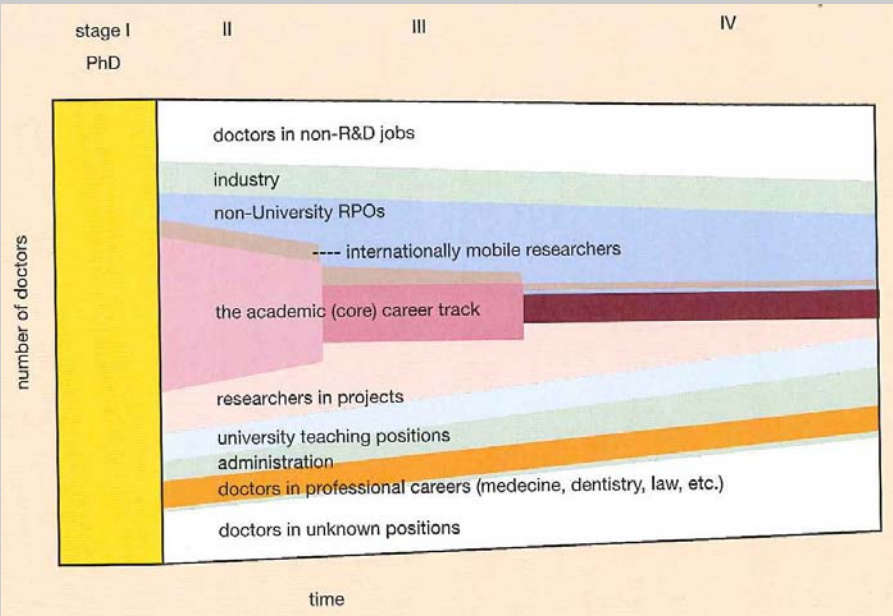
A scientific career is not just an 'excellent' academic career that culminates in a full professorship in the university or a similar position in institutions of high research productivity. Other career paths in universities, research institutes and industry also form part of the context of the scientific career (ESF, 2009). Although scientific careers differ greatly between disciplines, institutions and national systems, the following picture shows what can be regarded as the basic structure of the scientific career path. Only the central section represents the academic 'excellent' career path, with a linear progression from the PhD to the senior scientist position.



Source: European Science Foundation 2009, *Research Careers in Europe. Landscape and Horizons*, IREG, Strasbourg.

It seems clear that a majority of PhD holders follow non-academic research careers and other professional paths, although the distribution of doctoral-level researchers in the different career paths is likely to vary across countries. Yet, "throughout the research career, current focus is on excellence (typically defined as top 5-20% of applicants), while the rest of those who have entered the research career receive very little attention" (ESF, 2009, p. 28). This fact has also gender implications. More women than men leave the 'excellent' academic career path and it also entails a larger proportion of women who follow other paths in universities, research institutes, industrial R&D, or other science and technology related professions. Although research on gender segregation in science focuses on the academia, this report understands the scientific career in its broader context and intends to review the literature that explores the situation of women who do not follow the normative academic career path.

Box 2 – Schematic illustration of the diversity of research careers in the European Research Area (ERA) using Finland as a concrete example.



The ESF report made an attempt to quantify the proportion of PhDs that follow an academic career in Finland on the basis of official statistics and different surveys. Finnish universities annually award a total of approximately 1500 doctoral degrees. As the number of professors appointed annually is approximately 150, roughly 10% of the newly appointed PhDs can expect to attain a professorship.

[ESF] European Science Foundation 2009, *Research Careers in Europe. Landscape and Horizons*, IREG, Strasbourg.

Methodology and structure

This report is a meta-analysis of the academic literature on the topic 'science as a labour activity' included in the 'Gender and Science Database' (GSD). National experts in the 27 European Member states and 6 FP7 associated countries were in charge of selecting the most relevant national literature from 1980 onwards and preparing an informed bibliography. National experts codified the publications according to the following conceptual dimensions:

- A first descriptive dimension, which includes three topics: horizontal gender segregation, vertical gender segregation and pay and funding.
- A second dimension dealing with the analysis of the gender bias in structural social dynamics that are reproduced in scientific work, which includes two topics: Stereotypes and identity and science as a labour activity.
- A third dimension, dealing with issues related directly to gender bias in the scientific culture and scientific institutional practices, i.e. scientific research as an activity with its own values, rules and dynamics. It includes two topics: scientific excellence and gender in research content.
- A fourth and last contextual dimension, dealing with the analysis of policies towards gender equality in research.

The meta-analysis of the literature has been developed on a sequential basis. The national experts were in charge of preparing a national report giving a comprehensive overview of the most important trends, findings and gaps. The second stage was the preparation of country-group reports, dealing with similarities and differences across countries. The third stage was the elaboration of topic reports, which are meant to offer a more systematic review of the literature concerned.

The methodology used for preparing this report can be defined as circular or iterative. In order to identify the most important subjects of research and discussion, an iterative methodology of constant re-elaboration and restructuring seemed to be the most rigorous scientific option. We did not want to undermine the meta-analysis on the basis of our particular conceptual approach to the topic, therefore anticipating any conclusions which might be drawn. The starting material was made up of the GSD publications that were classified under the topic 'science as a labour activity' (approximately 1,500), the 5 country-group reports and the 33 country reports. The analysis of this material followed an iterative process: the abstracts of these publications were analysed in order to identify relevant subjects of discussion and specific findings; these results were contrasted with the revision of national and country-group reports; the most relevant publications were studied in depth, usually providing further bibliography and elements for analysis. Abstracts, reports and original texts were in this way revisited from a different perspective, subjects reorganised, conclusions reframed.

We would like to stress that our analysis has, nevertheless, important limitations. The GSD literature varies in terms of scope and quality of the abstracts; original texts were not always available due to our language limitations and, as in any research, time constraints played a role.

The results of our analysis are presented as follows. After this introduction, chapter 2 provides a first approach to the literature analysed, on the basis of both the expert reports and the statistical analysis of the GSD entries. Conceptual, thematic, geographical and methodological trends are briefly summarised.

Chapter 3 focuses on structural constraints in the academic career. It reviews the literature that deals with the ideal scientist and the temporality of the scientific career, male and female scientists' difficulties to combine their professional and personal lives, and the disproportionate effect on women, in the context of the gender division of labour. First, we review the studies that deal with the 'family-or-science' dilemma and address the extent to which women have to make different choices to men concerning their personal and professional life courses. Secondly, we address the literature that analyses the relationship between 'demographic' variables and career outcomes.

Chapter 4 deals with subtle discrimination in academia. In this chapter, we review the literature that explores subtle discriminatory practices in academic institutions, that is in universities and prestigious public research institutes. To do so, research goes beyond the universalistic criteria and strict norms that govern the formal procedures of recruitment and promotion in academia, analysing power relations, gate-keeping practices and informal networks as a source of tacit knowledge, support and recognition. Two major themes emerge in our review of the literature: one is a lack of support and encouragement to women; the other the use of double standards in the assessment of merit in formal selection procedures.

Chapter 5 deals with non-academic research careers. Here, we review studies about structural constraints and subtle discrimination outside the academia, comparing academic and industrial scientific career trends.The overall picture of gender inequality in industrial research appears to be quite similar to that of the academia, although specific features related to career paths, work culture, work organisation and human resources management appear to be relevant.

Chapter 6 focuses on institutional changes and their ambivalent impact on gender. It addresses current trends of institutional changes, both in academic and non-academic settings, of particular relevance from the gender perspective. In this chapter we review the literature that deals with the restructuring of universities under new managerial criteria; the erosion of the hierarchy and individual competition in certain university departments and R+D firms; the development of technology transfer professions and, finally, the sociopolitical changes in

Eastern countries and their impact on gender relations and scientific careers. Finally, in the last chapter we present some concluding remarks and recommendations for further research.

The report aims to provide a comprehensive meta-analysis of the literature. While dealing with conceptual issues and methodological trends, it attempts to illustrate the main debates and findings through selected references to studies. These references are not meant to be exhaustive, but indicative of the kind of research developed. Similarly, boxes are used through the text to delve into specific issues. They usually contain an abstract from the GSD or a quotation from a study particularly significant in illustrating what is discussed in the text. Finally, the report tries to avoid excessive overlaps with other topic reports. We deal with the debate about gender and scientific excellence, but refer the reader to the 'Excellence' report for further details. The same holds for the 'Policies' report, as the bulk of the literature addresses both women's situation and gender equality policies.

2. RESEARCH TRENDS

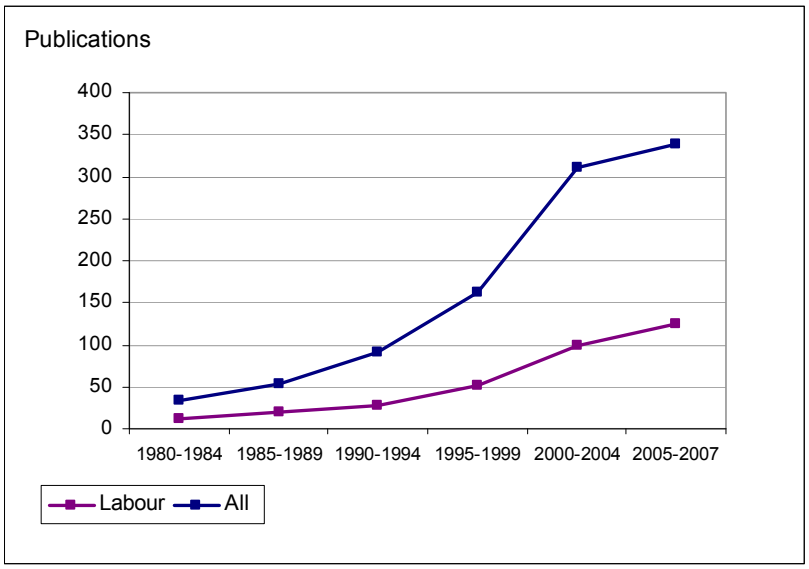
This chapter provides a general overview of trends in research, on the basis of the statistical analysis of the GSD and the expert reports. The GSD allows publications to be classified under different thematic and methodological criteria, including the main topics addressed; the institutional sectors, scientific fields and life-course stages analysed, the geographical and time coverage, the methodological approach and the kind of quantitative and qualitative techniques used. The main results of the statistical analysis of the GSD entries are presented and contextualised with the national and country-group reports.

Research on gender segregation in science has developed in close relationship to political debates and initiatives to foster women's advancement in science. While policy concern has gradually moved from women's recruitment to retention and career advancement, research has shifted from socialisation to organisational approaches, paying special attention to vertical segregation. The U.K. and Germany are the countries with the highest number of publications and both offer a rich strand of empirical research on labour-related issues from an organisational approach. Comparative research (across countries, scientific fields and institutional sectors) is scarcely developed. Overall, research focuses on academia and reflects the lack of systematic sex-disaggregated data on scientists and the difficulties involved in collecting personal and family information.

Conceptual trends

A total of 1,483 GSD entries are related to labour, which makes up one third of all the publications included in the database. This proportion is stable across the period analysed. As shown in figure 1, both GSD and labour-related entries experience a sharp increase as of the second half of the 1990s, which is parallel to the increasing number of policy initiatives undertaken by the European Union and some European countries at that time.

Figure 1 – Average number of publications per year



According to the experts' reports, research on gender segregation in science has developed in close relationship to the political debates and initiatives to foster women's advancement in science. Policy changes have been thoroughly conceptualised by Cronin and Roger (1999) and Glover (2001) on the basis of the U.K. and international developments into three successive positions, which loosely correspond to the three decades analysed in this report. They state that policy concern in the 1980s mainly focused on gender differences in the choice of study and

career. The reasons given for the low levels of women's scientific recruitment were based on theories of socialisation, contending that young women were discouraged from science by deep rooted ideas about science as being a 'masculine' field. Parents, teachers and peers' views contributed to forming very certain notions of the types of jobs which were suitable for either men or women. The policy initiatives which were developed to overcome these 'barriers' were mainly addressed to appeal to girls and challenge these stereotypes. Criticism towards this position emerged in the 1990s, contending that it was not enough to ask girls to change their perceptions and to 'fit in' to science: the nature of how science was taught and how jobs were organised also needed to be changed. Policy attention moved from entry and qualification issues to retention and attrition rates. In order to address women's needs and 'level the playing field' the policy focus shifted gradually from individuals to institutions and organisational procedures. Special attention was paid towards work-life balance issues and equal opportunities with respect to progress in the scientific workplace alongside men, free from harassment or gender discrimination. Policy debates during the 2000s emphasise the need to address the implicit and apparently neutral norms, values and standards of science and scientific institutions, including the epistemological basis of scientific knowledge.

Our review of literature reflects a similar shift in research, from socialisation to organisational issues. The initial focus was on gendered socialisation, how from an early age individuals internalise 'feminine' and 'masculine' roles that shape their educational and professional choices. From this perspective, a large bulk of literature on 'women and science' addressed women's biographies and subjective experiences, their ways to build a professional identity and solve conflicts in a male-dominated environment, how they managed to reconciliate their families and careers. The metaphor of the 'leaky pipeline' was understood mainly in terms of women's preferences and choices, even if socially shaped: women were said to be less professionally ambitious than men and prioritised their family over their career. Overall, the explanations for the under-representation of women in science were searched for outside science and the scientific institutions. Stolte-Heiskanen (1988, see box 3) provided an early account of the main gaps of this strand of literature. On the one hand, most of the research on the problems and obstacles against women's careers in science focused only on women as such, without any systematic comparison of men and women scientists. On the other hand, the obstacles presented by the social organisation of science and the culture of the scientific community to women's equal participation did not receive sufficient systematic attention. Finally, very little was known about women scientists working outside the halls of academia.

Thanks, among other things, to feminism and women scientists' activism, the 1990s witnessed a gradual shift in research towards organisations and professions, their implicit norms and standards, institutional practices and power relations. In the late 1990s, attention to gender discrimination in academia was indeed fostered by two major 'scandals': the article by Wennerås and Wold (1997), which found evidence of sexism in the peer-review system in Sweden, and the report by the Massachusetts Institute of Technology (MIT), which admitted publicly having given less pay and resources to female than male scientists of equal seniority (MIT, 1999). Research put the emphasis on overt and covert discrimination against women, attempting to unveil the hidden mechanisms of male domination in scientific institutions (Bagilhole & Goode, 2001; Krais, 2000). The ETAN report (Osborn, et al., 2000) made a plea to overcome patronage and the 'old boys' network' in European academic institutions and implement more transparent and fair employment and assessment procedures.

Recent studies address the progressive differentiation of men and women's careers through both supply-side and demand-side factors. The overall picture is that there is no single-factor explanation for gender segregation in science. It has the same root causes as gender segregation in the whole labour market: choice of study field, stereotypes, the demand for shorter or flexible hours of work because of the unequal care burden and differential income roles, and covert barriers and biases in organisational practices (Bettio & Verashchagina, 2009). The life course perspective puts the emphasis on the interaction between the institutional level and the individual level. As Xie and Shauman (2003) argue, this approach contends that gender inequalities in the scientific career are explained by the interaction of structural allocation and self-selection processes. It attempts to grasp the complexity of human life, with multiple trajectories in education, family and work, in which developments in the professional trajectory are accompanied, and possibly influenced, by developments in other areas. Some recent

studies also pay increasing attention to cultural and institutional diversity within science itself, namely in terms of national contexts, claiming that it is necessary to analyse more fully the mechanisms that underpin the feminisation process in specific national and professional contexts (Le Feuvre, 2009) although both comparative studies and research on non-academic careers need further development.

Obviously, research at the national or local level presents a large degree of variation against this general pattern. In some countries research on gender segregation in scientific careers is just starting or mainly focuses on women's 'deficits' and 'barriers'. Although relevant studies can be found in all the countries analysed, empirical research from an organisational approach appears to be more established in the Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Sweden and the U.K.

Box 3 – Research on gender and science: only women, only academia?

This review of the problems of women's careers in science 1) focuses on the reasons why the position of women in science is an important issue, 2) reviews the state of the art of research in this field and 3) indicates the major problems and gaps in our present knowledge, and outlines some directions future research may profitably explore. A comparative perspective is needed to overcome potential gender biases. Most of the empirical research on the problems and obstacles of women's careers in science focuses only on women as such, and the problems revealed are assumed to be particularly those relating to women scientists. From a methodological point of view, the validity of the generalisations concerning women scientists must rest on the demonstration that they are gender specific. This implies that there is the need for systematic comparisons of men and women scientists. A review of the literature shows that most research on women's careers in science concentrates on academic women. However, in the contemporary world of science and technology, a considerably greater share of research and development activities is done outside the universities. Yet, there is very little information about women scientists working outside the halls of academia, in independent public or private research institutions or in the research institutes and laboratories of the productive sector. The obstacles presented by the social organisation of science and the culture of the scientific community with respect to women's equal participation have not received sufficient systematic attention. Only by focusing on how these social processes of the scientific community affect women scientists will we be able to identify the problems faced by professional women that are specifically associated with being a scientist. The extent to which women scientists are represented in the scientific establishment participating in advisory and decision-making bodies is also a hitherto neglected research area.

Stolte-Heiskanen, V. 1988, *Women's participation in positions of responsibility in careers of science and technology: obstacles and opportunities*, Tampereen yliopiston sosiologian ja sosiaalipsykologian laitoksen työraportteja, sarja B 26/1988. Tampereen yliopisto, Tampere.

Geographical trends

The figures below show the distribution of publications in geographical terms. Figure 2 looks at the country in which the study has been published, whilst Figure 3 shows the country or countries the study analyses. In both cases, two countries stand out clearly: most of the publications have been published either in the U.K. or Germany and analyse the situation in these countries. The number of publications is at best a very rough indicator of the attention paid to science and labour-related issues at the national level. Any cross-national comparison should take into account that size matters (in terms of population, scientific community, etc) and acknowledge the increasing tendency towards publishing in international journals, which gives advantage to English-speaking journals. However, it remains true that in accordance with our review of the literature, very little has been published about the situation in some European countries whilst there appears to be a large bulk of research dealing with the U.K. and Germany.

The analysis of the GSD confirms that most of the literature on gender and science is developed at the national level, with only a small percentage of comparative studies. Of all the GSD publications, the large majority (81%) analyse the situation in one single country whilst many of the studies dealing with several countries focus on the compilation of statistics or address very general and conceptual issues. Although it is not possible to provide a precise figure, it seems clear that truly comparative research on gender differences in scientific careers is very scarce.

Figure 2 – Publications by country of publication

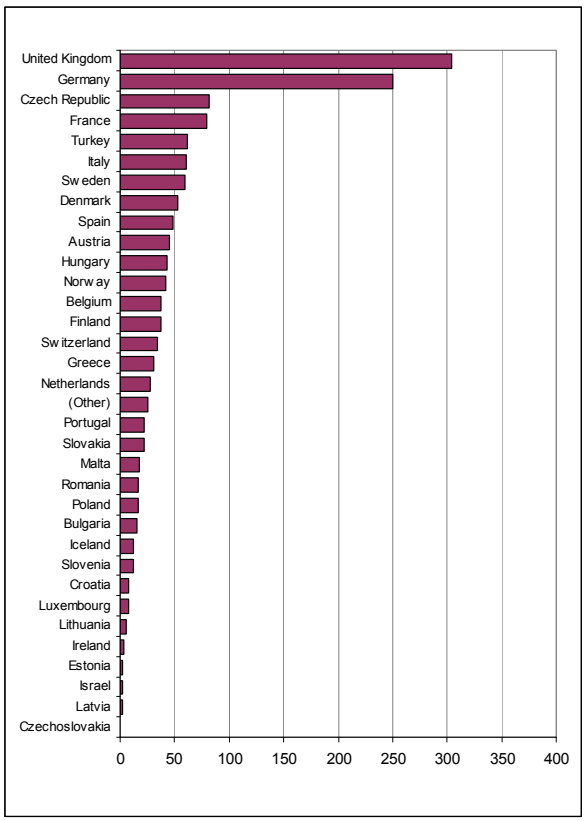
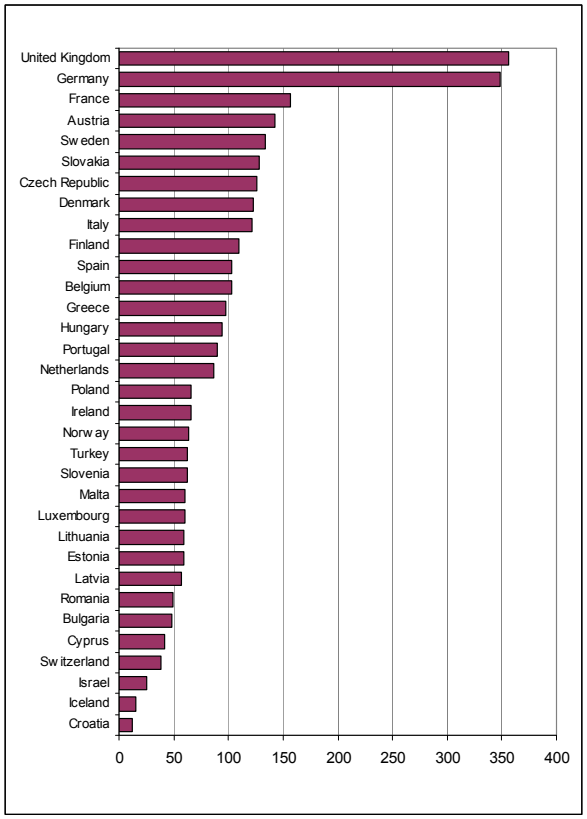


Figure 3 – Publications by country analysed



Thematic trends

Table 1 summarises the main trends of the labour literature as regards thematic issues. The data confirm that labour literature is mainly related to vertical segregation in scientific careers (68% of the labour entries also deal with vertical segregation), whilst horizontal segregation appears to be of lesser concern for this strand of research. It should also be noted that almost half of the labour entries are also concerned with stereotypes and identity, a fact that shows that socialisation and organisational approaches are closely interrelated. Only a small proportion of labour entries deal with such a paradigmatic issue for any labour analysis such as 'pay', but this fact shows that research on pay and funding is just developing in most European countries. Finally, it should be taken into account that many labour publications do not strictly focus on this theme, but are multi-topic studies that generally deal with women's situation in science and address a large variety of issues.

Most of the labour entries refer to the 1990s and 2000s, with just one third of the entries dealing with the 1980s and one fourth with the 1970s. There is, however, a significative strand of the literature that takes a historical approach, analysing the history of women's admission to university studies and the lives of women pioneering academia and scientific professions.

Table 1 – Percentage of publications by thematic issues

Relation with other topics	%
Vertical segregation	68.0
Horizontal segregation	47.3
Stereotypes and identity	46.5
Policies towards gender equality in research	28.7
Scientific excellence	23.8
Gender in research contents	22.3
Pay and funding	20.8

Period analysed	%
General / Not specified	3.7
Before the 18th century	1.5
18th century	1.8
19th century	6.5
1900-1945	13.1
1946-1970	18.5
1970s	23.1
1980s	34.7
1990s	50.9
2000s / Present-day	46.8

Institutional sector	%
All/General	42.1
Other	57.9
Total	100.0
Institutional sector - Other	**%**
Business enterprise sector	15.5
Government sector	28.3
Higher education sector	82.4
Private non-profit sector	3.4

Scientific field	%
All/General	40.9
Other	59.1
Total	100.0
Scientific field - Other	**%**
Education	20.2
Humanities and arts	19.4
Science, mathematics and computing	44.2
Agriculture and veterinary	8.8
Health and social services	25.5
Engineering, manufacturing and construction	29.8
Social sciences, business and law	33.7
Services	1.1
Specific scientific discipline	**%**
No	75.7
Yes	24.3
Total	100.0

Life course stage	
All/General	17.1
Other	82.9
Total	100.0
Life course stage -Other	
ISCED 0	0.4
ISCED 1	2.6
ISCED 2	3.6
ISCED 3	6.8
ISCED 4	5.6
ISCED 5	31.5
ISCED 6	38.8
Early-career scientists	80.1
Mid-career scientists	72.6
Late-career scientists	68.5

The analysis of the institutional sector differentiates between entries that do not address any sector in particular and the remainder which do. We can see that a large proportion of entries deal with science in general, paying no specific attention to diversity across institutional sectors (42%). Besides, most of the entries addressing this issue refer to the higher education sector (82%). Overall, these data confirm that a large bulk of labour literature focuses on the academia, with little research on industrial R+D. This is also a reflection of the fact that a substantial amount of literature on highly-skilled professions such as doctors, engineers or ITC professionals was not included in the GSD because it did not make any explicit mention with respect to research.

Trends are similar as regards the scientific field analysed. A large number of studies address science in general, without specifying any discipline (41%). The analysis also confirms that a high percentage of studies dealing with specific disciplines focus on the natural sciences, mathematics and computing, that is 'science' in the strictest sense (44%).According to the national reports, the professions most widely analysed are the most traditionally male-dominated, although more recent studies are paying special attention to fields like medicine or biology in which the proportion of women has rapidly increased. In some countries, namely, the UK, literature on gender and science only seldom includes social scientists. Finally, it is also worth noting that studies focus generally on researchers and do not include technicians or research support staff.

Finally, GSD entries are also classified according to the life-course stage analysed. In this case, we can see that most of the entries address some specific stages (83%), the early stage being the most widely researched (80%). This trend is confirmed by most of the national reports,

which highlight that research on gender and science pays special attention to young researchers, namely in terms of career and family conflict, working conditions and attrition rates.

Methodological trends

Figure 4 – Percentage of publications by methodological approach

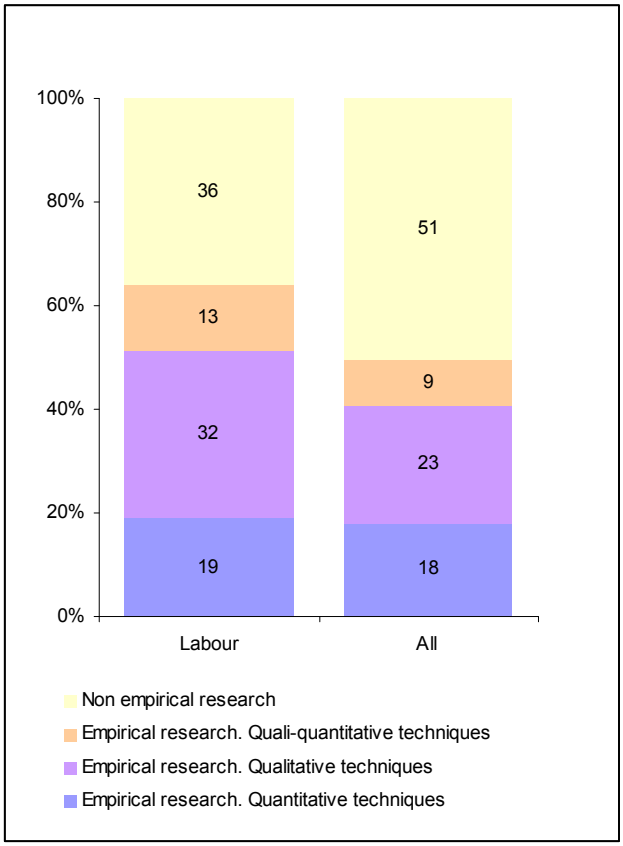


Table 2 – Percentage of publications by technique

Quantitative techniques	**%**
Representative sample	59.1
Micro-data	55.5
Longitudinal/cohort	10.6
Multivariate analysis	28.1
Qualitative techniques	**%**
Biographical research	25.6
Case studies	14.5
Content analysis	9.0
Interviews	72.3
Observations	8.7

Figure 4 compares the methodological approach of labour and all GSD publications. It shows clearly that labour related research appears to be more empirical than research on other gender and science topics. However, even labour research includes a high proportion of non empirical publications (36%). They are basically state-of-the-art studies, which compile some basic data and provide an overview of international literature and debates, usually meant to foster awareness and draw recommendations for policymaking at the national or institutional level.

If we examine the kind of empirical research carried out, we can see that qualitative research prevails (32%), although 13% of studies use both quantitative and qualitative techniques. Table 2 provides further details about the kind of empirical techniques used. Most of the qualitative studies are based on interviews (72%) whilst only 11% of the quantitative studies are based on longitudinal/cohort data and just 28% carry out multivariable analyses. Overall, these trends confirm what most national reports state: the majority of publications are based on small-scale studies, mostly based on the compilation of cross-sectional data and interviews in one or two institutions, which focus on the experiences and perceptions of female scientists.

The systematic comparison of men and women scientists is a trend apparent in more recent studies which usually adopt an organisational approach. However, literature reflects the lack of systematic sex-disaggregated data on scientists as well as the difficulties involved in collecting personal and family information, particularly salient in some European countries. This is a significant hindrance for research, which would need more systematic data on

sociodemographic variables and career advancement to develop more consistent lines of research, on the basis of both quantitative and qualitative approaches. The scarce longitudinal studies that manage to build on this approach provide meaningful insights into gender differences in scientific careers (i.e. Palomba, 2000; Abele, et al., 2002; Blackwell & Glover, 2008, among others).

3. STRUCTURAL CONSTRAINTS IN ACADEMIC CAREERS

Gender differences in career trajectories are closely linked to gender differences in the timing of events, the prioritising of roles and social relations across life courses. A great amount of the literature points out that the scientific career takes the traditional life course of men as the norm and this entails difficulties for combining professional and personal lives for scientists of both sexes, although in the context of the gender division of labour this conflict disproportionately affects women.

It is already well acknowledged that the sciences have developed historically in the absence of women and taking men as the norm. The recent US report *Beyond bias and barriers: Fulfilling the Potential of Women in Academic Science and Engineering* (NAS, 2007) provides a critical insight into the underlying assumptions of the ideal academic career from a gender perspective[1]. The model of the 'ideal scientist' that prevails in academia is based on the expectation that the scientist will have an unlimited commitment to science throughout the whole working life. In this way, the traditional scientific career presumes the model of an out-of-date male life course. Attention to other serious obligations, such as the family, is taken to imply a lack of dedication to one's career. Historically, this career model depended on a scientist having a wife to take care of all other aspects of life, including the household, family, and community. The model still fits some men but is increasingly unsuitable for both men and women who need or want to participate in other activities. This assumption is valid in all European countries, in spite of cross-national variations in the scientific systems. Being a good scientist means total dedication to work and a relegation of one's private life. Long working days are accepted as the norm and, therefore, as a norm that must be complied with (Currie, et al., 2000). The same holds true for complete availability: issues such a 'long hours' culture entailing presenteeism and unsocial working schedules, the 24/7 professional who is constantly 'on call' or geographically mobile (in search of career advancement, or operating internationally) are phenomena which have been observed in academic institutions (Ackers & Gill, 2005; Griffiths, et al., 2007; Halvorsen, 2002; Ward, 2000). The commitment to science also means availability to meet informal demands for relationship, networking and engagement in the scientific community.

A second trend of the normative scientific career is its rigidity. The scientific career is conceived as a rigid sequence of educational and occupational stages that are expected to be achieved at a certain age. Deviations or delays are taken to indicate a lack of commitment to the scientific career and are thus penalised (NAS, 2007). The sequence of stages varies across the European countries, but rigidity is always the norm. The rules for access to grants, fellowships and tenured positions are usually defined in terms of age or time elapsed since the achievement of academic degrees or the recruitment to academic positions. These rules may be strict and legally binding, or apply as institutional expectations but they penalise those who take longer to reach the threshold. Emphasis on steady and continuous research activity is one of the key elements taken into account for recruitment and promotion procedures: the women's life clock, which is often influenced by biological constraints and social expectations about maternity, is a deviation which, at best, is taken into account but never seen as the norm (Thorvalsdóttir, 2002, 2004). However, there are substantial differences in the age at which a scientific career is expected to 'take off ', and these differences may have important consequences in terms of gender equality. The same holds true for other age or time bars, which may be more disadvantageous for women in certain countries than in others (Osborn, et al., 2000).

[1] The report was issued by the Committee on Maximizing the Potential of Women in Academic Science and Engineering, National Academcy of Sciences, National Academy of Engineering and Institute of Medicine. Although it refers to the situation in US, the trends depicted may be applied to academia in general.

Caregiving symbolically conflicts with the ideal of 'unlimited dedication' to science. Beyond actual time and mobility constraints, difficulties for combining professional and family roles may also be the result of prejudices. In academia, caregiving is often seen as competing for the time and attention needed to succeed in highly competitive fields and, therefore, as indicating a lack of commitment to the scientific career. Prejudices against caregiving may exist and disadvantage women, even when caregiving does not imply less effort in the scientific career (NAS, 2007). In English speaking literature, the 'maternal wall' concept refers to the complex of constraints and biases that women encounter attempting to pursue scientific or engineering careers while also carrying major child-care responsibilities. Maternal-wall bias in academia is typically triggered when a woman becomes pregnant or requests maternity leave. At each point, maternity may entail negative competence assumptions and a distinctive maternal-wall catch-22 (Williams, 2004). Research has shown that the maternal wall, or family responsibilities discrimination, penalises mothers, women in general as potential mothers and fathers who seek an active role in family care.

These institutional constraints have a different impact on women's careers at different stages of the life course: they appear to be particularly acute in the early years of the scientific career, between the first university degree and first tenured position, which are the years in which parenthood and professional dedication conflict most. In this section we review the literature that explores two basic research questions: Do women have to make different choices to men concerning their personal and professional life courses? What is the relationship between 'demographic' variables and career outcomes?

Box 4 – A male career model

An article in Portuguese answering the question: what are the factors responsible for inequalities between men and women in science and the academic career is *O género na ciência – o caso particular da Universidade do Minho* (Gaio dos Santos, 2002). With the aim of ascertaining what discriminatory factors were present in the Portuguese academic context, thirty two interviews were given to teachers of Minho University. Data obtained through the interviews show that women in this sample, experience the work family conflict more acutely, because they must divide their time in a great diversity of contexts, while they are required to comply with a model of a male career which assumes absolute dedication to a career that is supposed to be uninterrupted. At the same time, the teaching overload and the absence of team work are pointed out by the individuals interviewed as some of the inhibiting factors of their scientific productivity; these factors seem to particularly affect women. Besides, 'subtle' messages transmitted by academy that the maternity option is incompatible with the development of a successful academic career, together with the absence of a real policy of family support continue to penalise women much more than men.

Gaio dos Santos, G. 2002, *O género na ciência – o caso particular da Universidade do Minho*, APS, CDROM.

3.1 Personal and professional choices

For both men and women, career paths in science are not linear or continuous but rather turbulent with some stages and points which are particularly critical for the continuance of their scientific career. Of particular importance are the three critical transition points (→) that mark the subsequent steps of standard career advancement:

PhD → Postdoc → Independent Researcher → Professor

Research shows that in each of these transition points, more women than men renounce, are expelled or are not promoted (NSF, 1994; NAS, 2007; ESF, 2009). Differences are already acute in the early stages of the academic career, a long period of career formation with intense productivity and mobility demands. It encompasses the process of obtaining a PhD, carrying out stages abroad, being recruited as a post-doc in a scientific institution and competing for a tenured-track position. Access to an independent research position (i.e tenure-track or tenured) is indeed one of the major critical points (Blickenstaff, 2005; ESF, 2009; Martínez, et al., 2007). The timing of this period varies considerably across European countries and scientific fields, but 25-35 years, sometimes even 40, might be taken as the common rule. Therefore, the greatest pressures for achievement and embarking on a scientific career coincide with women's fertility years and the social expectations about the right moment to have a family. It has been extensively stated that this coincidence disadvantages women: in addition to biological childbearing, most women continue to bear the primary responsibility for caregiving and household responsibilities. Combining the pressures of the tenure time-line with the formation of a family and bringing up children appears to be especially difficult.

It is a deeply-rooted assumption that future career progression relies very much on performance in this period. The disproportionate burden women have, may make it extremely difficult for those who decide to have children to give their career the same prioritisation as her male counterparts. It also requires many women developing sophisticated coping strategies to manage all of their demands successfully. Therefore, research has paid particular attention to this moment, which is called by some authors the 'rush hour', understood as the life stage in which women's family and academic requirements most collide and decisions related to having children and developing their academic career must be taken (ESF, 2009). Research shows that many women face this time as a 'choose-or-lose' dilemma of either having a family and children or striving to achieve a top position in science. The paradox is that this dilemma, spurious as it may be, has more than serious consequences: whilst there is no conclusive research about the impact of maintaining the 'dual role' on women's dedication to science and scientific production, it is nevertheless confirmed that there is a link between the research profession and family choices: female scientists are more often unmarried and without children than their male colleagues and women in general (Palomba & Mennitti, 2001).

A large number of publications deal with women's reconciliation of motherhood and a science career in the context of the gender division of labour. Many of these studies are interested in women's preferences and choices but nevertheless fail to analyse the systems and structures which act to constrain them. This has been also the prevailing view in academic institutions. As Connolly and Fuchs (2009, p. 59) contend, "how scientists manage to reconcile domestic and family (and other) responsibilities has long been considered a purely private matter by academic employers. Women's attrition from science was explained by 'choice' or 'deficit'. Academic and scientific organisations were either unaware or blind regarding their own contribution to gender inequality". However, other studies do not only show that this dilemma is gendered, but that it is exacerbated by institutional constraints and implicit academic norms, values and expectations that take the traditional male life-course as the norm. Several studies therefore adopt an organisational approach to analyse from a gender perspective the 'myth' and the reality of total availability in the scientific lifestyle (i.e. Beaufaÿs & Krais, 2005; Buchmayr & Neissl, 2006; Hasse & Trentemøller, 2008; Krimmer & Zimmer, 2003).

In this section we revise the literature that addresses the family-or-science dilemma, dealing with both women and institutional constraints. Four themes emerge from the literature review: first, the evidence of the dilemma as such, through the analysis of gender differences in the scientist's perceptions and family status; second, the variety of institutional constraints and academic cultures across national contexts and scientific fields, which shape a more or less acute dilemma for male and female scientists; third, the relevance of family-career tensions among the reasons behind leaving academia or pursuing a non-conventional path and finally, the variety of family arrangements among scientists and its impact on their professional and personal lives.

Family-or-science dilemma

Box 5 – To become a mother is risky for career advancement

This is a book about women who have completed their doctoral dissertations at the University of Jyväskylä, Finland. It deals with what doctoral studies and examinations mean today for the women who have obtained their doctorates. The number of women holding doctorates is increasing steadily, and in Finland today this group constitutes almost half of such degree holders. But despite their growing proportion, there are still many hindrances to their academic and professional careers. In addition, they face the challenges of their everyday life as women. Universities are currently undergoing considerable changes and the status of the doctoral examination is declining. The doctoral examination is one of the quantified and central results of Finnish universities and part of a control mechanism. The empirical section of this book is based on a survey of 352 women doctorate holders and a university student register. The subjects dealt with in the questionnaires included working on the dissertation, feelings about this, career, work, family, support and discrimination, work life satisfaction, working time and others. The results show that the university is still male dominated, although it is easier today for women to obtain their doctorates. Working in the university requires a competitive attitude, flexible working arrangements, a setting aside of one's private life and total dedication to work. Combining work and family life is difficult. Becoming a mother under such circumstances can jeopardise a woman's career prospects. Indefinite work contracts are available for only a few doctorate holders. However, women satisfied with their careers were also found among those surveyed.

Julkunen, R. 2004, *Hullua rakkautta ja sopimustohtoreita*, SoPhi 96, Jyväskylän yliopisto, Jyväskylä.

Research provides clear empirical evidence of the extent to which the role conflict influences the women's life course compared to men's. The wish to enjoy a family life in the framework of the prevailing gender unequal relations compel some women not to engage in research, withdraw from science or stop their progress, whereas other women take the choice to postpone motherhood to a later age or not have children. A large bulk of studies, mainly at the national level and dealing with a specific scientific field, show that: 1) A significant proportion of women withdraw from or stop their progress in the scientific career when they decide to form a family and have children (i.e. Athanasiadou, 2002; Glover, 2001; Ledin, et al., 2007; Tupa & Šaldová, 2004; Xie & Schauman, 2003); 2) Women scientists have a comparatively low fertility rate compared to their male colleagues and women in general. While male scientists have children at the same rate as the rest of the population, the fertility rate of women scientists is substantially lower (Blackwell & Glover, 2008, Buddeberg-Fischer, et al. 2003; Carabelli, et al., 1999; García de Cortázar, et al., 2006; Glover, 2001; HCST, 1995, 1998; Palomba & Menniti, 2001).

There is no systematic evidence of change over time, but as in other professional fields, it is clear that the intensity of the conflict is diminishing in a process parallel to the increasing presence of women in science. Recent research states that women's professional and family trajectories are more aligned than ever to that of men's (Alaluf, et al., 2003; Lind, 2006). For example, Durán (1972) highlights that in 1967 in Spain there were only 9 female full professors, all of whom were single and without children.Nowadays 1,400 women are full professors, most of whom have children: at the CSIC, the largest public research institute of Spain, only 1 in 5 female full professors does not have children, although this rate is still significantly higher than that of their male colleagues (7.5%) (García de Cortázar, et al., 2006). Other studies analyse the sociodemographic trends of scientists across time, achieving a similar conclusion. Gjerberg and Hofoss (1995) showed that a larger percentage of female than male physicians live alone in Norway, although the percentage of single people was larger among older than among younger female physicians, a fact that suggests that the necessity to choose between career and family was not as strong as it used to be.

Several studies refer to a deep generational change as regards career and family balance (see Etzkowitz, et al., 2000 in US and European comparative studies as Caprile, et al., 2008 and Hasse & Trentemøller, 2008, among others). Whilst older generations of women scientists adopted highly competitive strategies in line with the masculine ethos of scientific work, many young women and some young men nowadays appear to have a more balanced life and do not accept the fact that they have 'to pursue research as the main aim of life' (Ajello, et al., 2008). A considerable proportion of young academics of both sexes find the relationship between home and work in science unsatisfactory and unhealthy (Sturges & Guest, 2006). Hasse and Trentemøller (2008) contend that family issues have entered science for both male and female scientists: the system defines the good scientist as a male who practises a clear distinction between work and family life – and has complete dedication to work. This sets up a boundary between males and females in general, but also between the males who fit this stereotype and the new masculinities which have different values. Some young male scientists are also interested in being able to be with their children – and prioritise family life highly.

In general, research shows that these wishes collide with increasing competitive pressures in science and are not welcome in most academic institutions, leading young scientists and particularly women to feel they have to make an 'either or' decision between their career and family (see e.g. Fuchs, et al., 2001; Lind, 2008). A comparative analysis between the US and Israel concludes that women in both countries face a practical dilemma in combining a career with a family as well as a feminity dilemma related to their identity as women (Etzion & Bailyn, 2006). The comparative study of Caprile, et al. (2008) stresses that many young female scientists claim that they are not prepared to give up their personal life like some of the senior women scientists and see their professional future with frustration, because they acknowledge that balancing their personal and professional lives in the long term is not an established practice and does not lead to a successful scientific career. In a similar vein, Lützen and Larsen (2005) analyse the perceptions of PhD students in Denmark, showing that women are more sceptical of the academic environment and they do not want to sacrifice their family to the benefit of their career. The common perception is that only the most dedicated women make it to the top positions, but make great sacrifices along the way - so much so that they are not good role models for other women. Julkunen (2004) shows that young women regard the Finnish University as an extremely competitive environment, which makes motherhood risky for career advancement. Beaufaÿs and Krais (2005) suggest that academic culture in Germany has a strong bias against motherhood. The ideal of total availability, so deeply entrenched in the scientific lifestyle penalises women, regardless of their family status. Perhaps not so paradoxically, the authors consider that this is more detrimental for potential mothers than for who are already mothers. Women with children may demonstrate through their scientific work that they are as competent as their male colleagues. However, many young women end up believing that science is incompatible with family life and they feel that they have to leave the academia if they wish to have a family. Drews and La Serra (1994) showed indeed that parenthood has been for a long while a 'hot issue' in German universities. They surveyed male and female students, junior researchers in temporary positions as well as parents of small children with an overwhelming coincident result: the university must become aware of the 'child care question'.

There is also evidence of a clear shift in Eastern countries in the framework of the sociopolitical changes that have taken place following the socialist period: research highlights a pervasive change in the vital strategies of young women scientists, who tend to give more priority to their professional career over the traditional gender role of 'spouses' and 'mothers', delaying the age at which they marry and have their first child (Blagojevic, et al., 2004; Marikova, 2004; Torny, 2007). Parallelly, Balahur (2008) shows that in Romania the difficulties perceived in reconciliating a career and bringing up children are important de-motivators that drive women away from a career in science and technology. Overall, it is stressed that men and women do not face the same dilemma between their professional and personal choices in the early years of the scientific career. In contrast to the metaphor of the pipeline, Saldova (2007) uses the metaphor of science as a labyrinth, in which it is easy for young scientists to get lost, especially women aiming to combine the building of a scientific career with the formation of a family and having children.

It is a common finding to stress how early on in their careers women anticipate the role conflict. For example, Katsi (2004) outlines a critical differentiation between male and female postgraduate Greek students in relation to the dilemma of professional career and family life – while many women report that they have taken it seriously into consideration, most men admit that they have never thought about it. Field and Lennox (1996) found that many first and fifth year UK female medical students had based their choice of clinical attachments on the posts which would best accommodate their desire to have a family life in the future. However, other studies draw a more complex picture and show that career-family tensions cannot be overstated. Longitudinal research on doctors in Norway (Gjerberg, 2002) contradicts the idea that the low proportion of women in male dominated areas of medicine like surgery is only due to this kind of constraints. Women were found as likely as men to start their career in these fields: the main problem was their not completing specialist training. The study shows that reasons are complex. Heavy work loads with duties and nights on call make it difficult for women to combine childcare and work and make them change to other specialities. Also, female specialists in surgery and internal medicine tend to postpone having their first child compared to women in other medical specialities. However, the fact that many women change from surgery to gynaecology and obstretics, a speciality with similar workloads and unsocial schedules, shows that structural barriers in combining childcare and a hospital career do not fully explain the flux of women.

Institutional constraints and departmental cultures

The lack of widespread socio structural mechanisms to provide better management of family roles with academic careers is an important obstacle for women's advancement in science (i.e. Acar, 1994; Forster, 2001; Kramer, 2000; Ulmi & Maurer, 2005). It is a general trend, although literature highlights that the role conflict may be more or less sharp depending on institutional constraints and academic cultures, which show a great variety across national contexts and scientific fields. Indeed, the scientists' family status presents striking cross-national differences, as Le Feuvre (2009) stresses. In Germany, the typical male professor is a family man with two or more children, whilst half of the female professors do not have children (Zimmer, et al., 2007). In contrast, the percentage of professors in France who do not have children is similar for both sexes (about 13%) and men are somewhat less likely than women to have had two or more children (64% of the male professors, 69% of the women professors).

These differences suggest that the structural conditions of the academic career track, which vary greatly across Europe, are relevant. Countries such as France, which offers stable employment relatively early on in careers, are more favourable to female scientists than systems such as the German one, in which a succession of temporary jobs is particularly difficult for women to negotiate at a time when family responsibilities make them less mobile (Beaufaÿs & Krais 2005; Cheveigné, 2009). Majcher (2007) points out that academics face more acute career and family tensions in Germany than in Poland. Her study is based on two national surveys that investigated career development, recruitment procedures, professional performance and the work satisfaction of male and female professors in both countries. The comparison draws on the fact that there are certain similarities between the two university systems (the Humboldtian University once served as a blueprint for the Polish system) and both have undergone a process of growth and even of massification in the last two decades, which produced a situation of increased job opportunities for male and female scientists alike. Besides these similarities, however, the study stresses striking differences related to the status of women in society and to academic recruitment procedures. First and foremost, the obstacles to attaining a secure and life-long academic position in Germany are considerable. Although women in academia face significant problems in both countries, a university career seems to be less risky and more woman-friendly in Poland than in Germany.

Beyond structural conditions, literature also stresses the relevance of academic and departmental cultures. Hasse coordinated a comparative study (Denmark, Estonia, Finland, Italy and Poland) on gender and academic workplaces in the field of physics (Hasse, 2008; Hasse & Trentemøller, 2008). Among all the countries involved in the study, Denmark stands out as the country with the lowest presence of women at all academic levels. The study argues that this is at least partially related to the specific trends of academic culture in Denmark, highly individualistic and competitive in the initial stages of the academic career, which make it

extremely difficult to reconciliate family and career demands. However, even in this context the study found a certain variation across departments, particularly relevant from the perspective of family and career tensions: "In the physicists' 'folk-narrative' it is explained that women have problems because of children. This is not confirmed by this study, though. Instead we find that the context defines children as the problem. What is particularly interesting is that we find 'pockets' in physics where the physicists seem able to reconcile work and family life, avoid sexual harassment and in many ways seem to reconcile also the object of the activity with the community, the rules (implicit and explicit) and the division of labour without too much hidden competition. In the best practice examples we do not only see that the physicists can retain their love for physics, they also refer to a larger degree to the usefulness of their work, a strong feeling of group solidarity and being able to combine work and family life. Naturally the best practice groups are not all idyll because some people might not fit in within the boundaries of the group – and in this case they leave. But when we compare the 'complaining' quotes with our best practice examples we find another mind-set where both men and women feel comfortable – and in these groups we do not hear explicit examples of harassment in general, sexual harassment, nepotism or lack of understanding for family life responsibilities. The particular problem of an unsatisfactory social environment seems, in our analysis, to have been more or less solved in the pockets of best practice groups. Though many problems remain for male as well as female physicists (such as the short term contracts), these best practice examples show clearly that it is the workplace context for doing physics research which create leavers, especially female leavers, rather than children as such, demands for travels abroad, and work hours" (Hasse, et al., 2008, p. 123).

Box 6 – Cross-national culture differences in physics

Hasse and Trentemøller (2008) look at cross-national cultural differences in physics. On the basis of a comparative research in Denmark, Finland, Italy, Estonia and Poland, they identify three clusters of cultural models, which can be argued to function as different frames within which the inclusion and exclusion of scientists take place.The three ideal types of scientific cultures are called 'Hercules', 'Caretakers' and 'Worker Bees'. They argue that these ideal types of cultures concern the relationship to scientific work, the sense of workplace identity, attitude towards competition, the perception of power relations in the workplace and, finally, the position of gender in workplace relations.

In the 'Herculean' scientific culture, physics is the all-encompassing sole passion in the scientist's life, the workplace identity is the 'big ego', competition is connected to a one-to-one fight, and the power relations function as a number of anti-authoritarian power-games resting on unclear and hidden rules. In this scientific culture it is part of the hidden power game to use weaknesses shown by other people to one's advantage. If gender can be used in this competition, it will be. For 'caretakers', physics is everything in their life if it is socially acceptable to either, or both, the group and to a wider societal context. The focus on the workplace identity is primarily on the group and within the group. Caretakers do not compete with each other. The group has an internal power structure, where young members must earn their group position by working their way up. But once they are accepted they can discuss the leaders. Gender roles are usually accepted within the group: women are generally respected members but they rarely reach the top positions. For 'worker bees', physics is not everything in their life. Their workplace identity focuses on diligence, though without it taking time from their private life. They maintain a sharp dividing line between the private and public spheres. They are uninterested in competition and accept a formal hierarchy where the leader delegates work tasks. Gender relations are not used as a competitive element in this scientific culture.

The study discusses whether one scientific culture is more or less salient in a certain national context. It concludes that the 'Hercules' culture prevails in Denmark, the 'Caretaker' in Italy and the 'Worker Bee' in Estonia and argues that this trend may contribute to explaining the cross-national variation of women's presence in physics. Beyond this pattern, however, the study highlights a considerable degree of variation between departments, with collegial and family-friendly departments in Denmark which are able to attract and retain young men and women who do not fit in the 'Herculean' ideal.

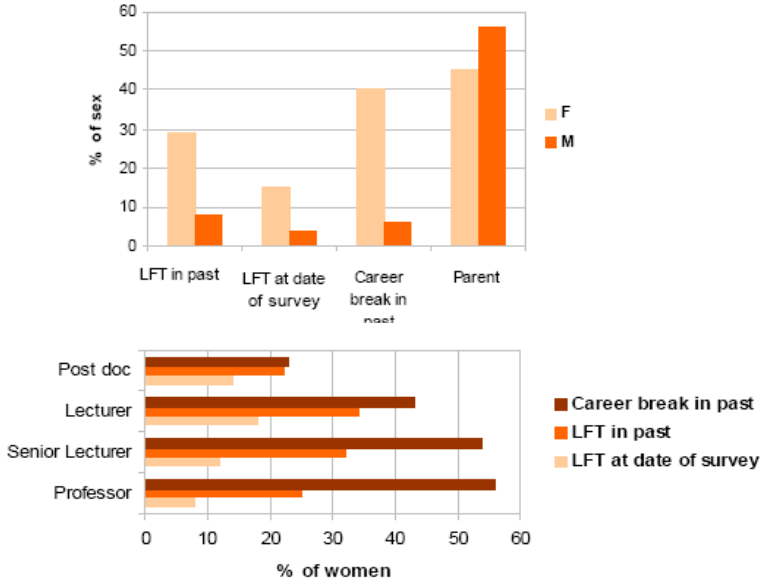
Hasse, C. & Trentemøller, S. 2008, *Break the Pattern! A critical enquiry into three scientific workplace cultures: Hercules, Caretakers and Worker Bees*, Tartu University Press, Tartu.

Career 'deviations' and leavers

In general, studies concentrate on scientists that pursue the most standard path and little is known about the numbers and attitudes of scientists who leave the academic pipeline or fail to adjust to the rigidity of the academic 'tempos' (i.e. career breaks, part-time work during specific periods, re-entries to the career track at a late age, etc). Data are only fragmentary, but they show that more women than men leave academia, whilst career breaks/part-time work due to family requirements are basically a women's issue. Although it is a commonly held belief that family-related issues account for the lion's share of career 'deviations' and leavers, a closer look at research in the field reveals a more complex picture (Mavriplis, et al., 2010).

The data from the 'Athena' survey can serve as an example of the extent of gender differences in career breaks and part time work (Athena Forum, 2007; see figure 5 below). The survey provides comprehensive statistics about gender and working conditions in UK universities (not including the social sciences). In 2006 the survey covered more than 70 universities and about 3,400 respondents of both sexes. It shows that the percentage of men who have taken a career break is almost negligible as compared to 40% of female respondents, even if more women than men do not have children. The same holds for working 'less than full-time': almost 30% of faculty women had been in this situation in the past (less than 10% of men) and 15% when the survey was carried out (4% of men). The highest percentage of women working less than full time was at lecturer level (18%). The survey further shows that a high percentage of women professors and senior lecturers had been working less than full time or had taken a career break in the past, a fact that according to the Athena report (p. 17) "suggests perhaps that the 'non traditional career path' is not necessarily a barrier to a successful career". Connolly and Fuchs (2009) carried out the same survey in a European university and found similar rates of career breaks among academic staff (39% women, 5% men). However, they highlight that taking a career break is more feasible or more acceptable once scientists have achieved a certain level of seniority and have survived the early selection barriers. Yet, 20 % of the women who had taken a career break reported that it had harmed their career. They also show that women that have considered but not taken a career break (16%) offer explanations that underline the 'either-or' nature of the decision, its tight coupling to becoming a mother, and the anticipation that the decision is potentially harmful to career advancement. Overall, they find a general disbelief among both male and female faculty that taking a leave would not harm one's career. Considering that career breaks are taken predominantly by women and almost exclusively for maternity leave, they contend that policies to support the work-family balance are important but also have the potential to increase existing gender inequalities.

Figure 5 – Career breaks and working less than full time (LFT) in UK universities, 2006



Source: Athena Forum, 2007.

Blackwell and Glover (2008) carried out a longitudinal study to analyse the patterns of retention of highly qualified women scientists in science-related employment in England and Wales. They compared retention in employing women with health-related degrees with that of women with degrees in science, engineering and technology, showing that the latter group had markedly lower retention rates. Differences in retention rates were found consistent with differences in family status. Those who stayed on in science-based employment have children later than other types of graduate and their rates of non-motherhood were also higher. Four-fifths of women in health-related occupations were mothers, compared to only two-fifths in science, engineering and technology.

One of the few comprehensive studies about leavers is that of Preston (2004), who surveyed about 1,700 scientists (not including social scientists) and engineers in USA. Her study confirms that women leave science careers in greater numbers than men: in particular, female scientists wishing to work at the university were found to leave employment altogether at a rate of 14% and exit to another occupation at a rate of 18%, whilst these percentages were 4% and 15% for men. It is obvious that withdrawal from the scientific career by a person who has finished their doctorate programme forms part of the possible risks that exist in an academic career and quite often it is a frustrating situation in which it is difficult to empirically distinguish the 'push' and 'pull' effect. However, the study provides evidence of both kinds of factors, as well as of certain gender differences in the reasons portrayed: men complain more about low salaries and the lack of promotion perspectives, while women refer to a more complex set of reasons, including difficulties to balance work and family life and a women-unfriendly environment.

Hasse and Trentemøller (2008) confirm these results in their cross-national qualitative study of reasons for staying/leaving academic physics. More women than men are leavers or intend to leave, but leavers of both sexes refer basically to the same set of factors. Some of them seem to push physicists out of academia, while other factors outside academia appear to pull the leavers out of the university as a workplace. The lack of positions, the short-term contracts and better possibilities of getting a permanent position outside academia are some of the most frequent reasons given for leaving. Though leaving university, which in most cases is equivalent to leaving research, can be a difficult decision, the prospect of more harmonious work and family life reconciliation pulls some of the leavers out of academia. Interestingly, they find that a better work-life balance is a consistent 'pull' reason not only for many women, but also men who do not adhere to traditional masculinity. Maternity leave is in many cases seen as a specific women's 'push' factor, namely for those on temporary contracts because they may loose contacts in academia or not be able to keep up to date with recent findings and write articles. Finally, women also refer to another set of reasons related to the sense of not 'fitting-in', isolation and a lack of support, etc.

There is also fragmentary research, mainly in the UK, on the phenomenon of career 'slow down'. Research in this field usually focuses only on women, which is certainly a drawback: as Palomba (2008, p. 53) states, "men who do not climb the career ladder are never interpreted as having made 'a choice' with respect to other social dimensions in their lives". Still, studies point to a mixture of women's choices and constraints. Forster (2001) analysed the conflict between the personal and professional life of academic women in the UK, finding that some of the women reported that they had opted to put their careers on hold because of domestic and family responsibilities and a few have resigned themselves to never achieving senior positions because of these commitments. Evans, et al. (2007) or Glover (1999) suggest that some women make a deliberate decision to 'tread water' staying at a level which is below their proven or predicted potential in order to maintain a workable balance. In Eastern countries, several studies hightlight that a lack of support, poor career prospects as well as family-related constraints often lead women to decline their professional ambitions and adapt themselves to the status quo, not striving for higher positions in their careers (Kornhauser, 1997; Saldova, 2007).

Godfroy-Genin (2009) shows how the phenomenon of 'working below potential' may be interpreted in different ways and highlights the need for further research. In her study of women in engineering research she concludes as follows: "From our interviews on what 'career' means for researchers, it is clear that there are different ways to make a 'good' career. We could

identify at least three different profiles with different personal agendas. The 'star researcher' is often the most common successful profile we think about: he or she has written lots of well-known publications, became director of an important research centre, member of the academy of science, and has discovered something which brought him/her a famous prize or a rewarding patent. The challenge exists in discovering other profiles and not obliging all researchers to stick to this role model. The 'administrator' may be another figure: he/she is a successful administrator of research, managing a laboratory and finding funding and positions to develop further activity. A third profile also seems to be a very successful one among researchers, even if it is not usually considered as brilliant as the others: we could dub it the 'quiet researcher', somebody who is focused on research itself and intellectual interest but does not want to spend too much time in administrative or managing tasks and chooses to preserve a satisfying work-life balance even to the detriment of his/her career. This is the case of numerous associate professors we have met and who declared that they were not interested in becoming full professors and were pleased with their actual position. This is what they declared during interviews, though it may be a way to turn personal failures or lack of ambition into something more positive. We do not know to what extent interviews are sincere and unbiased. Facts and representations and social desirability are always interfering" (Godfroy-Genin, 2009, p. 94).

Family arrangements

Box 7 – Researchers between two passions: The example of biologists

The academic world does not escape the glass ceiling or the leaden sky that weighs upon women's careers: in all fields, their presence declines as one rises in the hierarchy of ranks and honours. On the basis of statistical data and interviews, this article offers possible explanations for these gendered inequalities in the academic world by exploring a corner of the leaden sky, the one that weighs upon female researchers in natural sciences in France. It focuses on the subjective dimension, i.e. on pleasure and suffering inherent to the profession of the researcher, as well as on the contradiction between the imperatives of an ideal researcher and that of a mother. Trying to provide sociological interpretations with respect to the 'glass ceiling', the authors deal with the theme of female productivity and of its potential limitations due to family obligations, then with the 'Matilda effect', that is to say the hidden mechanisms of male hegemony in academic organisations that keep women away from the better aspects of the career. The authors then focus on conditions of work, its location and intensity, in order to point out the situation of the women biologists, between two passions, the passion for their work and the one for their children, and the ways they articulate them.

Marry, C. & Jonas, I. 2005, 'Chercheuses entre deux passions: L'exemple des biologistes: Sciences, recherche et genre', *Travail, Genre et Sociétés*, vol. 14, pp. 69-88.

Female academics living with their partner are significantly more likely than their male counterparts to be part of a dual career couple, i.e. a couple in which both partners strive for career advancement. Yet, even in this situation women are usually found to be primarily responsible for domestic responsibilities (Sturges & Guest, 2006). In general, research highlights that this situation contrasts with the fact that many male scientists enjoy the support of a partner who is not working, working part time or has a less demanding job, and focuses mainly on the family and children. However, several studies provide a more nuanced and complex picture of dual career couples' family arrangements.

Marry (2001b) contends that homogamy is advantageous for women belonging to the professional elites. She carried out a study on male and female ex-students of the elite higher education school École Polytechnique to analyse family arrangements and career advancement and found that having a relationship with another ex-student was an advantage for women's careers. Although the husbands' careers can be an obstacle for the wives, the study concludes that this process is less operative in the case of the elites. Gjerberg (2003) arrived at a similar conclusion analysing how doctors in Norway cope with their careers and families whilst Carabelli, et al. (1999), having explored the situation of economists in Italy, found that women with children and not in an endogamous relationship were in the worst situation. Behnke and Meuser (2003, 2005) point out that in Germany dual couples are somehow 'lifestyle pioneers',

who contribute to the modernisation and the de-traditionalisation of society, even if persistent gender differences are still present. Ajello, et al. (2008) highlight that in Italy physicists in endogamic relationships tend to share domestic responsibilities and to be more sympathetic to and tolerant with the 'busy' partner. According to Hasse, et al. (2008), a tendency towards a more equal distribution of household tasks does seem to be present among the young physicists compared to the older physicists in Denmark. Godfroy-Genin (2009) points out that the 'top women' in engineering research often describe very supportive partners, alongside social networks, as the most important support in their career. It seems clear that dual career couples in science and new feminities and masculinities are in need of further research. In the field of dual career research and policy-making the US is clearly ahead (see Schiebinger, et al., 2008).

A second issue that must be noticed is that many more women than men – although satisfied with their careers – have to cope with a sense of frustration and uneasiness due to the difficult choices they have to make in their personal life course: on the one hand, they are reasonably happy about their careers; on the other, they experience with anguish or frustration the personal price they have paid or the limited amount of time they dedicate to their families and personal life.As Marry and Jonas (2005, pp. 85-86) state, "nowadays there is in no country a direct causal link between women's success in science and children, but everywhere the work-life conflict is very strong in subjective terms.Without doubt, because women researchers share both the weberian ethos of total devotion to science and the ideal of a mother completely devoted and available for her children". As they note, the contradiction between these two imperatives is also dependent on material resources. Women engineers working in the private sector have more financial resources for developing coping strategies than women scientists in the public sector. This uneasiness is perhaps the most subtle issue - difficult to capture objectively - but it is, nonetheless, particularly important and emerges across numerous narratives and qualitative researches (Athanasiadou, 2002; Etzion, 1988; Forster, 2001; Hablemitoğlu, et al., 2004). Doyle and Hind (2002) confirm this finding, showing that academic women suffer higher levels of stress at work than men in similar positions.Research in the US points out that this uneasiness is particularly acute at the mid-stage of the academic career (NAS, 2007).

3.2 Family status and career outcomes

One of the most common explanations for the differences between men and women's careers is the conflict between the professional and family role: the hypothesis is that marriage and especially motherhood has a negative effect on women's involvement in academic work and scientific productivity, in comparison with men, single women or women without children.

Xie and Shauman (2003) provide evidence that in the US, marriage and motherhood are related to lower career prospects in the case of women scientists. They found "a clear and persistent pattern in which marriage and parenthood exacerbate gender differences, even after controlling for a variety of demographic and human capital explanatory factors. Gender differences among unmarried scientists are either small or nonexistent, but married women experience large disadvantages relative to men, especially if they have children. This interactive pattern results from two processes: the careers of men benefit from marriage and parenthood, while the careers of women are impeded by family responsibilities" (Xie & Shauman, 2003, p. 152). In European countries, there is no possibility of carrying out similar comprehensive studies, as data concerning scientists' marital status and children are very fragmentary. However, European research is far less conclusive on this point. For example, the longitudinal study of Abele (2002) shows that motherhood may be a hindrance for an academic career in Germany, but women who do not have children do not reach the same level in their career as men. Overall, available empirical studies do not show any clear evidence that women without children have better career prospects than their female colleagues, whilst it seems clear that successful men are supported by their family and the presence of children has little or nothing to do with their career opportunities (Palomba & Menitti, 2001).

In some European countries this fact has long ago been acknowledged, namely, in Finland, where the National Committee appointed to monitor obstacles in female researchers' careers in the 1980s reached the conclusion that in a scientific career women's double burden did not seem to be the worst obstacle, but rather their weaker and unequal position in the scientific community. According to empirical studies, the Committee concluded that children and the family may slow down women's scientific careers, but they also seemed to have positive influences on both men and women's scientific productivity (Husu, 2008). In spite of this, the prevailing view in academia is that women face more difficulties to achieve the highest scientific positions because they do not perform as well as their male colleagues due to having children and carrying out other domestic duties.

This section provides an overview of the empirical studies that address this question, focusing on those issues that have been more extensively researched. The first one refers to family-related mobility constraints, particularly acute in the early years of the scientific career. Secondly, particular attention has been paid to age and time bars, which may have a disproportionate effect on women due to time spent on family-related activities. Finally, literature has also explored the extent to which women with family commitments have similar levels of scientific performance to their colleagues, analysing trends as regards dedication, availability and scientific productivity.

Mobility

Beyond productivity pressures, reconciliation of personal and professional lives is particularly difficult when young researchers need to move or relocate abroad. Geographic mobility is not the only career path to career advancement, but it is a common prerequisite for having access to tenured positions in some scientific fields, academic institutions or national contexts. Xie and Shauman (2003) show that in the US, women with young children are less geographically mobile than either women without children or men. In contrast, men scientists' propensity to migrate only becomes restricted when their children enter their teens. Restrictions to mobility due to bringing up children have therefore different timing for men and women. In the case of men they coincide with the middle years of their career, a period of relative stability whilst mobility constraints for women are especially acute during the early years, the time of career formation, when the lack of geographical mobility may be most detrimental to the scientists' future career.

Several studies in Europe confirm that women scientists have more mobility constraints than men, although parenthood is not the only issue considered. More young women than men tend to give up the possibility of mobility when they have children or their partners will not move with them (i.e. Baptista, 2000; Cutileiro, 1987; Perista & Silva, 2004; Rodrigues, 2005). The inflection time in mobility comes at the PhD or post-doctoral stage. Young single women are at least as mobile as their male counterparts, but levels of mobility among women scientists decline at doctoral and postdoctoral stages (Ackers, 2004). Ackers also shows that women tend to be the trailing partner, regardless of their relative level of skills within the couple, suggesting that the impact of partnering (in comparison with parenting) has been underestimated when considering the mobility and career decision making of women in dual-career relationships.

Box 8 – Managing relationships in peripatetic careers: Scientific mobility in the European Union

This paper seeks to add to our understanding of the concept of 'tied migration' through a grounded and essentially qualitative analysis of the experiences of highly skilled scientists moving within the European Union (EU). The propensity of the highly skilled to move and the consequences of this for individuals and their families vary significantly between different employment sectors. Progression in scientific careers demands a very high level of international mobility particularly in some national contexts. Whilst research suggests that young, single women are at least as mobile as their male counterparts, levels of mobility amongst women scientists decline at doctoral and postdoctoral levels. Locating the research findings within existing literature on 'tied movers', the paper considers the nature and impact of partnering on the career decision making of male and female scientists. It concludes that the prevalence of dual science career couple situations (defined as situations in which both partners in a couple are employed in scientific research) reflects high levels of mobility and generates the kinds of tensions which result in the tendency of women to 'exit' from science careers and/or fail to progress. The findings reported upon in this paper confirm recent work on dual-career situations in noting the persistence of 'trailing' irrespective of the skill level of the female partner. It does, however, draw out some new issues. Firstly, the importance of considering the impact of mobility in the progression of trailing partners as opposed to simply engagement or salary. Secondly, in contradiction to recent work, the findings suggest that the impact of partnering (in comparison with parenting) has been underestimated when considering the mobility and career decision making of women in dual-career relationships. Although the paper is firmly based on the experiences of scientists, recent trends in European labour markets suggest that the pressure to attain international experience is beginning to shape career trajectories in many other employment sectors.

Ackers, L. 2004, 'Managing relationships in peripatetic careers: Scientific mobility in the European Union', *Women's Studies International Forum*, vol. 27, no. 3.

Age and time bars

Recent research states that the age, duration and career planning of women is more aligned than ever to that of their male colleagues (NAS, 2007; Lind, 2006). However, women's fertility age and the unequal distribution of domestic work are difficult to reconcile with what are considered 'ideal' rhythms of career that usually imply promotion at a 'young' stage (Marry, 2005). As stressed by the ETAN report (Osborn, et al., 2000), seemingly neutral age and time bars operate in this way as indirect forms of gender discrimination. Since age and time bars were first challenged in the 1980s in the UK the general tendency has been to suppress or qualify them by introducing specific clauses for taking into account time spent on caring. In the late 1990s, following complaints of indirect discrimination, Dutch scientific institutions were pioneers in adopting the notion of 'academic age': men and women who can prove they had a time lapse in their career for reasons of care may be regarded as younger than the official age limits. Since then, some countries offer researchers an extension of the academic age rules taking into account childcare time when applying for funding (e.g. Switzerland), or abolish the age limit at all, and offer appointments in combination with care responsibilities (e.g. the Netherlands) (ESF, 2009). During the second half of the 2000s, the example has been followed by some academic institutions in the Eastern countries, such as grant awarding bodies in Slovenia, Estonia, the Czech Republic (EC, 2009c) and, more recently, Hungary (Palasik, 2009). Recently, also the Research Assessment Exercise in the UK implemented the notion of 'academic age', rather than 'cronological age', when assessing the research output of academics (Bennett, et al., 2010). However, this kind of bars still exists in several countries, particularly for fellowships and examinations leading to permanent jobs. For example, the 8-year rule in Denmark states that scientists may only apply for an adjunct position within 8 years of graduation (Don Jensen, 2009). Another example of rigidity is Austria: under the new

University Act 2002, PhD and habilitation, that is the prerequisites of an academic career, have to be fulfilled within 10 years of achieving the university degree (Leitner & Wrobleski, 2009).

Even when there are no bars strictly in force, the deeply-rooted assumption that future career progression relies on performance during the early years of the scientific career has a detrimental effect on women's careers: not having the 'right age' is penalised. Well-ground evidence is provided by Marry (2005), who analysed the patterns of promotion to grade A positions in the French CNRS. Her study stressed the attraction of 'meteor-like careers' for evaluators, although no age bar was officially in force. One of the evaluators is quoted as follows: "In theory, age is not an argument, we try and concentrate on the scientific aspects of the work but, in practice, the profiles of young people who have rapidly published good quality articles are selected as future directors of large laboratories. It's true that when we run out of scientific arguments, we tend at the end, in this [disciplinary] section to be more impressed by people who have moved fast" (Marry, 2005; quoted in EC, 2008). A similar conclusion is reached by Cheveigné in her analysis of the same institution: "Age limits affect women more than they do men, whether official (such as the retirement age of 65 years, or the recently abolished rule for hiring a CR2 before age 32 years) or unofficial but imposed by the peer evaluation (such as the tacit limit beyond which it is 'too late' to be promoted to director of research, which varies with the discipline from about 45 to 55 years old)" (Cheveigné, 2009, p. 130). Finally, Delavault, et al. (2000) also stresses that age criteria may be tinged with subtle gender prejudices. In French universities, habilitation and promotion procedures to achieve a professorship are expected to be fulfilled between 25-40 years, with some variation according to discipline. However, this unofficial age criterion is not always considered equally for women and men. They found that evaluation panels recall the issue of maternity in the case of women 30-40 years old, whilst they tend to consider 40-year women as too old for being researchers, taking for granted that they have not been actively involved in research during the last years. On the contrary, 40-year male applicants appear to benefit from age, as if it were an indicator of accrued research experience.

Dedication and availability

In spite of the constraints that maternity may impose on women, there is no empirical evidence of women scientists with children working full-time spending fewer hours at work or working less intensively than their colleagues (Palomba & Menniti, 2001). Some studies suggest that men and women scientists with children, working full-time, spend the same number of hours in the work place, although women then dedicate more hours to childcaring and household tasks than men (NAS, 2007). The overall picture is that university or public research institutes may offer, for scientists in intermediate positions, more opportunities for flexible working time and reconciliation than many other professional settings, although conditions tend to be more disadvantageous for promotion (Strehmel, 1997).

This kind of empirical studies suggests that the main difference between men and women does not rely on their dedication to scientific work, but on their availability. In other words, it is not about the number of hours dedicated to science, but about being able to attend meetings at unsocial hours, travelling abroad or engaging in networking activities out of work. It appears that the 'ideal' of total availability for scientific work (out of the workplace time and space) should be seen more as a symbolic input than as an actual requirement for scientific research. As Hasse, et al. (2008, p. 122) state, "we see that the need to spend time on non-workplace related activities also creates a boundary between those with less 'external time-demands' and those who are responsible for picking up children from day care, leaving work 'early', doing house chores etc. These persons happen most often to be women, who are on the 'wrong' side of the borderline. Longer periods of time away from the workplace, e.g. maternity/ paternity leaves, may analytically be seen in the same light. In this period of time one cannot take part in networking (formally and informally), publishing articles and showing full devotion to the object of doing physics and this is problematic because all three aspects are part of the implicit and explicit competences that influence selection mechanisms".

Indirect evidence of bias against caregiving is the disproportionate effect of working part-time on women's careers in some national contexts. Van der Burg, et al. (1998) carried out a longitudinal study on academic staff members at Utrecht University and found that one of the

main differences between men and women was that working part-time did not have any effect on the probability of men's promotion, although it did negatively affect women's. Whether total availability is a 'myth' or an actual requirement for scientific research, it seems clear that this work culture penalises women (Bailyn, 2003).

Scientific productivity

Box 9 – Letter from a woman scientist

'The few women who stay in science and manage to combine family with work are often very productive. It is obvious that enormous selection has been exerted on the women who remain in science and you have to be highly motivated, highly committed and extremely well organised to survive. You also feel that you must be as productive as possible to convince colleagues that you should be taken seriously as mother and scientist. Looking at who stays in science is only part of the picture. If I look at my female contemporaries during my graduate and post-doctoral studies I am part of only ten per cent of those women who are still in basic science. Many of those have suffered poor career progression due to career breaks to have children. Many stopped when they had children and went into other careers when they went back to work, as they felt the break from research had been too long. In France my colleagues at the CNRS said they get about half the amount of their salary which they pay in childcare as a tax credit. This is in addition to a 'child award' of approximately £100 per month per child. How is France able to provide family friendly policies when the UK cannot?'

Letter from a woman scientist in her late 30s, working in an UK university with two small children and a partner also working as a research scientist.

Osborn, M., Rees, T., Bosch, M., Ebeling, H., Hermann, C., Hilden, J., McLaren, A., Palomba, R., Peltonen, L., Vela, C., Weis, D. and Wolh A. 2000, *Science policies in the EU: promoting excellence through mainstreaming gender equality. A report from the ETAN Expert Working Group on Women and Science*, Office for Official Publications of the European Communities, Luxembourg, p. 69

Academic performance is primarily measured by the number of papers, books and citations produced. In turn, these indicators are relevant criteria for recruitment, promotion and other forms of scientific recognition. Moreover, they are gaining weight as 'objective and neutral' indicators of performance within the current trend towards more transparent and accountable academic procedures that is taking place in many European countries. It is therefore not surprising that a substantial amount of literature is dedicated to the analysis of gender differences in scientific productivity.

As of the decades of the 1970s and 1980s, several studies started to analyse scientific production by men and women with contradictory results. Most of the evidence showed that, on average, women published less than men at a similar level (e.g., Cole, 1979; Cole & Zuckerman, 1984), although others such as Ferber and Loeb (1973) found that women were not less productive than men when other relevant factors were controlled and Reskin (1978) found that the discrepancy was smaller than usually supposed. In general, the prevailing view was that gender differences in scientific production were not satisfactorily explained: their existence was said to be a puzzle (Cole & Zuckerman, 1984).

The studies that examine the relationship between marriage, children, and scientific productivity do not find that family factors have a negative effect on women's scientific performance, particularly in terms of research productivity. Rather than hampering women's scientific performance, marriage and children appear to be associated with equal or somewhat higher research productivity (Fox & Faver 1985; Kyvic, 1990; Luukkonen-Gronow & Stolte-Heiskanen, 1983). Zuckerman and Cole (1987) examined the hypothesis that marriage and motherhood do not significantly affect women's research productivity as against the widely held belief that marriage and motherhood are incompatible with a (successful) scientific career. They conclude that women publish less than men, but marriage and family obligations do not generally account for the gender difference. Married women with children were found to publish as much as their single female colleagues did. This was generally true both for eminent and rank-and-file women

scientists. As Fox (2005) states, these 'counter-intuitive' findings should be interpreted taking into account the over-selection of women scientists: they refer to the scientific productivity of women who have survived a rigorous selection process and manage to stay in science, while family demands may take their toll along the way through graduate school and early career.

Recent US research sheds new light into this issue (Xie & Shauman, 2003). It shows that productivity is not an independent characteristic of individuals but rather a reflection of their position in the academic hierarchy and the access to resources that those positions make possible. When academic track, academic position, type of institution and available resources are held constant, men and women scientists are equally productive and family status (marriage, parenthood) does not have any impact on productivity. Some authors interpret these results in terms of Merton's concept of cumulative advantage (Merton, 1968; 1973): once achieved a certain academic position, its prestige leads to more invitations for research collaboration, to being quoted in colleagues' work and to receiving research funding, all crucial in getting published (Wennerås & Wold, 2003). As stated by Toren (1991, p .654), "if marriage and children have only a negligible influence on women's academic performance, then marriage and motherhood cannot be used to account for the persistent differential productivity rates of women and men, and its explanation will have to be sought in more complex social structures and processes […] To explain gender differences in academic careers and to gain better understanding of the incongruity between merit and rewards in academe in reference to women, we have to investigate complex mechanisms, such as discrimination, accumulative advantage and disadvantage, and changes in the opportunity structure through which these conditions are created and maintained".

Gender differences in scientific productivity have thus been attributed to women's low occupation in the highest academic posts and lower integration into the scientific community, such as influential posts in scientific associations or memberships of editorial boards of journals (e.g. Bentley & Blackburn 1992; Luukkonen-Gronow & Stolte-Heiskanen 1983; Prpić 1992, 2002; Toren 1991, 2001). The study by Carabelli, et al. (1999) investigated the career paths of Italian university professors based on longitudinal administrative records for the entire population of academic economists. It also made use of publication records drawn from bibliographical data banks and of a questionnaire administered to the female component in order to explore the importance of family conditions. Overall, the study suggests that 'supply-side' explanations like motherhood or publications cannot fully account for gender differences in career outcomes. One of the main findings is that marital status or the size of the family (number of children) had no clear impact on publications or career progression. At the time of the study, in fact, more than one third of the female economists were single or did not have children; among women with children, moreover, the number of children increased both at the bottom and at the top of the publication records or the career ladder (Bettio, 1999). In general women were found to publish less, but, controlling for publication, the study found evidence of lower probabilities of climbing up the career ladder and concluded that one of the main factors involved was much weaker networking resources. The study conducted by Benigni, et al. (1988) on researchers at the CNR, the largest public research institute in Italy, finds evidence of exclusionary practices, as for the same productivity indexes women tend to receive less visibility, and consequently less power in guiding research.

Some studies also find support for the negative effect of childcare on women's productivity when the children are small. Kyvik and Teigen (1996) found that women with young children and women who do not collaborate in research with other scientists are less productive than both their male and female colleagues. Ledin, et al. (2007) found slight gender differences in scientific productivity among applicants to EMBO fellowships that were explained by family-related time and mobility constraints. Although productivity differences were slight, the female success rate for EMBO fellowships turned out to be 20% lower than that of men. This strand of research suggests that time and mobility constraints may be relevant in terms of scientific performance in the early stages of the academic career –'the rush hour': according to the logic of cumulative advantage/disadvantage, slight differences at early stages may turn into wide differences in the allocation of opportunities for doing research and have a determinant impact on career outcomes. This appears to be the main conclusion of Manson and Gulden (2004). They carried out a longitudinal study in order to analyse the long-term impact of the family on the scientific careers of men and women in the USA. Using data from the surveys of doctorate

recipients for the years from 1973 to 1999, they analysed the trajectories of men and women twenty years after obtaining their PhD. The overall findings show that the period up to five years after obtaining the PhD is the most important for obtaining scientific recognition. Women without children or who had postponed motherhood to later years received tenure earlier. Men with a family, on the contrary, received tenure earlier.

Box 10 – Only time and mobility constraints?

The University College Cork (UCC), in Ireland, commissioned a study to assess the participation of women in science, engineering and technology (SET). Although increasing, the presence of women was very low: In 2005, only 25% of the SET academic staff in UCC was female and the proportion of women in full professorships was only 11%. Several workshops were carried out targeting different groups of the female SET researchers in order to identify the main barriers to building a career. The conclusions for post-doc researchers were as follows: "Concern was expressed about the lack of career path/structure or template for progression, and inconsistency in pay scales. As twelve monthly contracts were offered in most cases, there was no security of tenure or pension contributions, which resulted in a lack of stability. It was hoped that legislation on staff permanency might have an effect. It was considered that the university frequently loses the experience of post doctoral researchers (PDs). As it was necessary to 'get a foot in the door' in industry, there was a need to make the move early e.g. after a PhD. It was thought that experience gained in achieving a PhD was not accepted by industry. The lack of respect for PhDs should be countered and the university needs to educate recruiters regarding the valuable work of PDs. Family issues were considered to have more effect on women than men, and it was more difficult for women to combine their career and family. Anxiety was expressed about taking maternity leave as this might block career progression. Women with a family found it difficult to socialise after work and that added to the sense of isolation and prevented networking opportunities. This was worse for women off campus. The sense of isolation is exacerbated when women are sometimes the only female in meetings. It was felt that the systems excluded women, they do not have the chance to get to know people and this would be useful for writing purposes. These social barriers do not affect males in the same way. There appeared to be a lack of respect for females in a male dominated environment. […] Other concerns included the lack of mentoring opportunities, the lack of women at the top, not enough role models, resulting in no sisterhood. It was much easier for men for mentoring – probably because of the 'old boys' network. The group would not recommend a career in science as there is no defined career path, it is not family friendly and it is difficult to get a permanent job. PDs are very competitive, but there are not enough academic positions on offer, and women with families and mortgages especially, get 'comfy' and find it hard to move. Opportunities for industry experience are lacking. Different approaches by different departments to PDs are being experienced. On the whole, the UCC does not encourage teaching by PDs. Although academics are overworked, departments will not pay or allow PDs to teach for academic experience. More formalised procedures are needed when supervising students. Although PDs are active researchers, they are not involved in discussions with industry partners, and/or funding agencies – this makes them feel undervalued. There were a number of areas where information appears sparse, namely maternity benefits, and health and safety. Policies that are in place are not being effectively implemented. There is a lack of training in health and safety, lecturing, teaching, and grant writing. In-house training is not available to PDs, as they are not staff" (p. 10).

Galligan, Y. 2005, *Assessment of the Participation of Women in Science, Engineering and Technology and UCC*.

4. SUBTLE DISCRIMINATION IN ACADEMIC CAREERS

Structural barriers related to time and mobility constraints might be seen as indirect forms of gender discrimination and, indeed, this is the prevailing view of the literature. However, the studies revised in the previous chapter indicate that 'supply side' explanations like motherhood or lower productivity cannot fully explain differential career outcomes for men and women in academia. Overall, "the way women are or behave in comparison with men is believed to have been overestimated in past research, whilst insufficient attention has been paid to the way academic institutions are and behave" (Wissenschaftsrat, 2007, p. 20; quoted in Bettio & Verashchagina, 2009, p. 6).

As in other professional fields, the academic ladder is a hierarchy of power, recognition and income and gender segregation is not only the result of women's time and mobility constraints. Other forms of gender discrimination are at play, although they usually remain hidden beneath the veil of the meritocratic ethos that prevails in academic institutions. Current research at the national level provides well-grounded empirical evidence of this fact, in spite of cross-country differences in the presence of women, the organisation of science and the structure of universities and other academic institutions: among others, Bagilhole and Goode (2001) in UK; Beaufaÿs and Krais (2005) in Germany; Etzkowitz, et al. (2000) in the US; Gschwandtner, et al. (2002) in Austria; Husu (2001) in Finland; Palomba (2000) in Italy; Šaldová (2007) in the Cezch Republic or Ural (2001) in Turkey.

It is, precisely, the contradiction of the ideal values of science and the academic practices that is the starting point of this strand of literature. To examine this, the research goes beyond the universalistic criteria and strict norms that govern the formal procedures of recruitment and promotion in academia, analysing power relations, gate-keeping practices and informal networks as a source of tacit knowledge, support and recognition. In general, bureaucracy is said to enhance the advancement of women, as rules correct potential gender discrimination in hiring and promotion decisions (Reskin, 1977; Reskin & McBrier, 2000). However, it is also known that instituting more bureaucratic rules and levels of hierarchy may increase the power and salience of informal, hidden modes of operation (Dalton, 1959; Gouldner, 1954). Men's homosociability – the bonding of men – contributes to their maintenance of power (Kanter, 1977). When the hierarchy is male-dominated, as in academia, bureaucratisation may fail to counteract gender discriminatory practices.

Research perspectives are diverse. Some studies adopt a Bourdieu's approach to understand academic science as a social field: "The 'pure' universe of even the 'purest' science is a social field like any other, with its distribution of power and its monopolies, its struggles and strategies, interests and profits, but it is a field in which all these invariants take on specific forms" (Bourdieu, 1999, p. 31). Others put the emphasis on the culture of academic institutions, their implicit masculine norms and values, which define particular ways of doing science that are, nevertheless, historical and contingent (Schiebinger, 1999). Some frame gender relations in terms of patriarchy (Walby, 1989), while others contend different ways of doing gender (West & Zimmerman, 1987).

In spite of the multiplicity of perspectives, the literature, nevertheless, converges in some focal points. Academic institutions are seen as gendered institutions in which women have more difficulties than their male peers in entering the circles of academic power (Acker, 1990, 1992; Benschop & Brouns, 2003). The salience of informal male-dominated networks is highlighted (old-boy networks) together with such a well-known concept in the sociology of science as gate-keeping (Merton, 1973). Gate-keepers are established scientists or peers that control the definition of merit and the means of exercising academic power. The fact that the gate-keepers of scientific research in Europe are white, middle-aged male academics is argued to restrict the possibilities of those individuals that do not conform to this profile (Osborn, et al., 2000). Inclusion/exclusion mechanisms appear thus to be embedded in the standards and cultures of academic institutions and scientific disciplines, channelled through homosocial practices in informal networks and gate-keeping processes.

Gender discrimination is seen to operate at two distinct levels, although closely related. The first level is the lack of informal support in career advancement that leads to discouragement: from unfavourable tutoring and mentoring relations and the lack of collegial relationships with peers, to a hostile work climate and sexual harassment. As Husu (2005) stresses, gender discrimination in academia may take different ways, sometimes overt, but most often subtle and hidden: recruitment to attractive temporary positions can take place unannounced and closed, which is favourable to an exclusive group of men; invitations to women can be 'forgotten' when there is a place as a key note speaker at a conference. What is happening really can be that 'nothing happens' or that something that should take place in the career does not happen: not being seen, heard, read, cited, invited, encouraged. Consisting of non-occurrences, this kind of discrimination is hard to identify and challenge.

The second level refers to bias in formal assessment procedures that leads to unequal access to research funding or academic positions. Here, again, research shows the subtle ways in which discrimination may operate. From the unconscious use of gender-based double standards in highly formalised and seemingly gender-neutral peer-review processes in the early stages of the academic career, to more explicit bias when access to higher positions or awards is concerned and non transparent cooptation procedures prevail.

Rositter (1993) coined the term of the 'Mathilda effect' to highlight that gendered discriminatory practices follow the same logic of cumulative advantages and disadvantages already explained by Morton's 'Mathew effect'. The 'Matthew effect' refers to the social processes through which initial advantages in terms of capacity, structural location and available resources make for successive increments in advantage such that the opportunities for undertaking scientific research and receiving symbolic and material rewards for its results tend to accumulate for some scientists and scientific organisations (Merton, 1968, 1988). Following the same cumulative pattern, women's slight disadvantages in the early stages of the scientific career might turn into wide differences in career outcomes. In *Why So Slow? The Advancement of Women*, Valian (1999) contends that a continuous accumulation of small advantages for men and small disadvantages for women operate insidiously, resulting in very different career opportunities for the sexes.

Box 11 – The Matthew Effect in Science

The Matthew effect consists of the accruing of greater increments of recognition for particular scientific contributions with respect to scientists of considerable repute and the withholding of such recognition from scientists who have not yet made their mark.

[…] As originally identified, the Matthew effect was constructed in terms of enhancement of the position of already eminent scientists who are given disproportionate credit in cases of collaboration or of independent multiple discoveries.

[…] The Matthew effect may serve to heighten the visibility of contributions to science by scientists of acknowledged standing and to reduce the visibility of contributions by authors who are less well known.

[…] A macrosocial version of the Matthew principle is apparently involved in those processes of social selection that currently lead to the concentration of scientific resources and talent.

Merton, R.K. 1968 'The Matthew Effect in Science', *Science*, vol.159, no. 3810, pp. 56-63.

Evidence of gender discrimination casts doubt on the myth of individual merit in science. Most research in the field shows the problem through the lens of 'patriarchy', highlighting the contradiction between the myth of individual merit and the reality of a patriarchal support system (Bagilhole & Goode, 2001). As these authors contend, the "central argument is that, in terms of academic careers, individualism is the myth while male support systems are the reality, in the

process disadvantaging women who do not take to the former and are excluded by definition from the latter" (p. 161). "This perpetuates an in-built conservatism where those who emerge via such processes are very likely to be another one of the 'guys'" (p. 171). For those men who find themselves in influential company, this process of networking, mentoring and sponsorship need not necessarily be a conscious activity. This gives men a way of learning the tacit, implicit, indeterminate skills of a profession, while active requests for 'support' from minority groups are often interpreted in deficit terms. A substantial bulk of research adopts the Bourdieu's concept of 'habitus' to frame the problem. It is argued that scientific activity is subjectively interiorised through a set of specific schemes of perception, feeling, thought and action that structure scientific performance. This scientific lifestyle has developed historically under male domination and creates subtle 'gender borders' which women cannot easily cross. Several studies build on this approach to analyse empirically gender inequalities in science: among others, Engler (1993) in electrical and mechanical engineering; Frank (1990) in biology and psychology; Gomard and Reisby (2001) in philology and chemistry; Könekamp (2006) in chemistry and engineering or Rogg (2001) in social sciences.

Other studies put more emphasis on diversity and the current changes in the ways of doing science and doing gender. Hasse and Trentemøller (2008) highlight the extent of the variation within scientific cultures and the related tensions between traditional and more egalitarian gender relations, looking at the impacts on the life and academic careers of both men and women. A recurrent theme is the drastic change that scientific practice is experiencing and the obsolescence of individualistic criteria when science is increasingly complex and collective. From this point of view, it is argued that scientists of both sexes would benefit from systems of recruitment, assessment and promotion that took this collective dimension more properly into account. Criticism of the highly hierarchical and individualistic university system in Germany (Beaufaÿs & Krais, 2005), or the obsolete and individualistic rules for assessment and promotion in the French CNRS (Cheveigné, 2009) are examples of studies that point in that direction. More or less implicit to this strand of the literature is the acknowledgment of a certain de-gendering process in academic institutions and scientific practices.

Box 12 – Inequalities men-women in the CNRS

This very detailed work on employment in the French national research organisation CNRS (Centre National de la Recherche Scientifique) was carried out between 1998 and 2003 with the support of the SGEN (Syndicat Général de l'Éducation Nationale) trade union, by a collective team. In the first part, the researchers examine women's situation in the CNRS analysing the proportions of men and women in different functions and disciplinary sectors, their wages, the way they occupy part-time jobs or short term contracts, and the presence (or absence) of women in positions of power. In the second part, they demonstrate discriminations at work in the recruitment processes of both researchers and support staff. The authors finally highlight the discriminations in promotion and all along the careers of female support staff and researchers.They conclude that there remains a difference between men and women's situation in the CNRS and that an active policy needs to be elaborated to allow any serious improvement.

Daune-Richard, A., Hurtig, M., Jadelot, C. & Serne, H. 2004, 'Inégalités hommes-femmes au CNRS', *Profession éducation*, vol. 136.

4.1 Lack of support

Informal networks are a pivotal source of support for career advancement in science. They provide the feeling of belonging to the scientific community, access to professional resources, opportunities for advancement and encouragement. Research coincides to highlight that women's poorer networking resources is a powerful, albeit subtle, explanatory mechanism for understanding women's greater attrition and slower career progression compared to men's. It works through an accumulative logic of 'non occurrences' and slight exclusionary practices that

progressively disadvantage women's careers and cause a sensation of isolation, difficulty in assuming the risks inherent to the scientific career and low professional self-esteem.

Etzkowitz, et al. (2000) build on this approach to analyse gender segregation in US universities. Their point of departure is that "formal positions are only a rough indicator of success, since individuals of the same rank differ widely in the strength of their networks and their access to scientists with relevant knowledge for possible collaboration" (p. 124). Networking resources are considered to play a key role in career advancement: they allow for exchanging contacts, knowledge and information; for improving the amount, speed and veracity of the information to which one has access, for enabling and facilitating the social support essential in maintaining motivation regards scientific activity and for being able to accept criticism at work. Networking in academia is seen to follow a pattern of social relations in which power spreads in concentric circles through a snowball process: those placed more centrally are those who accumulate more networking resources and have the capacity to generate more social capital in their connections with others.When people initially manage to extend their social capital, the probability of future inclusions increases exponentially. In the same way, a lack of initial connections in the early stages puts people at a disadvantage for the rest of their professional career. It is from this perspective that differences in the social capital between men and women in US universities are extensively analysed.

Their study is based on the empirical analysis of professional relationships and networks in a sample of university departments belonging to different scientific fields (biology, chemistry, physics, computer science and electrical engineering). The quality of the professional relationships is assessed through two dimensions, colleagueship and reciprocation. The first dimension, colleagueship, deals with the scientist's sense of inclusion, the enactment of a positive professional identity which is conferred through social support relationships with other members of the department. Reciprocation affects the scientist's ability to access and exchange tangible professional resources and is analysed through indicators that show the extent to which exchange relationships are unequal and reflect power imbalances. According to the authors' study, 'untenured' women have less colleagueship (less social support) than their 'untenured' male colleagues, and women, regardless of their status, tend towards less reciprocation than men (more unequal relations), which limits them in obtaining the necessary resources to have a successful scientific career. According to this study, these dynamics are still more pronounced in those departments in which the proportion of women is very low and women tend to have a 'token' status. A critical mass of women (more than 15% of faculty members) may be one factor that can overcome the barriers against women's success, but fails to solve all problems.

The study also looks at the quality of professional networks and distinguishes between two types of connections: the intradepartmental networks, based on strong ties within the department itself, and the interdepartmental networks, which refer to the establishment of bridge bonds between different departments. Interdepartmental networks are basic for the learning of new breakthroughs, for getting important papers before they are published, for learning where researchers invest their resources, for importing techniques from other disciplines and generating channels for presenting work. The analysis shows that men and women have similar intradepartmental networks when there is a 'critical mass' of women in the department, but women's interdepartmental networks are smaller than those of their male colleagues.

Research in European countries provides a similar picture, in spite of the variety of national contexts and academic institutional settings. From a comparative perspective, it is perhaps worth noting that pervasive, albeit subtle, exclusionary practices appear to be at work even in countries considered to have reached the highest levels of gender equality inside and outside academia. As Husu (2001) stresses, Finland might be considered a paradigmatic example of the resilience of this kind of hidden discrimination. From a comparative perspective, Finnish social support systems, including good quality childcare and long maternity and parental leaves are relatively favourable, though not unproblematic, to the combining of professional work and parenting. Women in Finland have historically had a stronger presence in higher education and academia than in many other European countries. Indeed Finland is at present, and thanks to a recent organisational reform, the EU country with the highest proportion of women among full professors. Yet, Husu's extensive study shows that Finnish women continue to experience various forms of gender discrimination and sexism in academia: sometimes overt, but most

often covert and hidden. In many cases, discrimination operates through covert forms of 'non occurrences' that are especially hard to challenge. Even sexual harassment, when it occurs, tends to remain hidden. The subtlety of these practices is widely confirmed by qualitative research on women's perceptions in academia. As Koski and Tedre (2003) state, gender issues seem to be simultaneously absent and present, to vanish whenever they were about to be found. Their study highlights the widespread difficulty of generalising personal and individual experiences to female experiences and of specifying the ways in which gender issues are present in the university. Perception however changes when these experiences are dealt with collectively, as discrimination is more easily identified in other colleagues' stories than in one's own. A large amount of literature explores subtle gender boundaries in everyday academic life and discourses, namely local/institutional level studies which address covert discriminatory practices against women and the strategies they adopt to cope, assimilate or rebel (e.g. Benckert & Staberg, 2001; Bondestam, 2004; Gomard, 2002; Højgaard, 2003; Knights & Richards, 2003; Mählck 2003; Maragoudaki, 2009; Søndergaard, 2002).

Box 13 – Academic women and hidden discrimination in Finland

Academia promises much for women.Formal obstacles regarding women's access to higher education or advancement to even the highest academic posts are rare. Women have made great gains as recipients of higher education, and in many countries over half of the student population is female. However, women's under-representation among academics and gender inequalities in academia are persistent and a global phenomena. This is also the case in Finland, one of the leading countries in the world when it comes to overall gender equality, and a country with the highest proportion of women in the professoriate within the European Union. This doctoral thesis approaches academia as gendered organisations, characterised by gendered divisions, symbols and interactions. It draws on over 100 semi-structured interviews and written accounts from women in eleven Finnish universities and all the main disciplinary fields. In examining academic women's gender discrimination experiences and related responses and coping, it explores how persistent gender inequalities in academia are both reproduced and challenged, in the seemingly gender equal Finnish setting. Specific issues explored include sexual harassment and motherhood in academia; academic women's support in their careers; and the survival strategies they employ. The book demonstrates how sexism and hidden discrimination continue in the daily life of academia, but also underlines the various ways academic women continue to challenge this. The book is addressed to not only academic women but all concerned with changing academia, science and society towards greater equity, increased inclusion and the full valuation of women in the production of knowledge.

Husu, L. 2001, *Sexism, Support and Survival in Academia. Academic Women and Hidden Discrimination in Finland*, Social Psychological Studies 6. Deparment of Social Psychology. University of Helsinki, Helsinki.

Connolly and Fuchs (2009) provide further evidence of current gender differences in career support, expectations and achievement on the basis of a survey to faculty at a prestigious European university offering a wide range of study opportunities with a focus on SET. Among other things, they analyse career aspirations by considering whether faculty expect to become senior academics and whether the respondents indicate that they have achieved their ambitions. Only a very small proportion, even amongst professors, expects to become a senior academic although 68% claim to have achieved their career ambitions within academia. They control for individual demographics – gender, age, family status and domestic responsibilities, position, type of work contract, and whether the employee has taken a career break. Not surprisingly, those who are already employed as junior professors are more likely to indicate that they expect to become a senior academic, whilst those employed in junior faculty or in post-doctoral positions report very low expectations of becoming a senior academic. Holding constant other variables (age, grade, contract) they find a significant gender differential: women are much less likely to expect to reach the 'top' (figure 6). In considering whether scientists have achieved their ambitions (figure 7), they also take into account indicators of research

performance – number of publications and degree of engagement with the national or international research community – and some variables which indicate the workplace culture – support from senior colleagues, encouragement to apply for promotion and so on. Those who report benefiting from a supportive work environment were much more likely to have achieved their ambitions. Having controlled for the range of demographic and work based factors, they again find that women are much less likely to have achieved their ambitions.

Figure 6 Career expectations
Evaluated probability of becoming a senior academic

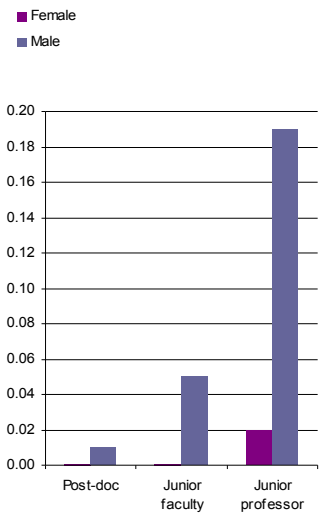
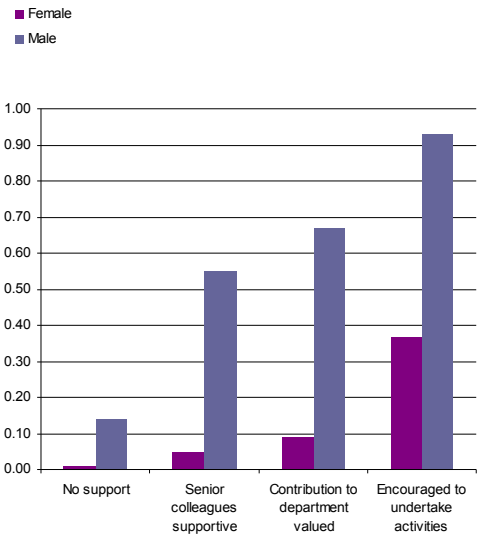


Figure 7 Achieved career ambition
Probabilities – controlling for age, grade, contract



Source: Connolly, S. & Fuchs, S. 2009 'Analysing the Leaky Pipeline in Academia' in European Commission 2009, *Women in science and technology. Creating sustainable careers*, Office for Official Publications of the European Communities, Luxembourg, pp. 59-68.

Although research in this field tends to be fragmentary, with small-scale qualitative studies that focus on a variety of discriminatory practices in a particular institution, the review of the literature indicates three themes that have received special attention. A great bulk of the literature focuses on the early stages of the academic career, particularly PhD supervision and mentoring. A second strand deals with subtle forms of exclusion and inclusion in the allocation of opportunities, resources and tasks in the intermediate academic stage, such as the tendency to find more women in teaching and administrative tasks. Finally, there is another strand of the literature that explores from a more general point of view issues related to the unfriendliness of the work climate, in which the analysis of sexual harassment emerges as a distinct theme.

Mentoring

Here we understand mentoring relations in their widest sense, considering a mentor as some senior scientist to whom PhD students or junior scientists can turn for advice and encouragement. Support is particularly important during the PhD and post-doctoral stages, the time for career formation and integration within the scientific community. Direct support from the PhD advisor or mentor and a supportive departmental climate are important factors to reduce both dissatisfaction and emotional exhaustion during these years of intensive dedication and uncertainty about career prospects, in which the coincidence with the fertility age is an additional source of strain for women. It is also a well documented fact that more women than

men leave academia during this period, although the proportion of women among PhD students, PhD holders and post-doctoral researchers is growing more or less steadily in most countries and scientific disciplines. However, women's attrition remains particularly high in the transition from post-doctoral positions to independent (tenured) positions (Blickenstaff, 2005; ESF, 2009; Martínez, et al., 2007), the moment in which an academic career can be considered as established. Need, et al. (2001; see box 14 below) highlight the paradox of enormous differences in expectations, small differences in ambitions and no differences in career efforts of male and female PhD students. Their study identifies the quality of faculty-student interaction, and particularly the quality of supervision, as the most influential factor for academic expectations.

Ledin, et al. (2007) provide further evidence on gender inequality in professional support to young researchers as a widespread phenomenon in European countries. Their study is based on a survey of applicants for the prestigious European Molecular Biology Organisation's (EMBO) Long-Term Fellowships (LTFs) and the Young Investigator Programme (YIP). They found that women reported having received less professional support than men: 32% of the female YIP applicants reported that they had a mentor, whereas 71% of those who did not have a mentor would have liked to have had one. For men, the situation was more balanced: 49% had a mentor and 46% wanted one. In general the survey found that more women than men felt they were in need of better mentoring. Furthermore, women more frequently reported that their supervisors had become less supportive and more critical when they had children. Women also felt that in hindsight, men had received more support from their supervisors at the PhD and postdoctoral level: 27% of LTF applicants and 44% of YIP applicants. In addition, 17% and 34% of the women at the early postdoctoral level or the independent research level, respectively, had witnessed what they felt to be negative discrimination of women, and 7% and 13%, respectively, felt that they had been discriminated against. The authors' conclusion is clearly stated: "We fully accept that this is subjective, but if we also consider the responses of the male applicants to the programmes—2–8% of who reported having witnessed the negative discrimination of women—we feel justified in concluding that there is an element of discrimination against women, even in modern professional environments" (Ledin, et al., 2007, p. 986). These findings are also consistent with US research, which provides similar evidence of young women reporting feelings of isolation and lack of support from peers, mentors or advisors and, in general, senior faculty (NAS, 2007).

Research reflects that the vulnerability of young scientists at these initial stages depends largely on the structural conditions of the academic career track. In highly insecure, dependent and individualistic systems there is more room for discretion and potential bias. It is the case of the German model of assistantship, in which one professor can "make or break an academic career", as Roloff (2001, p. 6) states. Beaufaÿs and Krais (2005) have analysed this issue extensively and its consequences in terms of gender equality. They contend that there are four major distinct trends that make it particularly difficult to take up a scientific career in Germany. First, there is only one career model, the university model. The scientific system does not provide the opportunity to follow other scientific paths: the directors of research in the public research institutes tend to be university professors and young scientists have to be trained and acquire their academic degrees (PhD and habilitation) at the university. Secondly, there is a general rule against internal appointments at the university. Young scientists cannot apply for a position in the same university in which their academic degree has been obtained. Third, there is not a proper university ladder with a series of intermediate tenured-track positions. The first secure position at the university is that of the professorial chair. While professors enjoy a high degree of power and scientific independence, young scientists are forced to remain for a long time in a highly insecure situation. Their opportunities for scientific research and career advancement are strongly dependent on the professor to whom they are attached. Finally, career prospects are extremely unpredictable, and not only because the number of professorial chairs is reduced. Criteria for appointment remain largely obscure and the whole system depends on cooptation. In this kind of all-or-nothing game in which luck plays its role, gaining the favour of the professor to build a powerful set of connections remains the most effective strategy. Young women face more difficulties than their male colleagues to survive in such a system, and there is overwhelming empirical evidence that maternity and the family is not the root of the problem. Women face without doubt more acute time and mobility constraints that play a role in cooling out processes, but dedication plays a highly symbolical role and women

are first seen as female and potential mothers than as committed scientists. The fact that remains is that women are and feel less supported and encouraged to take up an academic career. Langfeldt (2006a, 2006b) confirms the lack of support, weak institutional integration and hostility against parenthood as distinct trends of PhD training in Germany with a clear gender dimension and provides further empirical evidence of gender differences in networking resources. She analyses the size and structure of the circle of people in which the doctoral candidates move in the event of professional or motivational difficulties. The results show that there are no differences in the size and structure of the networks of male and female PhD students, although the old boys' network emerges and is important for post-doctoral researchers.

Aside from institutional constraints, other studies analyse the extent to which disciplinary cultures generate specific modes of gender relations or gender imbalance in terms of the recruitment of young scientists (e.g. Leicht-Scholten, 2008; Lützen & Larsen, 2005; Yair, 2009). In general research highlights some factors –the degree of male-domination, the differences between natural and social sciences, or between science and technology – although studies are heterogeneous and do not provide a comprehensive picture. Interestingly, a trend that emerges in these studies is the relevance of different structural conditions in natural and social sciences: academic life may be tougher for young scientists in social science and humanities, compared to natural science and medicine where working in research teams is much more common. The relevant finding is that this structural isolation may act as an unintended exclusionary mechanism for women, who tend to be under greater family-career tensions or have poorer network resources (Lützen & Larsen, 2005; Yair, 2009).

Indirect evidence of the extent of subtle forms of discouragement and exclusion towards women during these initial years is provided by US literature. Mentoring is a relatively institutionalised practice in the US academic system, with a large number of studies evaluating its effects in terms of retention, productivity, professional satisfaction and career advancement. It is indeed a common finding in US longitudinal studies that a good mentoring relationship has a clear positive impact on the career outcomes of women and minority groups, with this effect in men being lower or non-significant: in the case of women, satisfactory mentoring experiences are associated with lower attrition and better results in terms of publications and tenured positions (NAS 2007, 2009). In other words, formalised mentoring relationships may provide, to those that do not conform to the implicit academic 'norm' – women, minority groups – the kind of in-built support that most men get inadvertently through informal relationships.

Box 14 – Ambitions without a chance. Gender differences in expectations, ambitions and the career efforts of PhD students at the University of Amsterdam

This article answers the question about the extent to which male and female PhD students differ in their expectations, ambitions and career efforts, and, to what extent these differences can be explained by characteristics, either individual or of the academic organisation. We answer these questions with research data that has been collected since 1999 among PhD students at the University of Amsterdam. The results show that there are enormous differences in expectations, small differences in ambitions and no differences in male and female PhD students' career efforts. Furthermore, the research results indicate that the importance that PhD students give to a private life, especially a preference for part-time work, compete with the efforts that are considered necessary for an ambitious academic career. Finally, three characteristics of an organisation affect the efforts that PhD students want to make for their academic career. Support of their supervisors, having a formal PhD contract and there being a larger number of female full professors increase the efforts that PhD students want to make regarding their scientific job. Their supervisors' support has proved to be the only factor that affects their expectations of becoming a full professor.

Need, A., Visser, J. & Fischer, A. 2001, 'Kansloze ambities? Sekseverschillen in verwachtingen, ambities en loopbaaninspanningen van promovendi aan de Universiteit van Amsterdam', *Tijdschrift voor Arbeidsvraagstukken*, vol. 17, no. 4, pp. 350-364.

Professional activities and institutional resources

Research highlights that the structural location of men and women differs widely, even among scientists of a similar rank. The overall trend is that women tend to be overrepresented in less prestigious institutions and less prestigious tasks, with a more peripheral location in scientific networks and less access to institutional resources for doing science. Studies in Europe highlight the gender dimension of current dualisation tendencies in the higher education system, with an increasing divide between prestigious universities involved in high-quality research and other universities mostly dedicated to teaching (e.g. Blagojevic, et al., 2003, for the analysis of the higher education system in the Eastern countries). A similar pattern is found in the extremely competitive US higher education system (Xie & Shauman, 2003)

Gender differences in professional activities and institutional resources may be a result of blatant discrimination. In the late 1990s, the Massachusetts Institute of Technology admitted to having given fewer resources and lab space to female than male scientists of equal seniority (MIT, 1999, 2002). Since then the need to guarantee equal access to institutional resources has been present in the US academia and recent studies show that equality prevails among scientists in the same institution and similar position (NAS, 2009).

Our review of the literature shows that this concern is not present in European studies. However, great attention has been paid to the kind of academic tasks that men and women perform. The unequal distribution of academic tasks between men and women is a sensitive question, because promotion criteria are usually based on research outcomes, albeit teaching and administrative tasks may require substantial energy and time. The general assumption is that women tend to dedicate less time to research and more to teaching than their male colleagues, although this pattern cannot be generalised. This is one of the issues considered in diagnosis studies linked to gender equality programmes that have taken place during the last decade in a series of European universities. For example, Izquierdo, et al. (2004) analyse the allocation of tasks in detail at one of the most important universities in Spain, finding that women tend to dedicate more time to teaching and other 'invisible' and poorly recognised tasks than men of similar rank. In Germany, gender differences in the teaching workload among PhD students and post-doctoral researchers have long been considered one of the factors that disadvantages and discourages women (Mersmann, 1996; Roloff, 2001), although research shows that such differences are decreasing (Lind, 2006). A recent US study concludes that the situation varies across disciplines: in some fields, the amount of time dedicated to research, teaching and other services is similar for male and female scientists of similar rank (biology, civil engineering, electricity and physics), while in others it is indeed confirmed that men dedicate more time to research than women (chemistry and mathematics) (NAS, 2009).

In general, the literature stresses that eventual gender differences in the allocation of time to research, teaching and administrative tasks have relevant consequences for career advancement. However, it is also worth noting that research in this field provides other relevant reflections. Women, precisely because they are more frequently than men victims of the contradictions inherent to the academic system, appear to be more aware of the tensions related to the fact that academic institutions do not fully foster and recognise research cooperation and non-teaching activities. This is the main conclusion of the study by Cheveigné (2009) on gender inequalities in the CNRS. Attention to the collective dimensions of research is the main specificity in the women's discourse that differentiates it from that of men's: "The women we interviewed at all levels of the hierarchy chose to privilege the collective dimension in a very explicit way: they subscribed less readily than did men to the value of idealized isolation for the researcher, and they spent a lot of energy attempting to palliate objective isolation and to ensure collaborations at all levels, whereas their male colleagues readily adopted more individual strategies. However, in spite of official statements to the contrary, promotions both for researchers and support staff are mainly based on individual accomplishments or activities. In allowing such a situation to go on, the organization reinforces the observed contradictions, especially to the detriment of women. It confirms an individualistic model through the way it considers some types of activity. At the same time it makes collective work both more necessary and more difficult through the way it imposes excessively complex organizational requirements on its employees. Thus, it validates traditional gender relations in science, instead of seriously counteracting them" (Cheveigné, 2009, p. 130).

Box 15 –Women scientists perceptions of their work conditions and career development

This article reports preliminary findings on Portuguese women scientists' perceptions of gender issues in their institutions. Empirical data were collected by means of an electronic open questionnaire sent to the members of AMONET (Portuguese Association of Women in Science). Basically, the study aims to examine the degree of satisfaction with their profession, the difficulties they meet in everyday professional life, and whether they feel or have ever felt gender discrimination in their institutions. Findings show that all respondents feel happy or very happy with their profession. However, discrimination is mentioned by a significant percentage, even if such discrimination quite often assumes an elusive form, suggesting that higher institutions still discriminate against women. The findings, articulated with the literature, also lead to discussion about power and leadership, both in the hands of male academics in the majority of the institutions, as well as to the clarification of the different male and female perceptions of ambition.

Gonçalves, M. 2006, *Scientist women perceptions of their work conditions and career development*, Universidade Nova de Lisboa, Faculdade de Ciências e Tecnologia, Unidade de Investigação, Educação e Desenvolvimento, Caparica, vol. 7, pp. 147-155.

Sexual harassment

Studies about the work climate in academic institutions tend to highlight that a male-dominated environment can be hostile to women in several ways, from difficulties in socialising with male colleagues to bullying and sexist attitudes. The most blatant is sexual harassment, a particularly delicate matter. US literature has paid considerable attention to this theme (i.e. Paludi & Barickman, 1991; Patai, 1998) but according to our review there is no systematic research in Europe. However, the existence of sexual harassment has been documented in a number of studies and it is worth noting that in countries such as Finland and Sweden research on this theme appears to have been encouraged by greater sensitivity on the part of academic institutions and equality policies. In spite of this, all the studies provide a common picture of the difficulties in counteracting a phenomenon that tends to remain hidden and leads to the victim's isolation.

A study at the University of Helsinki evidenced the pervasiveness of this problem (Mankkinen, 1995). During the previous two years about 7% of the university staff had suffered sexual harassment, 78% of whom were women. Of the students, almost 3% had been victims, the majority of whom were also women. The study confirmed that sexual harassment may take multiple and diverse forms, from serious harassment to the overemphasising of sexual roles, or ambivalent disturbance on the part of a colleague or a student. In turn, it could be a single harsh incident or a more continuous process, in some cases under promises of career advancement. It was found that sexual harassment provokes a deep feeling of isolation and professional discouragement. The study highlighted the veil of silence that most often surrounds this kind of practices. Usually the victims evaded the harasser and did not talk about the incident publicly. Starting action against this person was difficult, due to the shame of the victim or institutional practices and traditions of covering such incidents up. In a similar vein, Bagilhole and Woodward (1995) contend that the incidence of sexual harassment in UK universities is underestimated, as well as its impact on women's professional careers. On the basis of a qualitative study in a UK university, they conceptualised the different types of sexual harassment that exist in universities, both among students, as well as among teaching staff, constructing a gradation that ranges from verbal intimidation right through to physical assault.

The ambiguity that surrounds the very understanding of sexual harassment has been explored by Carstensen (2005) in Swedish academia. The study argues that the use of this concept is partly informed by the assumed gender neutrality of the professional order and partly by what are culturally expected interactions between men and women. However, the space for drawing a boundary and naming some type of behaviour sexual harassment seems to be minimal. Harassment tends to become 'everything' and 'nothing' at the same time, with this ambiguity paving the way for the invalidation of sexual harassment as a real problem in the academic

setting. Similar conclusions were also drawn by Färber, et al. (1994), who analysed empirical sexual harassment by professors with respect to students in one German university, underlining its dramatic consequences on the students' academic careers. They argued that the topic of sexual harassment was particularly controversial in the academic debates about political correctness. Supporters of a liberal atmosphere at universities blamed the women that reported harassment for being 'touchy' and all too disposed to seeing themselves as victims. It was also found to be the prevailing mood among students, with many victims having shared these opinions before being sexually harassed themselves.

Box 16 – Support, encouragement and recognition in men and women's academic careers. Results from the Athena survey.

The Athena Forum's mission is to provide a strategic overview of developments that seek to, or have proven to, advance the career progression and representation of women in science, technology, engineering, mathematics and medecine (STEMM) in UK higher education. Forum members are nominated by the UK's leading scientific professional and learned societies. One of its activities is to carry out surveys regularly on the differences, both real and perceived, between men and women's career progression in UK universities.

The 2007 Forum report presents the findings of the 2003/04 and 2006 surveys. The 2003/04 surveys together covered 40 universities and 4,282 respondents (F 1,535, M 2,747). The 2006 survey covered more than 70 universities and 3,453 respondents (F 2,288, M 1,165).

Results point to the institutional processes where changes could make a difference. They suggest that much still needs to happen before women perceive themselves to have the same level of support, encouragement, development opportunities, and recognition as their male colleagues:

<u>Key career transitions- promotion</u>

- Women are less likely than men to be encouraged to apply for promotion.
- Women are less aware of promotion criteria and processes.

<u>Career development</u>

Career development provision

- The higher the grade, the more likely it is to be provided by employers.
- Women are less likely than men to have employer provision, and more likely to look for it in their professional societies.

Factors contributing to career progression

- Women are more likely than men to rate the following as important: external collaborative work, external networking and support/encouragement from their partner/family.

Professional activities

- At the professorial level women are as likely/more likely to be invited to contribute to conferences, however, at lecturer level women are overlooked.

<u>Organisation and culture of STEMM departments</u>

- At the professorial level women are much less likely than men to head departments, but do carry at least a fair share of all other admin/management roles.
- Men feel themselves to be 'better treated/better supported' by their departments.
- Women feel their 'disadvantage' far more strongly than do their male colleagues, in particular in relation to promotion and visibility in senior management.

<u>Flexibility in the working day, working year and working life</u>

- Over half the female professors and senior lecturers in the 2006 survey had taken career breaks.
- For women who had taken career breaks, good quality child care and flexible working were the most important factors for returning to work.
- Flexible working was valued highly by men and women.
- At senior lecturer level significantly more women than men rated as important, meetings finishing on time/being held in core time.

Athena Forum 2007, *Report 2 Athena Surveys of Science Engineering and Technology (ASSET): Headline Findings on Women's Career Progression and Representation in Academic Science from the 2003/04 and 2006 Surveys*

4.2 Double standards

Gender discrimination may operate not only through subtle forms of isolation and discouragement, but also in formal processes of assessment that have a direct effect on the allocation of opportunities, i.e. who receives a grant or who is appointed to a certain position.

Research in this field is scarce and relatively recent. The pioneering work was that of Wennerås and Wold (1997) concerning awards of postdoctoral fellowships in biomedicine in Sweden. The evaluation procedure was apparently excellent for ensuring fairness: five committee members, who were not allowed to review candidates institutionally close to them, evaluated each dossier. As it is well known, however, their study showed that the performance of men with ties to the committee members was systematically overestimated whilst that of men and women with no connections was underestimated. Women – as well as unknown men – had to publish twice as much in order to receive the same score as men who were known by at least one committee member. Women without connections therefore suffered a double handicap and to be scored as one man with connections they had to demonstrate such an outstanding level of productivity that was only attained by three of the 114 applicants (two women and one man). "Hence, being of the female gender and lacking personal connections was a double handicap of such severity that it could hardly be compensated for by scientific productivity alone" (Wennerås & Wold, 1997, p. 342). In order to prevent such a waste of talent, they claimed for a 'scientific evaluation of the system of scientific evaluation' and the development of peer review systems with some built-in resistance to prejudice and nepotism.

As a means of avoiding any eventual gender bias, the ETAN report (Osborn, et al., 2000) made an explicit call to increase the transparency and accountability of the peer-review system. This recommendation, thanks to the support of the European Commission, has substantially encouraged research and debate at the European level. The report *Gender and Excellence in the Making* (EC, 2004) provided a first opportunity to move forward and deal with the multiplicity of factors that may bias the definition and measurement of merit across the whole academic career track. In turn, the report *The Gender Challenge in Research Funding* (EC, 2009c) analysed from a gender perspective the procedures used for allocating grants, fellowships and research funding in general.

Research in this field has been parallel to a process of increased formalisation of systems of evaluation in most western countries, itself part of a broader emphasis on transparency and accountability in the whole academic system. However, formalisation remains at odds with access to the scientific elite, in which procedures for recognition are far less transparent and criteria more diffuse and intangible. Both themes emerge neatly in the literature review.In recent years, research appears to be paying increasing attention to assessment criteria and peer review processes in the early stages of the academic career, although the more opaque procedures of cooptation in the scientific elite remain largely under-researched.

Formalised peer review processes

It is a well documented fact in psychosocial research that gender does matter in evaluation procedures. In spite of a general move towards more equal gender relations and values, the majority of both men and women tend unconsciously to rate the quality of men's work higher than that of women's when they are aware of the sex of the person to be evaluated, but not when the sex is unknown. Evaluation experiments show that changing the submitter's first name results in a significant difference in the scores assigned to identical documents (Steinpreis, et al., 1999). Experiments conducted by Foschi (2000) evidence the pervasive, albeit unconscious, use of gender-based double standards, with stricter standards for women than for men. That peer-review system is vulnerable to this kind of prejudice was first evidenced by Wennerås and Wold (1997). A metaanalysis of 21 studies has shown that men have a statistically significant (7%) higher chance of receiving grants than women (Bornmann, 2007; Bornmann, et al., 2007). Overall, literature contends that differences in men and women's success rates require further scrutiny. Of particular concern are grant and fellowship programmes for young researchers with huge gender differences in success rates, because it does not seem plausible to find large

differences in scientific performance at such early stages (de Pablo, 2006; Watson, et al., 2005).

In the Netherlands Brouns (2000) conducted a similar study to that of Wennerås and Wold, also of postdoctoral fellowships. The study analysed gender bias in assessment procedures in one of the major institutions for scientific grants in the Netherlands, the Dutch Organisation for Scientific Research (NWO). Two scientific fields were selected: one in which women were very successful (science and mathematics), and another in which women were not (biology). A total of 128 files were analysed on the basis of a correlation of characteristics of the applicant (sex, age and scientific productivity), assessments by the external advisors (peer review), and the final decision of the NWO. It was found that on average, women had slightly better publication scores than men, a fact that was interpreted as confirmation of more stringent self-selection processes in the case of women. Unless they were particularly well qualified, women did not apply. Secondly, it appeared that when men and women had equally high productivity scores, women were more often characterised as 'good researchers' while men were described as 'brilliant researchers'. Finally, the expected correlation between track record, peer review, and the NWO decision could only be demonstrated for the male applicants. In the case of women the connection between qualification and success was not straightforward. Women in biology were evaluated less favourably than were men with similar track records, whilst women appeared to receive preferential treatment in science and mathematics.

This study may be considered illustrative of the overall situation. It does not provide a straightforward confirmation of pervasive discrimination against women in peer-review procedures but it shows that discrimination may and does occur. The evaluation of merit is not independent of gender relations in academia and the society at large (EC, 2004). Ledin, et al. (2007) did not find any evidence of gender bias in the allocation of the European Molecular Biology Organisation's (EMBO) post-doctoral fellowships, in which women's success rate is on average 20% lower than that of men. Having tested different ways in which unconscious gender prejudices may have influenced the decisions made by the selection committee, their overall conclusion was that the system was not biased. Nevertheless, it is also worth noting that the EMBO has adopted a proactive policy of transparency and gender monitoring in its selection processes for some time. The institution has fostered gender awareness among members of the selection committees with gender disaggregated statistics available from 1996 onwards and regular monitoring of its selection processes with regard to gender. The 'evaluation of the evaluation' is a powerful mechanism for preventing any potential gender bias. It is well known that the devastating results of the study of Wennerås and Wold (1997) led to a reorganisation of the peer-review procedures within the Swedish Medical Research Council. Their study was replicated some years later, with perhaps not that surprising result: gender bias appeared to have been eliminated, but nepotism still remained (Sandström & Hällsten, 2008).

Although it is widely agreed that more transparency is needed to remove potential biases in assessment procedures, either gender-related or not, the scrutiny of peer-review systems is usually met with reticence by academic institutions. Many expert reports contend that more often than not, the analysis is simply not possible because the information about the applicants is not made public. The case of the Czech Republic is just one example among others. Although several studies have been recently carried out in order to analyse why women receive fewer awards than their proportion among scientists would justify, in-depth analysis of gender bias in assessment procedures is hindered by the lack of data: even sex disaggregated data on applicants and awards are not made public, despite a motion from the National Centre for Women and Science (NCCWS) calling on the Research Council to do so (Křížková, 2009). Perhaps it should be remembered that the Wennerås and Wold (1997) study could only be carried out after the authors cited the Swedish law authorising access to official documents.

Another strand of research looks into the criteria for evaluation[2]. As Feller (2004) states, assessment procedures that only rely on bibliometric measures not only exacerbate existing inequalities between men and women in the scientific system, but might not be the best way to assess the scientific potential of candidates. Particularly, slight differences in the quantity of

[2] See the topic report "Gender and scientific excellence" by Elisabetta Addis for in-depth discussion of gender bias in assessment criteria and bibliometric measures (Addis, 2010).

publications at an early stage of the scientific career might turn into wide differences in the allocation of opportunities for doing research and have a determinant impact on career outcomes. This is, at best, the main conclusion that can be drawn from the above mentioned study of the EMBO fellowships (Ledin, et al., 2007). Their bibliometric analysis showed that there was a small but statistically significant gender gap in the number of publications, which they explain in terms of women's greater time constraints due to the traditional gender roles. Research in this field has paid special attention to the implicit norm of uninterrupted dedication that prevails in most grant schemes, with disproportionate effects for the take off of women's careers (Linková, 2002; Thorvalsdóttir, 2004).

Finally, research in this field also contends that the undervaluation of non-research activities and of certain subjects and research approaches are also factors to be taken into account. One of the conclusions of the International Congress of gender bias and inequalities in the evaluation of academic quality, held in Spain in 2008, is that the assessment of the academic curriculum has been reduced practically to the consideration of publications and participation in competitive research projects, with teaching activities implicitly devaluated (Izquierdo, et al., 2008). Other authors point out that the evaluation system esteems the knowledge produced by the established scientists. This fact entails bias against non mainstream research subjects and methods, which are more frequently used by women than by men due, among other things, to their more peripheral situation in the scientific system (Drotner and Mouritsen, 1999; Hearn, 2001). It is what Garcia de León (1990) refers to as 'sophisticated discrimination'.

Box 17 – Sophisticated discrimination

Sophisticated discriminations are those derived from women's own research styles: methods, characteristic subjects, specific problems, the singular use of academic language…Their own style characterised by opposition to males (i.e. observed in the social sciences) and which may be negatively assessed in an examination by a usually all- male panel. A research style that is shown not as a free choice, but rather as an external imposition that is related to the researchers' lack of power, i.e. a large national survey requires heavy financing that is usually achieved by men, as they are in the highest teaching and research hierarchy: the professor; the use of qualitative methods is seen in women researchers.

Statistics, university manuals, testing, course programmes …, generally divide the study of women's social reality, not deliberately but due to its andocentric 'scientific' appearance. What happens on paper is indicative of what can also happen in the non-belligerent field of books, and intensely in the complex processes of judging the intellectual production of a candidate, and in the general selection processes.

García de León, M.A. 1990, 'Las profesoras universitarias: el caso de una élite discriminada', *Revista Complutense de Educación*, vol. 1, no. 3, pp. 355-372.

Cooptation procedures

The trend towards transparency and accountability in academic assessment procedures is aimed at counteracting the hidden power dynamics that are at play when any funding or appointment decision is made. The higher we climb in the academic hierarchy towards the elite, the more the informal power dynamics that all organisations have are developed through the so-called 'invisible colleges' or 'old boys' networks'. As Palomba states (2006, p 136), "we are still fighting to demonstrate that the low female presence at the highest levels of the scientific hierarchy is an indicator of the incapacity of research institutions to follow changes in society (such as women's increase in higher education) which in turn highlights the dysfunction of a system for the evaluation of scientific excellence that did not abolish or weaken the 'old boys network system' of co-optation, a system well known by those who participated in whatever procedure for evaluation or selection where the antinomy between the criteria of 'being part of'

(a discipline, a 'school', an academic circle, etc.) and those of merit enter inexorably into conflict, to the full advantage of the former".

This statement is based on the results of the study on gender and science in Italy coordinated by Palomba (2000), which casts more than doubts on the meritocratic ideal. In the framework of this study, Menniti and Cappellaro (2000) analysed the factors influencing access to the highest scientific positions (A grade) at the National Research Council (CNR), the largest Italian public research body with over 6,000 scientific personnel. The analysis was based on a cohort of about 1,000 scientists –of which a fifth were women – who entered the B grade in the same year. Survival analysis techniques were used to measure an individual's probability of surviving until a given event takes place within a certain time interval. The 'event', in this case, was being promoted to A grade. The study showed that men had a significantly higher probability of being promoted, other factors being held constant (age at promotion, disciplinary field and number of publications). For example, after seven years at the B grade, men had a 23% probability of being promoted to A grade, while women only had a probability of 12%. After 11 years of permanence in the B grade, men had a 28% probability of being promoted, women less than half the chance. The conclusion is that "factors such as age at promotion, disciplinary fields and the number of publications only provide a partial explanation to the gender differences occurring in scientific career pathways. The main explanatory factor is and remains gender" (Palomba, 2006, p.136). Similar studies have been made in other academic settings and countries, with similar results (i.e. Micali, 2001 for university professors in Italy or Sabatier, et al, 2006, for life scientists in France). Interestingly, Sabatier, et al. (2006) found that everything else being equal, women had to demonstrate a higher level of involvement in professional networks to be promoted to the highest academic grade.

Research exploring the gender dimension of these hidden power dynamics that govern access to the elite positions is scarce. A notable exception is the study of García de León, et al. (2005) about the Royal Academies of Science in Spain.The academies, which are the most prestigious scientific institutions in the country, were completely male-dominated until the late eighties. The appointment of the first woman only took place in 1987 and ever since women continue to be severely represented, even in comparison with their presence among full professors: they are what García de León calls 'a minority within a minority'. The study is based on an extensive qualitative fieldwork on both male and female members of the academies and was intended to understand the power relations and symbolic processes that are at play in the reproduction of male domination.Scientific excellence is understood in this study through the lens of Bourdieu' concepts of habitus, social and cultural capital and distinction (Bourdieu, 1979). 'Distinction' is said to be established by the high social groups through cultural and social uses learnt only in a long classicist enculturation process. Understanding scientific excellence through the concept of 'distinction' allows the focus on the implicit and symbolic mechanisms of power reproduction in science that lead to the over-selection of women. The study thus highlights that to enter these academies, women have to pass, first, the same filter of scientific performance that men have to pass, according to which they must achieve as much as men; secondly, the patriarchal filter, that forces them to behave like men; and third, to bear the burden of being singled out as pioneers in the Academia.

Zimmermann (2000) adopts a similar approach to analyse the appointment of professors at German universities, focusing on the hidden power games that are at play behind the scenes. It shows how quality and decision-making criteria in appointment procedures (which are supposedly handled objectively) are negotiated, situationally modified and recodified several times. Suitability thus constructed is the mechanism for the persistence of male homosocial recruitment patterns that are enormously stable in higher academic positions. Already established professors negotiate the necessary qualifications for new faculty members, choose the candidates and decide whether they fit into the faculty or not or whether qualifications should be re-interpreted in order to make them suitable. The resilience of these self-perpetuating mechanisms was analysed by Vazquez-Cupeiro and Elston (2006) in Spain. Spanish universities have been recently reformed to establish a more meritocratic model of recruitment and promotion. However, the tradition of 'sistema endogámico' (an 'inbreeding' system) persists, under which appointments are frequently made on the basis of internal (departmental) networks. This was found to operate to the disadvantage of women in the two disciplines studied, psychology and engineering. In a similar vein, Van den Brink (2009) looks

'behind the scenes of sciences' to explore gender practices in the recruitment and selection of full professors in the Netherlands. The study is based on exhaustive empirical evidence, with almost 1,000 appointment reports and about 60 interviews with committee members. The research challenges the view of an academic world where the allocation of rewards and resources is governed by the normative principles of transparency and meritocracy, and highlights the distance between the ideal ethos of science and the actuality of social interaction in daily working situations. The results reveal various gender practices tied in with professorial recruitment and selection, such as the influence of the dominant recruitment by invitation, in which gatekeepers recruit new professors in their own homogeneous male networks. Committee members appear to use micropolitics to bend the rules to their own advantage.

Box 18 – Professional networks and gender differences in promotion

The aim of this paper is to analyse the factors that influence the length of time there is to promotion for male and female academics. Promotion is defined as elevation to a professorship. The authors examine the role of academic profiles, which are based not only on publications, but also include activities such as fund raising, consulting, teaching and managerial appointments (for instance, being dean of a department). The paper examines the factors that speed up or slow down the progress of an academic career for males and females, respectively, to explore the effects of the « glass ceiling ». Survival and duration models are used to test whether the gender differential persists after controlling for observed and unobserved heterogeneity. The originality of this paper lies in the use of duration models to track sex differences in promotion criteria. It highlights that there are different criteria of promotion for male and female academics: women have to demonstrate higher involvement in different networks in order to be promoted.

Sabatier, M., Carrère, M. & Mangematin, V. 2006, 'Profiles of Academic activities and careers: does gender matter? An analysis based on french life scientist Cvs', *The Journal of Technology Transfer*, vol. 31, no. 3, pp. 311-324.

5. SCIENTIFIC CAREERS OUTSIDE THE ACADEMIA

In most European countries, statistical evidence suggests that the mobility of researchers between academia and industry basically goes one way: scientists trained in the university find a research position in industry, but returning from industry to academia is very rare, among other things, because the rigidity of academic institutions leaves little room for deviations in the academic career (ESF, 2009). Statistics also show that in most countries more women than men leave the academia in the PhD or post-doc stages, although more men than women find a research position in industry. According to the most recent data for the EU-27, women account for 39% of researchers in the governmental sector, 37% in higher education and hardly 19% in the business sector. The severe under-representation of women in industrial research is a common trend in all European countries, although percentages vary a great deal (EC, 2009a). Does it mean that industrial research is more hostile towards women than academic research? According to our review of the literature, this question does not have such a straightforward answer.

In this chapter we review the literature on gender and research careers outside the academia. In spite of the increasing importance of industrial R&D activities, very little is known about the careers of researchers in non-academic science and technology areas (ESF, 2009). This is also true from a gender perspective. Academia is the dominant concern in the literature on gender and science, with only few studies dealing with industry and other non-academic R&D areas.

The European Commission's initiative 'Women in Industrial Research' (WiR) has played a major role in situating this issue on the political agenda. At the end of 2001, the European Commission set up an expert group to analyse and make recommendations to improve the situation of women in industrial research. The so-called WIR report (Rübsamen-Waigmann, et al., 2003) stressed the under-representation of women in industrial research and criticised the lack of gender awareness in some companies, arguing for a general change of research cultures and modern working conditions, which would allow men and women to have both a research career and a family life. Furthermore, under the WIR initiative a study compiling statistical data and describing good practices in companies (Meulders, et al., 2003) and a survey on company level data and good practices (EC, 2003) were commissioned. Later on, the expert group Women in Science and Technology (WiST) presented their report on the 'business perspective' (EC, 2006), which examines what can be done to attract more women researchers into industry. A second WIST report was presented with further research on diversity management and work/life balance in all kinds of R&D institutions: universities, research institutes and companies (EC, 2009b).

These reports coincide in highlighting two main problems in industrial research that disproportionately affect women. First, there is a lack of structures to support a healthy work/life balance and secondly, a need to develop a more inclusive work culture in order to include more diverse researchers and enhance creativity. As stated in the WiR report: "To promote diversity and gender balance, companies need to treat the individual as a whole person. This involves work/life balance policies that allow employees to accommodate family and caring responsibilities and, if they wish to engage in cultural, religious, community, trade union or other activities. Secondly, there is a 'democratic' principle that entails building a listening culture, where systems and structures are transparent and open. This puts an end to patronage, the 'old boys network' and nepotism and allows for recruitment and promotion based purely on merit" (Rübsamen-Waigmann, et al., 2003, p. x).

Box 19 – Working conditions and trends for female researchers in industry in EU Member States

Based on the European Labour Force Survey (LFS) in 2002 a first analysis was undertaken to analyse the working conditions and situation of female researchers in industry. Preliminary data show the following trends:

- During recent years (1995-2000) in industry (Business Enterprise Sector – BES) employment of highly qualified female scientists and engineers increased faster than that of males.
- At the EU level, nearly 60% (in Spain, more than 80%) of all women scientists and engineers in industry/BES are under 34, they were significantly younger than their male colleagues and tended to be younger than other female employees (non-researchers) in the same sector.
- Women scientists and engineers are more likely to have a temporary contract than their male colleagues (this is even more pronounced in the public sector). However, there are significant country differences: many more women scientists and engineers have temporary contracts in industry/BES in Belgium, Italy, Luxembourg and Portugal than in other EU countries.
- A higher proportion of female than of male scientists and engineers in industry/BES is employed in small and medium-sized enterprises (SMEs).
- In all EU countries the proportion of women scientists working part-time is clearly smaller than that of other female part-time employees in the same sector. Only every sixth female scientist or engineer works part-time in the business enterprise sector. Country differences are significant: while nearly half of all women scientists and engineers in the Netherlands work part-time, only 4% do so in Denmark.
- Scientists and engineers are four times more likely to work from home than other employees, especially male scientists and engineers. While 12% of women scientists and engineers in enterprises usually or sometimes work from home, the percentage for men is 18%. Again there are distinct country differences. Nearly 50% of all female scientists and engineers in Denmark usually or sometimes work from home, while in Spain and France working from home is almost non-existent.
- In the EU, relatively fewer women (28%), who work as scientists in industry/BES, have one or more children as compared to female non-researchers working in the same sector (34%).

Rübsamen-Waigmann, H., Sohlberg, R., Rees, T., Berry, O., Bismuth, P., D'Antona, R., De Brabander, E., Haemers, G., Holmes, J., Jepsen, M. K., Leclaire, J., Mann, E., Neumann, J., Needham, R., Nielsen, N. C., Vela, C. & Winslow, D. 2003, *Women in industrial research: A wake up call for European industry*, Office for Official Publications of the European Communities, Luxembourg, p. 20.

Beyond these comparative reports, gender inequality in industrial research has not been widely studied. We have found some basically descriptive studies in a few countries, mainly providing statistics, together with other small-scale studies, especially about women in engineering, usually exploring the situation in a specific sector and country. Comparative and large-scale empirical studies are scarce, although some relevant studies have been carried out recently. This is the case of Prometea for engineering (Godfroy-Genin, 2009), Women-core in the field of construction-related research (www.women-core.org) or WWW in ITC (Valenduc, et al., 2004). In addition, studies about non-academic research have been recently promoted in some countries by ministries or public institutions within the wider scope to fully address women's advancement in research-related professions (i.e. Papouschek & Pastner, 2002 in Austria). Finally, engineering professions and professional identities have been widely analysed across European countries from a gender perspective (i.e. Evetts, 1996; Faulkner, 2007a, 2007b; Marry, 2001, 2005; Sagebiel, 2007)[3].

[3] See the topic report "Stereotypes and identity" by Felizitas Sagebiel and Susana Vazquez-Cupeiro for a review of this strand of literature (Sagebiel & Vazquez-Cupeiro, 2010).

In spite of these limitations, the overall picture of gender inequality in industrial research appears to be quite similar to that of the academia. Even the women with the best academic records have more difficulties than their male colleagues in starting a professional career: they take longer to find a job and their employment status is more insecure (de Vicente, et al., 2004). Literature identifies dynamics common to the academy, as well as some mechanisms specific of industry, to explain the unequal situation of female researchers. The difficulties for reconciliating professional and private life, unequal access to informal networks, the lack of mentoring and informal support, and the existence of stereotypes that discriminate against women in male-dominated contexts are some of the factors common to both academic and non academic settings. The distinction between structural barriers and other forms of subtle discrimination is also relevant for industry (Dainty, et al., 2000; Matthies, H. 2005; Papouschek & Pastner, 2002). As shown in the following paragraphs, however, specific trends related to the career path, work organisation and work culture and human resources management are also relevant.

Academic versus non academic careers

Research on non academic careers highlights the fuzzy borders of science, technology and innovation. The linear model of three steps in scientific production –basic research, applied research and development- has significantly changed. Scientific development is more and more based on a more complex interaction between university, industry and government, in which these old distinctions are significantly blurred, increasing linkages between academic institutions and industry develop and new science-society interface arenas emerge (Etzkowitz, 2003). Nevertheless, academic and industrial research cultures remain very different and, despite many interactions, careers are segregated. This is one of the main findings of Prometea, a comparative study about women's research engineering careers in academia and industry in several European countries: "Academic and industrial research cultures remain very different. Despite many interactions, careers are segregated. Money and ideas circulate rather fluently: academic research is often partly financed by the private sector, and temporary jobs related to specific projects in academic laboratories may be financed by industry. On the other side, industrial research may be helped by the public sector through various instruments. We could hardly find an academic laboratory in technological research that lacked frequent communication with industry, and vice versa. However, despite continuing interactions, we observed few career changes, which is not so surprising if we consider the lack of bridges between these two cultures" (Godfroy-Genin, 2009, pp. 83-84).

Overall, the literature claims that in industry there is nothing similar to the rigid norms and expectations with regard to a successful scientific career that prevail in academia. Research highlights that non-academic careers do not follow a common pattern. There is huge diversity in companies and no clear pattern emerges. Work cultures and systems of recruitment and promotion vary a great deal, not only on the basis of national contexts and research fields: they are also organisation-specific and even lab- or team-specific. This is a clear conclusion of the few large-scale empirical studies in the field (Godfroy-Genin, 2009; Valenduc, et al., 2004). Papouschek and Pastner (2002) further contend that the heterogeneity of non-university research needs to be acknowledged to understand the diversity of gender segregation patterns.

Time and availability

In spite of heterogeneity, non-academic careers appear to be as demanding as the academic ones in terms of dedication and availability. Furthermore, in industry as in academia, career progression relies very much on performance in the early stages, which is likely to be the period of forming a family and having children. Several studies stress that long working days, complete availability and dedication to work and the absence of flexibility to reconcile professional and private and lives are common trends in industrial R+D (DTI, 2005; Equalitec, DTI & Inova Consultancy, 2005; Rübsamen-Waigmann, et al., 2003; Wynarczyk & Renner, 2006). In many organisations, the old view of highly committed employees who can rely on private support at home still persists as the implicit assumption of an 'ideal worker' ethics that equates a work committment with uninterrupted employment and a very long working week (Gerson, 2004). This model of 'total availability' entails difficulties and disadvantages for many women and some men who need or wish to achieve a balance between work, family and leisure. Again, the

requirements of dedication and availability are especially acute in the early stages of the career, forcing women in their thirties to confront a dilemma between being 'the ideal worker' and the decision to form a family. This dilemma, in a context in which there are few flexible working practices, no role models of successful women and a certain perception of a lack of equal opportunities, is relevant for understanding the fact that more women than men leave R&D companies (EC, 2006).

Vendramin, et al. (2000) define the situation in the ICT sector as a vicious circle. ICT is not attractive to women because of the long working hours, with irregular and little predictable schedules and the masculinisation of the sector, with a predominance of 'boundless' young male professionals with no family responsibilities. These two aspects create a vicious circle in which the 'total availability' model becomes a norm that discourages women. These trends are confirmed in the comparative study WWW, carried out by Valenduc, et al. (2004) in several European countries (Austria, Belgium, France, Italy, Ireland, Portugal and the United Kingdom). To characterise working conditions, they use the concept of 'blurring boundaries', which is the confusion and constant permeability between the professional and personal spheres. In the ICT sector, work is fast-paced, driven by customer demands and developed in small companies with little developed human resources that exacerbate long working days and unpredictability. These conditions limit any attempts to organise a private life, the feasibility of a part-time working day and good prospects of returning after career breaks, which particularly affect women. Indeed, some studies point out that the problem is not the workload, but the lack of autonomy. Working time flexibility appears to be quite a widespread practice in ICT professions, but presenteism remains relevant and flexibility is usually linked to longer and unsocial working schedules rather than the work/life balance. Some studies contend that women in ICT might be willing to accept longer hours in exchange for self-management of working time (Gerwitz & Lindsey, 2000; Laufer, 2000).

Dual professional career system

A second distinct trend between industrial research and academia is the existence of a dual professional career system, with both technical and managerial career paths. As stated by a recent French study, companies do not recruit life-committed researchers: they recruit personnel with high scientific and technical skills who are expected to take charge of R&D activities, but also other tasks and, eventually, management responsibilities (MDR, 2004). In this report, three different paths are presented, with a different mixture of technical and management roles. The 'expert' path is strictly for research, built on scientific or technical progression on a certain subject. Only a minority of researchers, having obtained a certain level of expertise, adhere to it. Most of them follow the 'transversal technical' path, which entails R&D responsibilities in a wider technical field and the supervision of other researchers, usually in the framework of a technical area or department. The third path is the 'research manager', a position only reached by a minority of researchers. Here management roles clearly prevail and work focuses on the most strategic R&D level. It is obvious that these three paths follow a certain pattern of progression. Success is usually conceived as achieving a research management position, whilst companies have to make efforts in order to offer career prospects to those researchers that wish to remain in the 'expert path'. Several studies point out that this is not the case in many companies in which scientific and technical roles do not allow for progression up the career ladder. In general terms, successful industrial researchers do not stay in R&D, except for a few who become experts; they turn to management careers instead because of the lack of promotion opportunities in R&D (Godfroy-Genin, 2009; Herman, 2009).

Research reflects certain ambivalence towards the dual professional system from the perspective of gender equality. Some authors highlight that recruitment in R&D activities is one of the most effective strategies for women to reach high management positions in companies (Marry, 2004). Others point out that it entails not only giving up research, but also a 'technical identity' that women have usually adopted with substantial effort in a male dominated field (Faulkner, 2007b). Furthermore, the opportunity to change from a technical career to a management role usually appears at around 30-35 years, coinciding with the period of family formation: the management career, like the academic career, is implicitly based on a traditional masculine model. This is a general trend in management, but it is particularly important in R&D

companies with a dual professional career path system: not taking the 'right decision' at the 'right time' may entail loosing any possibility of career advancement (Herman, 2009).

Finally, other studies highlight that this ambivalence is also present in women's own narratives. When they refer to their careers, they insist upon passion, interesting topics and personal development; yet on the other hand, they refer to a career ladder, hierarchy and power: "The discourse about the women researchers' career definitions reflects the existing paths of management and expert careers in industrial research but also creates a picture of a holistic career, in which pleasure with the work content, personal growth and a satisfying private life can go along together. The various personal career definitions emphasizing something beyond management and expertise also showed that the two-ladder model in industrial research is probably not sufficient to motivate and hold people in the company in the long term" (Thaler, 2008, quoted in Godfrey-Godin, 2009, p. 88).

Productivity and mobility criteria

Productivity in industrial research is not based on publications, as in academia, but rather on the number of patents or other achievements in industry, which are usually confidential – and can hardly be formalised. Sex-disaggregated data about patentees are scarce, but in general reflect that only a few women appear as senior researchers in patent applications; their presence is certainly lower than their presence among industrial researchers (Rübsamen-Waigmann, et al., 2003). In the case of women in construction-related research, the women-core study found that patenting does show significant differences between male and female researchers. Only 10% of female researchers are patentees, and this percentage drops to 4% when the patent is licensed. For men, these figures are 16% and 11% (Vallès, et al., 2009).

Mobility is another relevant criterion for promotion in industry. Certainly mobility is a prerequisite for academic careers, usually in the early stages, and especially in some disciplines. In industry the mobility requirements are more pervasive: particularly in the large ITT and energy multinationals, the availability to travel is an important element for professional progression and promotion, as it tests committment to the company (Herman, 2009). A successful career in a multinational without a considerably long period abroad is inconceivable (EC, 2006). In other cases, frequent mobility between companies is the most straightforward way to career progression, because companies, with the exception of large corporations, offer little career prospects. It is what Valenduc, et al. (2004, p. 30) call 'nomadic careers' in the case of ICT: "Several studies show that ICT companies want their staff to be highly devoted to work, to accept all forms of flexibility and to offer total availability to the employer. At the same time, these same companies weaken the guarantees of job security: reorganisations, downsizing, closures and businesses process re-engineering have demonstrated to the workers that competence, performance and availability are not sufficient to ensure job security. As a consequence, the workers must now manage by themselves their employability and career. The expressions 'nomadic career' or 'boundaryless career' illustrate these new forms of professional trajectory, in which work relation is based on the development of employability as a counterpart of performance and flexibility, whereas the traditional work relation exchanges job security against loyalty". Some authors argue that this pattern may be positive for women, because it adapts to their already discontinuous professional career path due to family commitments (Bender, et al., 2001). Valgaeren (2005) contends that the nomadic career certainly corresponds more to the reality of women's professional paths, whilst success in the classic linear career is more typical for men. Other authors, however, stress that women are, nevertheless, disadvantaged in the development of professional networks and the investment in training by time and mobility constraints (Bailly, et al., 2000).

Box 20 – Gender differences in labour insertion and career advancement of 'excellent' graduates

Even 'excellent' graduates experience gender discrimination when it comes to developing a professional career. This study analyses gender differences among 'excellent' graduates in labour insertion and career advancement.For this purpose, the study selected the graduates in the 1997-1998 academic year who achieved the 15 highest academic reports in a number of universities and fields of study (taking the final average of their academic results). In order to analyse professional development, the study relies on the active collaboration of a sample of 45 large and mid-size enterprises operating in Barcelona, Granada and Madrid. The total sample of excellent graduates is made up of 630 graduates. The first finding of the study is that women are over-represented among excellent graduates (60.5% women and 39.5% men), although there are relevant variations by field of study: the presence of women is greater in humanities and social and health sciences; slightly higher in experimental sciences and, on the contrary, very limited in technical degree courses. The study shows the extent of gender discrimination in labour insertion by analysing selection procedures: more than 80% of enterprises place high value on time and mobility requirements (changing working schedules, frequent travel, geographical mobility), assuming the stereotype that men will fulfil these requirements more readily than women. On the other hand, the study shows that women with temporary contracts double the number of men in the same situation; they enjoy less autonomy in their job, receive less recognition from their employers when they make suggestions that contribute to the organisation and face more difficulties in achieving the highest positions. These findings confirm the initial hypothesis of the study, demonstrating that women's careers begin later, progress more slowly and are shorter than men's. The study shows the persistence of the glass-ceiling effect which prevents women from being promoted on an equal footing.

de Vicente y Royo de San Martín, A., Arredondo Rodríguez, J. M. & González Fernández, M. J. 2004, *La excelencia académica de las universitarias españolas, demandas del mercado e inserción laboral. Incidencia de las políticas de igualdad de ámbito nacional y de las comunidades autónomas*, Ministerio de Educación y Ciencia.

Lack of inclusiveness

Several studies have analysed overt and covert forms of gender discrimination in SET companies. They appear to be closely connected to the long hour culture and the lack of flexibility in balancing a professional and private life, shaping an organisational culture which lacks the atmosphere of inclusiveness. Research in this field has developed most in English-speaking countries, particularly regarding engineering, ITC and large corporations.

Evetts (1996) analysed the careers of female scientists and engineers in large industrial organisations, addressing the difficulties experienced in the workplace, namely their experience and awareness of gender and their attempts to manage relationships with co-workers, managers and clients. The main conclusion was that difficulties are not associated with the culture of engineering itself or women's feelings about and experience of using technology and generating technical solutions. Problems of career development lie with implicit gendered expectations of employees and the processes and structures for promotion and implementation of organisational policies.

Bagilhole, Dainty and Neale have extensively explored the situation in large construction companies, focusing on organisational structures and their effects on women's professional careers (Bagilhole, et al., 1997; Dainty, et al., 1999; 2000). According to these studies, a strong competitive entrepreneurial culture prevents women from being professionally promoted through a combination of two mechanisms: inflexible working practices and discriminatory behaviour. These mechanisms are maintained through small independent work teams coordinated by male operational managers who control the processes of team recruitment and promotion. From this position, they reproduced an intolerant working culture with those

candidates that do not follow the traditional profile. These patterns are exacerbated by a general lack of promotional opportunities which had led to congested career hierarchies within the middle management levels. This resulted in animosity towards women, who were seen as threats to the limited promotional opportunities available within the organisations. Animosity was manifested in overt and covert discriminatory behaviour: from overt harassment and bullying, to covert discrimination in the form of the maintenance of a culture of long working hours and enforced geographical instability. This strand of research provides a pessimistic view of current strategies to reduce segregation based on the idea of the critical mass when male-dominated culture is so deeply embedded. Powell and Dainty (2006) argue that in this kind of work environment, women change their behaviour to fit the culture they work in so that the critical mass of women entering masculine employment areas will not automatically bring change in work cultures, and isolation will persist.

Studies about the ICT sector also show that a male-dominated environment can be hostile and discouraging for women. Gurer and Camp (1998) state that there is 'subtle but constant' discrimination against women in a prevailing male environment such as that of computer scientists: women are likely to face discrimination sometimes unconsciously expressed by male colleagues through their behaviour, jokes or discussions. For Spertus (1991), sexist humour, sexual displays, discussions and difficulties in socialising with male colleagues may cause female ICT professionals to feel uneasy and uncomfortable. Laufer (2000) stresses that in a masculine environment, women may lack a mentor or colleagues' support, which may make them more likely to leave when a problem arises.Other authors refer to paternalism and more explicit sexist practices (Adam, et al., 2004; Pourrat, 2005). Valenduc, et al. (2004) contend that these trends are not as widespread as is sometimes claimed: their study shows there are also cases of exclusionary and supportive work cultures, without a clear pattern.

Research also points to more or less subtle forms of gender discrimination in promotion procedures. Among the complaints from female engineers employed in large corporations, the CREW report (2001) includes pressure from allegations of reverse discrimination and perceptions of different standards for judging men and women. Valenduc, et al. (2004) find considerable evidence of the persistent stereotyping of women by managers and executives in ICT industry, particularly in relation to their skills, availability for work and career committment. In many cases, decisions in favour of a woman tend to be made hesitantly even if she is better qualified than the men who apply: whoever chooses a woman has to justify his or her decision even more strongly and confront suspicions of tokenism. Matthies (2005) analyses how gender stereotypes, the duality between management and expert paths and male-dominated nepotism combine to hinder women's career advancement in industrial chemical research. Singh and Vinnicombe (2002) identify gender differences in the reported meanings of committment from high-tech engineering managers that may have an impact on the assessment and career prospects of women when evaluated by the mostly male engineering managers. Many other studies refer to the disadvantages of women when it comes to career progression as arising from homosociability practices. Visibility regards management remains a key factor for career progression and informal networks favour men in this respect. Women are excluded from participation because the networks are built around male homosociability, or out of work contact in evening hours which clash with home life (Jensen, et al., 2005).

Box 21 – Between nepotism and reflexive standards. Personnel policies and career chances in industrial research

This study describes and analyses professional development possibilities and career successes of male and female industrial researchers in chemistry. For the study, 9 male and 9 female researchers were interviewed, 8 expert interviews were conducted with representatives from research management, the gender equality group and the work council. Industrial research differs from academic research in that there is a much greater variety of career promotion prospects and possibilities for an earlier acceptance of management responsibilities. Industrial research organisations open up more diverse job promotion opportunities for academics than do governmental or academic organisations, but career progress means paying the price of less research work. The analysis of career paths has shown that the glass ceiling hinders women from attaining high-ranking positions or positions in management and that there is a clear tendency for women to be left behind in the salary hierarchy even if they fulfil the formal criteria to reach high positions. One of the reasons for this is that men and women's career orientation is judged differently: a career-orientated woman is seen as 'undiplomatic', whereas a male colleague focusing on his career will be called 'targeted'. Furthermore, the organisational culture of the company studied is extremely masculine in its connotations, and this systematically reduces opportunities for women. The myth of 'sameness' will not open up new possibilities for women, as the restricting factors built by the masculine culture are too dominant, as are stereotypical gender roles and gender-embedded behaviour expectations. In addition, the image of the 'ideal manager' further reduces possibilities for women. Standardised procedures of personnel development should allow for more transparent assessment, but they are not free of subjective perceptions and the possibility of interpretations by superiors. Therefore a gender neutral judgement is not guaranteed.

Matthies, H. 2005, *Zwischen Nepotismus und reflexiven Standards. Personalpolitiken und Karrierechancen in der Industrieforschung*, Wissenschaftszentrum Berlin für Sozialforschung, Downloaded on 09/10/2008, Available at: http://www.pdfdownload.org/pdf2html/pdf2html.php?url=http%3A%2F%2Fskylla.wzb.eu%2Fpdf%2F2005%2Fp05-102.pdf&images=yes

Career breaks

Career breaks in industry are not widely researched. One relevant exception is the UK project 'Equalitec: advancing women in ITEC (information technology, electronics and communications)', which launched a series of studies to examine the perspectives of women who want to return to the ITEC sector following a career break (Equalitec and University of Bath, 2005). Although the group of women returnees was found very heterogeneous, some common trends were identified. Central to the understanding of career breaks is that they are processes which include 'in-and-out' periods, that is the career break may be preceded by a period of part-time work before later returning full-time. It is relevant to distinguish between relatively short career breaks (not more than 6 months), and the longer ones. The short career breaks do not have the same impact on professional careers as the long ones, especially in terms of loss of confidence or the need for requalification. In general, research about returnees suggests that the length of their break from employment is a significant factor in their ease and level of re-entry as is their level of confidence in their ability to surmount new changes in the industry and the assurance that the culture to which they are returning is sympathetic towards people with family responsibilities (Hughes, 2002; Panteli & Pen, 2001).

A key factor for understanding the professional consequences of any career break is to consider the whole 'in-and-out' process. Most women who take a career-break are between 26 and 35 years of age, and their main reason is to give birth and look after their young children (Equalitec and University of Bath, 2005; Herman, 2009). As Herman states (2009), this kind of short career break is usually preceded by a period of part-time work and less availability to travel, to stay at work late, etc. Lack of sleep, arrangements in some cases to continue breast-feeding, the

organisation of social support networks, etc. form part of the in-and-out process and can condition career progression.

Long career breaks are found to have more serious consequences, particularly in such a dynamic field as ITEC. A long break creates a knowledge gap and subsequently a deficit in confidence, self-efficacy and opportunities to network (Equalitec and University of Bath, 2005; Panteli & Pen, 2008). The prevailing obstacle in industry is the impossibility of having shorter working days or flexible working schemes. In the case of career breaks of over two years, the need to upgrade qualifications may be a relevant barrier. Women having career breaks of more than two years usually come back when their children are older and do so full-time. However, full-time work and working responsibilities make retraining difficult if this is not provided by the company itself. Long career breaks may also have a serious impact on confidence and perceived opportunities with respect to returning. Women who stay away more than two years with their children at home find it extremely difficult to come back.

Box 22 – Women in engineering research: academic versus industrial research careers

"A systematic review of procedures for promotion and criteria for successful career paths in all countries and sectors reveals that academic and governmental criteria and industry criteria[1] are very different. Excellence in academia is essentially based on publications, yet excellence in industrial research is based on patents or industrial achievements that often have to remain confidential.

Career paths themselves are different, as we have observed in our samples: successful academic researchers stay in academic research most of the time, so the retention of women is a concern. In contrast, successful industrial researchers do not stay in R&D, except for a few who become experts; they turn to management careers instead because of the lack of promotion opportunities in R&D. As a consequence, measures to retain women in R&D could go against women's careers if more career opportunities are not created in industrial research.

A last divide concerns human resource management. Industry appears more concerned with gender and provides (apparently, at least) better and more transparent human resource management than academia and governmental bodies. On the contrary, many researchers in academia complained in interviews that recruitment and evaluation procedures were not transparent and are not clearly explained, that career support is very poor, and that there is no official human resource management, so many women discover the rules of the game too late. Almost no researchers told us about helpful careers advisors or efficient permanent careers support services, but the situation varies from country to country. There are lots of programmes[2] to support women in Germany or in the UK in academia, and these are more or less efficient. In Sweden, industry is often considered more woman-friendly by young researchers because of the lack of human resource management in academia. Regarding gender awareness, sceptical attitudes and hidden or open discrimination were noticeable in academia in some countries, though less so in industry".

[1] Those criteria have been rather easy to identify for the academic and governmental spheres (even if transparency varies from one place to another). For the industrial sphere, as each company has its own policy, they have been impossible to explore in detail, but the overall picture is common to normal human resource management in companies.
[2] Mostly mentoring and training to apply to fellowships and project proposals. Those programmes are often proposed to women only.

Godfroy-Genin, A.S 2009, 'Women's academic careers in technology: a comparative European perspective', *Equal Opportunities International*, Vol. 28 Iss: 1, p. 84.

The vanish box

The low presence of women in industrial research does not necessarily imply that industry is more hostile towards women than academia. The low numbers of female industrial researchers should be first explained from the perspective of horizontal segregation in university studies. It is clear that industrial research relies mostly on professionals in the S&E fields: mathematics,

natural sciences, life sciences, computing and engineering. With the exception of life sciences, the degrees in greater demand in industrial research are the most male-dominated. It is not surprising, therefore, that the proportion of women researchers in industry is lower than in universities and public research institutions, which have researchers from a broader spectrum of disciplines (Meulders, et al., 2003; Rubsamen-Waigmann, et al., 2003).

It is well known that literature shows that, in general trends, the more bureaucratic, formal and transparent personnel practices are, the weaker the gender segregation (Reskin & McBrier, 2000). However, we have revised a large bulk of literature showing that this may not be the case in academic institutions. Informal networks and non transparent cooptation procedures play a major role and leave room for gender bias, whilst the rigidity of the early stages of the academic career track penalises women's career prospects. There is indeed fragmentary research showing that academia may be seen as a more hostile workplace for women than industry, especially in countries such as Denmark in which the academic career track is particularly insecure and competitive. Nexø Jensen (2003) shows that academia in Denmark educates more than 60% of PhD students, but subsequently employs less than 25%. More female than male PhD students are on a career path leaving academia, and the prevailing view among students is that the private sector offers better working conditions and career prospects.

Some studies stress that human resource management differs substantively in industry and academia. The tradition of academic autonomy has meant that the human resources function of universities is under developed meaning that protection afforded to under represented groups in other organisations workplaces is not as strong (Ledwith, 2000). Finch (2003) considers that inequality is endemic in these institutions since it is replicated, reinforced and sustained by its many different, yet interdependent, occupations and hierarchies. Academics are an unusual profession in that an individual's merit is not solely evaluated by their employer but also by an external audience of academic peers, editors, founders and students/ patients. In industry, human resource management can be more relevant to fostering an inclusive work culture. Godfroy-Genin (2009) finds that this perception is shared by many female researchers in engineering, who think that industry provides better career support and more transparent recruitment and promotion procedures, sometimes with a tight focus on recruiting talent and diversity management. Nina Smith, Vice-Rector at the University of Aarhus, Denmark, argues similarly (Smith, 2008, p. 48): "My impression is that in the most progressive Danish private firms – not all private firms – there is a much more positive view on diversity management with respect to gender and ethnicity. In academia I also think times are changing – maybe as a response to the development in the private sector". She thus contends that academic institutions should apply the kind of professional human resources management that most progressive private firms are already applying: "There is an open window now for changing things by applying more general instruments that assist in professionalizing human resource policies and practices relevant for both men and women. These are mentoring and talent nursing policies, transparent and fair recruitment processes, family policy, child care, and workplace culture etc. This is exactly the same type of policies that you can now find in many private firms!" (p. 50).

Available data on the gender pay gap gives some support to this view. Table 3, based on She Figures 2009 presents the gender pay gap for a selection of occupations in private enterprises and the public sector. As can be seen, the gender pay gap is substantial, although it has decreased or remained stationary in recent years, with the exception of the category of senior officials and managers (ISCO 100) in the public sector (from 22% in 2002 to 28% in 2006). The table also shows that for the category of professionals (ISCO 200) and technicians (ISCO 300) the pay gap appears to be wider in the public than in the private sector. As *She Figures* (EC, 2009a, p. 72) contends, "this finding can be surprising given that it is generally believed that the stronger regulation in the public sector better protects women against discrimination. This is thus not certified by our data which could tentatively lead towards a different explanation: Could it be that private enterprise is more efficient than the public sector and as such cannot go without recruiting bright women and appreciate their true worth in their pay?"

Table 3. Gender pay gap in % by selected occupations for employees in private enterprises and the public sector, EU-27, 2002 and 2006

ISCO codes			Private enterprises		Public sector	
			2002	2006	2002	2006
100		Legislators, senior officials and managers	29	30	22	28
	110	Legislators, senior officials and managers	u	u	-	-
	120	Corporate managers	28	30	-	-
	130	Managers of small enterprises	32	28	-	-
200		Professionals	31	29	46	38
	210	Physical, mathematical and engineering science professionals	22	22	42	29
	220, 230,240	Life science, health, teaching and other professionals	36	33	42	40
300		Technicians and associate professionals	28	26	36	27
	310	Physical and engineering science associate professionals	26	25	35	25
	320, 330,340	Life science, health associate, teaching associate professionals and other associates professionals	30	28	40	32

Source: She Figures 2009 (pp. 88-89), on the basis of the Structure of Earnings Surveys 2002 and 2006 (Eurostat)
'u': unreliable due to small sample size. GPG (unadjusted) = The unadjusted Gender Pay Gap (GPG) represents the difference between average gross hourly earnings of male paid employees and of female paid employees as a percentage of average gross hourly earnings of male paid employees.

Indeed, recent empirical evidence points in that direction. It is, for example, the case of biotechnology firms, in which flat structures and networking appear to offer better scientific career prospects for women than universities or large corporations (Smith-Doerr, 2004). Or the fact that rising numbers of women scientists are found to leave academia in order to take up careers in other science and technology related professions, which provide not only new career paths, but also more favourable work conditions that meet women's needs compared to academic science (Ranga, et al., 2008). Etzkowitz, et al. (2009) call this phenomenon of women's disappearance and reappearance the 'vanish box', and claim that it is a more accurate representation of the gender attrition in the higher echelons of the academic career than the 'leaky pipeline'. We deal with these new developments in the next chapter.

Box 23 – The vanish box

"A significant number of highly qualified women in science apparently disappear from the scientific career pipeline as if into a vanish box. Highly motivated women, who are unable to use their training in traditional academic fields, are available to pursue alternative career paths. Blocked from pursuing high-level careers in academic science, these apparent dropouts are more appropriately characterised as 'push-outs'. Some become full time homemakers or pursue careers unrelated to science. Others re-tool and reappear in technology transfer and other science-related interface professions.
A vanish box, rather than a pipeline, may be the most appropriate metaphor for the situation of women in science […]
We wish to better understand the changing relationship among gender, science and the economy through the study of women's participation and advancement in the Technology Transfer, Incubation and Entrepreneurship (TIE) professions in the UK, Germany, Finland and Romania. On the basis of comparative qualitative research on entry into the field, work-life balance, and access to professional networks, we suggest a vanish box model to better understand the relative disappearance of women from the upper levels of academic science and their reappearance in TIE at the intersection of science and the economy".

Etzkowitz, H., Ranga, M., Conway, C., Dixon, L., Ylojoki, O., Vehvilainen, M., Vuolanto, P., Fuchs, S., Kleinert, C., Achatz, J., Rossman, S., Banciu, D. & Dumitrache, N. 2009, *Final Activity Report. The Vanish Box: Disappearance of Women in Science; Reappearance in Technology Transfer*, p. 5.

6. INSTITUTIONAL CHANGE

In the previous chapters we have revised the literature dealing with gendered structural constraints and subtle discrimination in both academic and non academic settings. The focus was on the mechanisms that account for the persistence of gender inequality in science in spite of the societal trend towards more equal gender relations. This chapter focuses on current changes in research institutions and their ambivalent impact on gender equality in science. We review the literature dealing with the restructuring of universities under new managerial criteria; the erosion of hierarchy and individual competition in certain university departments and R+D firms; the development of technology transfer professions and, finally, the sociopolitical change in Eastern countries and its impact on gender relations and scientific careers.

6.1 Institutional change in academia

Institutional change in universities –and sometimes, also large public research institutes – is driven by the so-called initiatives of New Public Management (NMP), which are intended to resolve the alleged inefficiency and excessive bureaucracy of public institutions by introducing a market logic in the non mercantile public sector. Central to this restructuring is fostering competition for financial and personal resources within and between academic institutions. NMP thus challenges the fundamental tenets of the traditional model of academic freedom, i.e. unconditional funding and minimal state intervention in the management of the system (Becher & Kogan, 1992; Parker & Jary, 1995; Prichard & Willmott, 1997). Managerialism is channelled through the development of greater levels of monitoring of both institutions and individuals through a range of regulated evaluation schemes and performance measures that are meant to foster efficiency by increasing competition and financial accountability. NMP initiatives first developed in the 1980s in UK universities, coupled with substantial cuts in public funding, a growth in student numbers and overall pressures to intensify teaching and research work (Barry, et al., 2001). According to some authors, the end result of this process is an academic production line on the model of the 'McUniversity' (Parker & Jary, 1995). NMP initiatives are later transferred to a lesser or greater extent to other national contexts, in a general trend towards increasing competition for public funding and emphasis on transparency and accountability in the allocation of funds. The traditional direct steering approach by public ministries of science and education is thus changed: detailed control of inputs and processes becomes replaced by control of outputs and results, with greater external evaluation of research production and teaching.

The gender dimension of this institutional change has been approached very differently across national contexts. Whilst literature in Germany, Austria or Switzerland explores the ways in which the NPM might serve to foster gender equality in academia, UK literature, where NMP has been longer in place, rather focuses on its gendered impact on the academic profession. Parallel to this strand of studies, other authors focus on institutional change at the departmental level, highlighting the emergence of less hierarchical, more collegial and inclusive departmental cultures that offer more opportunities of career advancement to women.

New Public Management

Several studies analyse the experience of NMP restructuring in UK academic institutions from a gender perspective. Thomas and Davies (2002) contend that the restructuring of higher education appears to be geared towards a highly individualistic and competitive culture that promotes a masculine subjectivity and career path that does not contemplate other career options and domestic committments. Their qualitative study in three universities shows the extent of female faculty's concerns over the intensification of work and the increased working hours, coupled with increasing student numbers, shrinking resources, the widening of the academic task, increased administration and greater accountability for performance. Academic women also emphasised the development of a strong performance culture, with primacy given to research-based activities, in terms of institutional and managerial targets. The devaluation of

teaching was seen as an additional source of strain. Overall, "academic life was perceived to be much more competitive, ruthless and single-minded, with the pressure to publish and generate income resulting in a self-protecting, self-serving, less collegiate and more 'divide and rule' atmosphere" (Thomas & Davies, 2002, p. 383).

Restructuring in the public sector has been shown to disadvantage women particularly at certain stages of their life and career, for example, women with caring responsibilities who do not have flexibility in their lives outside work to make a committment to 'long hours', the spill-over of work at home via remote technology or out-of-work study to meet new qualification expectations (Bennett & Tang, 2008). Looking at science occupations specifically, Leonard (1998) has studied the type of posts created through restructuring the management hierarchy and concluded that a focus on finance, commercialisation and facilities management have strong masculine associations which have had negative consequences on women's promotional prospects. Knights and Richards (2003) further highlight that academic restructuring is coupled with a rapid increase in fixed-term contracts that disproportionately affects women. Many temporary staff are on research contracts, which are normally of a short fixed duration owing to the nature of research funding. However, they also refer to a growing trend of using fixed-term contracts — sometimes rolling contracts — for full-time teaching positions. Others have looked at the knock on effect in workplace culture and concluded that managerialism can give rise to a 'bully-boy' culture in which men fair better than women (Leathwood, 2000). Barry, et al. (2006) provide one of the few comparative studies on the gendered impact of NMP in England and Sweden. Drawing upon more than 60 semi-structured interviews they stress how the new managerial requirements elicit different identity-management responses. Despite cultural differences and the time lag when reforms were introduced in Sweden and England respectively, it emerges that women academics in both countries face more difficult compromises than their male counterparts to sustain work in higher education. It would especially appear that women in middle range positions wanting to advance their careers have been left with fewer choices of positive identities under the new managerialist approaches.

Central to NMP restructuring is the development of an external assessment system to compare the quantity and quality of academic work and financially rewarding departments and universities, which in the case of the UK is institutionalised through the Research Assessment Exercise (RAE). Several authors highlight the double-edged nature of this trend. Thomas and Davies (2002) state that the promotion of measurable, gender-blind performance criteria can be viewed as a challenge to the traditional practices of patronage and nepotism, although this trend is parallel to the intensification of work and individual competition and may thus exacerbate gender differences in career outcomes. In a similar vein, Knights and Richards (2003, p. 390) argue that "in seeking to reverse generations of sexual inequality, it is probably necessary simultaneously to support and criticize meritocratic systems of equal opportunity or remain ambivalent in the same way as Foucault (1984) suggests using enlightenment reason against itself. In this sense, we have to defend universal meritocratic values insofar as they help women and minorities to challenge discrimination on any other grounds. But it is important to recognize the tendency for meritocracy and masculine conceptions of reason to privilege what can be measured, thereby reproducing prevailing gender distributions of advantage within academia. In relation to the RAE in UK academia, this would involve recognizing that we cannot simply universalize the concept of merit but have to situate it within the context of its use".

In contrast to UK literature, the German-speaking literature discusses, mainly theoretically, the potential benefits of NMP restructuring for gender equity in academia (Castaño, et al., 2010)[4]. This divergence in scope and focus may at least be partially related to the timing of restructuring alongside the large structural differences between the 'humboldtian' German university model and the Anglo-Saxon one. German-speaking literature acknowledges that gender equality in science cannot be achieved only by legislation and regulation (i.e. Aichhorn, 2000 in Austria or Degen, 2001 in Germany) but at the same time highlights that NMP restructuring might serve to make inroads into the male-dominated and reform-resistant academic institutions, namely, it is said that the NMP may bring greater transparency and accountability and steer the

[4] This overview is based on the topic report 'Policy towards gender equity in science and research' by Cecilia Castaño, Jörg Muller, Ana González and Rachel Palmen, which provides an in-depth assessment of this strand of literature.

establishment of more systematic linkages between university reform and gender equality policies. From this perspective, special attention has been paid to the establishment of equal opportunity officers in the universities. Several studies stress the difficulty involved in evaluating the real influence of equality representatives in the light of the informal procedures and silent agreements that are often more important in appointment procedures than the formal regulations (i.e. Müller, 2000; Steffens, et al., 2004). Interestingly, the empirical study of Wroblenski, et al. (2007) concludes that equality officers contribute substantially to the professionalisation of appointment procedures in terms of transparency, accountability and comprehensibility, which is considered a precondition for identifying and preventing discrimination. However, they are largely limited to operating on an informal basis, at best encouraging women to apply: in the case of conflicting situations their intervention is usually ineffective and strongly stigmatising for the women concerned.

German literature also provides a paradigmatic example of 'good practice' in the long-term development of a comprehensive strategy of university restructuring tied to equality policies, the Free University (FU) Berlin. The FU was not only among the first German universities to implement promotion measures for women, but also to put into practice an internal performance oriented allocation of funds. Färber (2000a, 2000b, 2007) analyses especially the impact of this funding system in relation to teaching, research, recruitment promotion and women's promotion. She contends the 'practical success' of the women's policy concept, which she argues is related to the fact that the legal base for the performance-related allocation of funds implied a strengthening of the women representatives' position in top level decision commissions. The reports issued by the Gender Equality Officer of the FU (Koreuber, 2008) give more recent insights on the positive impact of making faculties responsible for co-financing new positions. Thus, by combining a faculty-specific budget with financial resources available for hiring women, faculties were able to create more positions which led to a considerable increase in the number of women academic staff.

Departmental cultures

Some UK studies deal with the emergence of more supportive and collegial ways of leadership at the departmental level, finding that some middle-managers take on a transformative stance wih regard to the 'hard' managerialism discourse from senior managers at the strategic institutional level. Goode and Bagilhole (1998) single out women as 'transformers', whilst Barry, et al. (2001) find both men and women managing supportively, alongside widespread resistance and disaffection towards hard managerialism. Hasse and Trentemøller (2008) also conclude that there is a considerable degree of variation between departments and stress the emergence of more inclusive, collegial and family-friendly departments even in countries such as Denmark, where the academic culture is particularly individualistic and competitive. Overall, this strand of literature highlights the relevance of the departmental level for fostering women's presence and career advancement in academia.

One of the most comprehensive studies is that of Etzkowitz, et al. (2000) in the US. Having analysed a series of departments in different scientific fields, they conclude that change is taking place in the departments, although it is dependent on departmental leadership. Departmental attitudes toward women students and faculty form a continuum, in which two ideal-types can be identified at the extremes. The instrumental departments, with a small number of women in isolated positions, are characterised by a highly hierarchical power structure that lies in the 'eminent older male scientists'. In relational departments, with a relatively high proportion of women, there is a less hierarchical and more collegial atmosphere which fosters professional collaboration between the members of the department. They identify four types of change strategies towards more relational departmental cultures, of which the so-called 'strategy for departmental reform' appears to be the most successful:

- *Bottom up programmes:* Informal interventions that normally start as a voluntary social movement by the women of the department. This kind of initiatives is highly flexible, low-cost and enable the ad-hoc monitoring of the conflicts and needs of the department without administrator intervention.
- *Top down programmes:* Administrator initiatives which often have a structure of incentives that promote the faculties to make changes by providing financing. For these

to be successful, they require the involvement of the faculty and students in their design, implementation, monitoring and assessment.

- *Idiosyncratic programmes:* Programmes in which a person tries to introduce a specific change or fill a vacuum in the system in relation to the women's situation in the department. They can become very successful programmes when an individual's efforts are recognised by other individuals with more power in the institution, and who see the idiosyncratic change as a model for other programmes.
- *Strategy for departmental reform:* Initiatives led by the departmental manager or those who have departmental power. This type of strategy may show the potential of the new organisation of scientific work if it can involve a critical mass of like-minded male and female faculty in relation to issues concerning career and family balance, the tenure clock and other specific obstacles that many women and some men find throughout their scientific career path.

6.2 New developments outside academia

Literature shows that engineering has proved remarkably resistant to gender change, in spite of several decades of public and private efforts to promote women's presence and their decision-making. It is also the case of ICT, a relatively young professional field, which was initially expected to be less bound by gender prescriptions. In spite of this, there is fragmentary evidence of either gender experts or women scientists that see academia more hostile to women than certain companies. And indeed women appear to have a strong presence in some non-academic technical fields: it is the case of the biotech industry or technology transfer professions. Recent developments in these fields suggest new lines of reflection and research.

Biotech industry

The study of Smith-Doerrs (2004) about biotech firms in the US suggests that flat networking organisations offer better prospects for women's scientific careers than large hierarchical organisations. The development of the biotechnology industry since the 1980s exemplifies the emergence of a new organisational model of scientific knowledge production in contrast to the large pharmaceutical corporations and established universities. Typically, biotech firms are founded by academic scientists with venture capital backing. They tend to be small, research-intensive organisations, primarily concentrating on genetic engineering and molecular biology for human therapeutic and diagnostic applications. Their ability to remain on the cutting edge of scientific development and innovation is based on the successful management of interorganisational networks: collaboration with universities and research institutes for basic science, with pharmaceutical corporations and hospitals for clinical testing, and with venture capital for funding and management advice.

Smith-Doerrs compares the gender patterns of the entry and promotion of life scientists in two distinct settings: 1) academia and large pharmaceutical corporations traditionally organised with hierarchical career ladders and 2) biotechnology firms governed by networks, with project-based teams, flatter organisational structures and multiple ties with external collaborators. Her study is based on the statistical analysis of the careers of about 2,000 life scientists, combined with interviews with male and female researchers in both settings. The study does not find any distinct pattern of masculinisation/feminisation: In the 1980s and 1990s, biotech firms offered job positions to about 8% of life scientists and male and female scientists were found to be equally attracted. However, she finds that gender differences are relevant in terms of career prospects: women in biotech firms are about eight times more likely to head a research lab than in more hierarchical settings, whilst no significant difference is found for men.

The study contends that contrary to expectations, this kind of network with flexible structures offers better protection from discrimination than bureaucratic structures. While bureaucratic rules create accountability in employers and enforce direct disincentives for discrimination, the network form of organisation produces the same functions through other mechanisms with greater efficacy. Smith-Doerrs argues that there are three main reasons why flexibility places

constraints on discriminatory behaviour: (1) increased transparency in organisations, (2) a greater choice in forming collegial relationships, and (3) collective rather than individualised rewards. Transparency means that those who hire and promote are accountable to many others outside their office—including, in biotech, venture capitalists and external scientific advisers. The project-based nature of the work allows scientists a greater choice in selecting research collaborators whilst collective rewards favour diversity and collaboration, in contrast to personal networking for individual rewards in bureaucratic organisations. Flexibility is also especially appealing to women because it also means greater opportunities to do challenging research with fewer institutional constraints, namely, the tenure clock. A central tenet is that in biotech firms the power difference between management and knowledge-producing employees is not as great as in more hierarchical organisations such as traditional pharmaceutical corporations. Thus, as Smith-Doerrs (2005, p. 42) states "a scope condition of this increased gender equity in network organizations may be that it is limited to knowledge-expanding sectors. Perhaps network firms that mainly produce goods rather than create knowledge would be less likely to include individuals of different ethnicities or gender in the trusted circle".

The study focuses on the new organisational forms of knowledge production and their consequences for gender equality in science. It is a common finding that women are usually well represented when a new field emerges at the periphery of science, but are then pushed out when the status of the field rises. Patterns of masculinisation and feminisation in science related with centrality and status are well documented. However, as Etzkowitz (2007) stresses, it is not the case of the biotechnology industry. Women's presence in high positions persists now that biotechnology has been consolidated as one of the most dynamic scientific fields. If other studies confirm the findings of Smith-Doerrs, the transformation of scientific work from hierarchical organisational to flat network structures could be seen as one of the driving forces towards gender equality in science.

Hybrid professions in science/business interfaces

In recent years, research on gender, science and technology has also been concerned with the emergence of new science-related professions. These new professions develop at the intersection between science and the economy and are based on a mixture of scientific and business roles: technology transfer, incubation and scientific entrepreneurship (TIE). As the products of science have become more relevant to achieving political and economic objectives in recent decades, the importance of linkage mechanisms between university and industry has increased. In order to bridge the gap between the achievement of R&D results with commercial potential and the creation of new economic activity, formal methods of university-industry collaboration have been promoted, such as venture capital firms, incubator facilities and science parks. Their role is to facilitate the process of transferring research results into economic goods. Innovation literature has paid considerable attention to these interface areas, but the people who engage in these emerging professions have hardly been studied, and much less from a gender perspective. However, this approach makes a particular interesting case to examine whether women that have left academia successfully reappear from the 'leaky pipeline' in science-related occupations that have opened up as a result of the increasing economic and social relevance of science. This was the aim of the WIST project (Etzkowitz, et al., 2009), a comparative study of TIE professions in the United Kingdom, Finland, Germany and Romania, which draws on previous research in the US (Etzkowitz, et. al., 2000).

In terms of gender equality, the study finds both positive and negative common tendencies. TIE professions require hybrid competence: one has to understand research logic, to have experience and understanding of the business world, to understand research and development funding mechanisms and have basic knowledge about policy making. However, TIE is in an incipient stage of professional institutionalisation, with a flat career ladder and an under-developed system of professional recognition and promotion. It is a demanding professional field in which long working days prevail, although time organisation is also highly flexible and offers better opportunities for balancing professional and family lives than other professions, namely, academic science. It is a field with no ageism, rather the contrary: age and experience are generally appreciated and benefit both sexes, including people who take career breaks and those who shift their career. In general, a good working atmosphere and high satisfaction dominate, although low salaries are relatively generalised. These are common trends in all the

countries analysed, although differences are found in the extent of women's presence in high positions and the degree of influence of informal networks: "The **UK case study** suggested that a tentative movement toward gender equality may be identified through the rising importance of relational occupations such as TIE. The sector is populated equally by both sexes, and the gender neutral status of the sector is evidenced in a number of ways, including recruitment. The **Finnish case study** highlighted different conditions for women's participation in TIE, in particular regarding institutional type. For example in science parks, female employees were often found do lower level work, which does not involve as much developing new ideas and generating new projects. In **Germany,** women's representation in TIE appeared to be lowest where the profession is most developed or most important. An observation that lends support to the notion that in German TIE, women fall back behind their male counterparts at a fast pace once enough rewards and prestige have been accumulated or assigned to attract men. In **Romania,** TIE is still a relatively new area and women's presence in top management positions was relatively low but overall the appointment of experts, salaries and opportunities for career advancement in TIE organisations appeared to be based on competences, experience, performance and professionalism, rather than gender" (Etzkowitz, et al., 2009, p. 16).

The case of Germany is useful for illustrating the mixture of positive and negative trends in which technology transfer appears to be a double-edged sword for gender equality. In the framework of the WIST project, Achatz, et al. (2010) analysed the careers of people working in technology transfer at the university-industry interface. They show that on the surface technology transfer is almost perfectly gender balanced, but marked gender differences exist between and within the transfer organisations. The study finds a 'motley crew' with a diversity of disciplinary backgrounds, professional experiences and career expectations, as well as significant differences between men and women. Three types of entry to the field are identified: 1) the 'accidental' movers, a balanced category of men and women coming to technology transfer primarily by chance, from an academic, but mostly non S&E background; 2) 'strategic' movers, a predominantly male group entering the field mostly after pursuing a career in S&E, and 3) 'forced' movers, an exclusively female group entering the field after a career break, most often after a 'forced decision' following the impossibility of returning to a scientific career after a maternity or child-care leave. Such women tended to view technology transfer as a 'second best' alternative to a scientific research career, while men tended to view it as a useful jumping off point for a career in science-related business.

Overall, the share of women among staff in technology transfer organisations in Germany is higher than the share of women among academics or faculty in the respective institutions. In a within-field comparison, however, the female proportion is particularly low in the transfer activities of the prestigious German umbrella organisations. Technology transfer in umbrella organisations is more professionalised than in German universities, and is sometimes set up to circumvent the boundaries characteristic of the public service in Germany, for example regarding legal status (limited liability companies) and salary structure – characteristics that might draw a larger pool of people to technology transfer in general, and more men in particular. The authors thus conclude that women's opportunities and gains are fragile because of the still transitory nature of the field. Technology transfer in Germany may be seen as a double-edged sword: "given that almost half of the women we interviewed are working part-time, the intersection of 'career' and 'flexibility' in technology transfer together with a considerable workload then becomes a double-edged sword. Technology transfer in Germany offers responsible and flexible work and the opportunity to balance career and family to all. However, female scientists disproportionately make use of this opportunity, thus amplifying the potential gender bias in German technology transfer by running the danger of being expelled to the less rewarding jobs and organizations in the field" (Achatz, et al., 2010, p. 83).

6.3 Sociopolitical and institutional change in Eastern countries

In this last section we deal with literature addressing sociopolitical and institutional change in the former socialist Eastern European countries. In spite of specific national trends, the lives of scientific women in the Eastern countries have a series of common characteristics that are related to a general context of socialist history and post-socialist transformations, full of

contradictions and paradoxes, in which both gender relations and scientific institutions have experienced important changes[5].

The gender contract and the scientific career during socialism

During socialism, the prevailing gender contract was characterised by its ambivalence and contradictions and could be defined as 'modernisation without liberation' (Blagojevic, et al., 2003). The Soviet model of equality guaranteed women's access to secondary and higher education, established a series of quotas to guarantee the equal presence of men and women across scientific fields and, at the same time, built an intense network of nurseries and services to attend to children and the elderly to enable women to work full-time (Stretenova, 2010). In the late 1970s, women achieved parity with men in secondary education in all countries and also in higher education in many countries. Women's increasing access to higher education continued throughout the 1980s. The structure of female occupation was gradually changed and more and more women took on qualified posts, including academic ones. However, the process of female empowerment was parallel to a process of disempowerment, with the reinforcement of conservative gender roles which emphasised women's safeguarding of traditional values and family life. Horizontal and vertical segregation in the labour market was intensified with women adopting the role of second breadwinners.

In the 1980s, as a result of the quota measures and the social and economic value bestowed on the engineering and technical careers, the proportion of female graduates in these fields was considerably higher than in the Western countries, although vertical segregation was equally persistent. However, the mechanisms explaining vertical segregation during the times of socialism may not be the same as those prevailing in western countries or at present time. The building of a scientific career during the socialist period had its own specific characteristics (Blagojevic, et al., 2003; Stretenova, 2010). There were not female role models, because of the pioneers who had gone into the universities before the Second world war and were considered the natural enemies of the socialist revolution. The new generations of scientists emerged under conditions in which building a career meant a moral committment to the regime, intellectual censorship (including feminism) and the impossibility of creating networks or women's associations. In this context, concepts such as vertical segregation or the glass ceiling were hardly in use. The difficulty in publicly identifying social problems supposed that they were rarely analysed, theorised or interpreted. As a result, there was a lack of empirical studies on scientists and scientific institutions, and particularly, on the mechanisms leading to vertical segregation, beyond the evidence of the social and cultural persistence of the traditional gender roles (Blagojevic, et al., 2003).

Post-socialist transformations

For all Eastern countries the 1990s was a decade of transition from centralised planned economy to market oriented economy and from an authoritarian political regime to a liberal democracy. This meant a series of social and cultural transformations that also have a gender dimension. Blagojevic, et al. (2003) contend that complex processes of continuity and discontinuity led to the exacerbation of conservative gender roles. On the one hand, political and economic transformations led to the weakening or virtual disappearance of the whole system of social policies and care services for children and the elderly. Whilst this significantly overburdened women and reinforced traditional gender roles, the perceived relationship between women's issues and the official socialist policy entailed that antifeminism and anti-communism went hand-in-hand during this decade of transformations.

As regards science, the percentage of GDP dedicated to R&D was drastically reduced in all countries, except for the Czech Republic and Slovenia. In the universities and public research institutions, a series of structural reforms were implemented, of which one of the most visible aspects was the drastic reduction of R&D staff, which in some countries was as much as 50% and affected men and women equally. In this context, two 'hot questions' appear to be particularly relevant, also from a gender perspective.First, the issue of unemployment among

[5] This overview is based on the Enwise report (Blagojevic, et al., 2003) and the first chapter of the country-group report of the Eastern countries (Sretenova, 2010).

highly educated individuals; secondly, the issue of migration, including the migration of scientists and academics from the eastern countries (Stretenova, 2010).

In general, gender research in this field is limited and very little is known about the impact of the social transformations and structural reforms of the academic institutions in the careers and lives of scientists in the eastern countries, albeit some interesting reflections and studies stand out. Particularly interesting are some studies carried out in the former German Democratic Republic (GDR) in the 1990s. They underlined the deterioration of the situation of women scientists and their career prospects, both for structural and cultural changes: the restructuring of universities was parallel to the exacerbation of covert discriminatory practices. In a few years, from 1989 to 1992, there was a process of radical structural transformation in the university system in the German Democratic Republic. This process entailed a drastic fall in university staff, an increase in the use of fixed-term contracts and the overall redesigning of the career track for young scientists. For women, university restructuring entailed a process of displacement from teaching and research (Burkhardt, 1993). Although one of the promises of the German reunification process was that the percentage of women scientists would increase, in fact reform supposed the adoption of the West German model, more exclusionary towards women (Felber & Baume, 1997). Kriszio (1995) contends that the deterioration in women's situation was less a result of direct discrimination than an effect of structural changes, namely the acceptance of West German staff structures and the conversion of permanent positions into temporary ones. Hildebrandt, et al. (1992) further highlight that discriminating trends were also shown in the enforcement of traditional role models to the benefit of men, the increasing lack of interest in women's research and the dismantling of the institutional representation of women's interests, such as women's promotion plans and women's commissions.

Box 24 – On the situation of women at Universities in East Germany after the turnaround

In contrast to the school system, university staff are overwhelmingly male. There are considerable differences between different countries which cannot be explained by the degree of 'modernity' of a society, as a comparison between Northern and Southern European countries shows. An important factor influencing the opportunities and obstacles regards women's careers in higher education lies in personnel policies. In this contribution, it is argued that the generally better position of women scientists in the former GDR in comparison to united Germany is not only the result of a different attitude to female employment (and its corresponding childcare) and a programmatic committment to women's emancipation (at the top of the hierarchy, among professors, the proportion of women was as low as in West Germany – 5%), but primarily of differences in the personnel policies and structural conditions of the academic career (probation and advancement within a system of basically permanent positions, no forced mobility, no ban on appointments in the 'home' university). In the second section of this text, the mechanisms for the restructuring of former East German universities after the turnaround and its impact on women scientists is analysed: political renewal and dismissal of 'burdened' people, content and scientific renewal, evaluation criteria following West German subject profiles and quality standards, new advertising of all professorship positions, quantitative job cuts, especially in the middle level positions (particularly pronounced in East Berlin), acceptance of West German staff structures and the conversion of the majority of permanent positions into temporary ones. The deterioration in women's situation is less a result of direct discrimination than an effect of the structural changes.

Kriszio, M. 1995, 'Zur Situation von Frauen an ostdeutschen Hochschulen nach der Wende am Beispiel der Humboldt-Universität zu Berlin ' in H. Sahner & S. Schwendtner, eds. *27. Kongress der Deutschen Gesellschaft für Soziologie. Gesellschaft im Umbruch: Sektionen und Arbeitsgruppen*, Westdeutscher Verlag, Opladen, pp. 146-151.

European integration

During the 2000s, structural reforms in R&D systems in Eastern countries show a general move towards the adoption of NMP approaches. A central aim is to foster competition both at the level of individual scientists and institutions, especially to attract research funding outside the

allocated state budget subsidies. A second objective is to support the collaboration and linkages between public institutions and private companies (Stretenova, 2010).

After the drastic fall of R&D staff during the 1990s, the number of researchers and university staff began to increase again, although the problem of 'brain waste' is still significant and particularly affects women. Blagojevic, et al. (2003) made a distinction between brain drain (which involves the circulation of brains) and brain waste (which involves loss of human capital). Research lends support to the the hypothesis that in most eastern countries internal and external brain waste predominates over brain drain. This mainly affects highly qualified women, given that women with economic difficulties tend to be more willing than men to accept jobs that are beneath their qualifications and, in general, work for lower pay.

Increasing competition in science is also leading to significant changes in the vital strategies of young scientists, namely women. Career and family tensions appear to be more acute nowadays than in the past. As already stated, several studies evidence a shift in the vital strategies of young women scientists, who tend to give more priority to their professional career, delaying the age at which they marry and have their first child (i.e. Blagojevic et al., 2004; Marikova, 2004; Torny, 2007).

Box 25 – Family and work in the life of Czech women scientists across generations

Comparative studies about the situation of women in science during socialism and democracy are still very limited. A relevant study is that of Marikova (2004). This is a qualitative interview-based research depicting the differences between the experiences of young women scientists who built their career in the 1990s and older women scientists who built their career under the state-socialist regime. The data were collected as an outcome of the project "Women in Academy of Sciences – position of women in the structures of the Academy of Science between the years 1953 to 2000", funded by the Czech Academy of Sciences. The author stresses that vertical discrimination barely varied in these fifty years, although structural conditions of the career track significantly changed after the end of the socialist regime. The study discusses the barriers young female scientists face when entering the academic field and also the problems they encounter when they have a family and children. From the life trajectories of the older scientists, it is obvious that they did not strictly set out to build a career, as can be seen in the stories of the young scientists. Many of them had children first and then they returned to the academic field. Because competition was weaker and chances fewer, especially for scientists who were not members of the communist party, there was no rush for the older scientists.

Marikova, H. 2004, 'Práce a rodina v životě českých vědkyň: generační a genderové srovnání', *3 (2004)*, vol. 1-2.

Parallelly, other studies stress the persistence of vertical segregation, in spite of a positive trend towards the improvement of gender equality in universities in most Eastern countries. According to Stretenova (2010) this is not a result of the adoption of new organisational approaches and/or the implementation of gender equality policies at the universities. Rather, this positive shift in the figures of academic women towards the top positions might be interpreted as a result of different processes, namely, there is certain desprestige of academic science while the private sector is rapidly growing in most eastern countries. Some male scientists are leaving universities looking for better career and life chances either in industrial research, the private sector or abroad. It is therefore contended that current trends in women's presence in science should be analysed taking into account R&D financial issues, particularly R&D expenditure per capita researcher, researchers' remunerations and gender pay gap. Women's presence appears to be higher in the countries and sectors with worse R&D financial conditions.

7. CONCLUSIONS AND RECOMMENDATIONS

The aim of this report was to provide an analysis of the literature dealing with the underlying causes of gender segregation in science related to the organisation of work and the difficulties of balancing professional and personal lives. Most studies emphasise that gender differences in scientific careers are decreasing for more recent cohorts. This, nevertheless, does not mean that women have equal opportunities to attain equal academic status as that of men.

Research on gender segregation in science has developed in close relation to political debates and initiatives to foster women's advancement in science. While policy concern has gradually moved from women's recruitment to retention and career advancement, research has shifted from socialisation to organisational approaches, paying special attention to vertical segregation. The initial focus was on gendered socialisation, how since an early age individuals internalise 'feminine' and 'masculine' roles that shape their educational and professional choices. The 1990s witnessed a gradual shift in research towards organisations and professions, their implicit norms and standards, institutional practices and power relations. Recent studies tend to address the progressive differentiation of men and women's careers through both supply-side and demand-side factors. The overall picture is that there is no single-factor explanation for gender segregation in science. It has the same root causes as gender segregation in the whole labour market.

The review of the literature shows that family and career tensions play a relevant role in explaining the low rates of women embarking on a scientific career. These tensions are especially acute in the early stages of the academic career, from the first university degree to the first tenure-track position, a long period of career formation with intense productivity and mobility demands, which coincides with women's fertility years and social expectations about the right moment to establish a family. The family-or-science dilemma is not only gendered, but exacerbated by institutional constraints and implicit academic norms, values and expectations that take the traditional male life-course as the norm. The 'myth' of total availability in the scientific lifestyle penalises involved parents but also women as potential mothers. Many young women end up believing that science is incompatible with family life and feeling they have to leave academia if they wish to have a family. And indeed, family issues may act as a filter in early selection procedures.

For those women that manage to stay in science, research shows that their professional and family trajectories are more aligned than ever to that of men. Literature also stresses that family and career tensions cannot explain vertical segregation in science. Overall, the available empirical studies do not show any clear evidence that women without children have better career prospects than their female colleagues and succeed in catching up in their careers with men. Marriage and children do not appear to have a significant influence on women's scientific productivity and academic performance. To explain gender differences in scientific careers it is necessary to investigate more complex mechanisms, such as discrimination and accumulative advantage and disadvantage. Gender discrimination is seen to operate at two distinct levels, although closely connected. The first is the lack of informal support in career advancement that leads to discouragement. The second level refers to bias in formal assessment procedures that leads to unequal access to research funding or academic positions. Overall, research coincides in highlighting that women's poorer networking resources is a powerful, albeit subtle, explanatory mechanism for understanding women's greater attrition and slower career progression compared to men's. It works through an accumulative logic of 'non occurrences' and slight exclusionary practices that progressively disadvantage women's careers and cause a sensation of isolation, difficulty in assuming the risks inherent to the scientific career and low professional self-esteem. Women's slight disadvantages from the early stages of the scientific career might turn into wide differences in career outcomes.

Academia is the dominant concern in the literature on gender and science, with only few studies dealing with industry and other non-academic R&D areas. The overall picture of gender

inequality in industrial research, nevertheless, appears to be quite similar to that of the academia. Subtle forms of gender discrimination appear to be closely connected to the long hour culture and the lack of flexibility in balancing a professional and private life, shaping a work culture which lacks the atmosphere of inclusiveness. However, research also stresses that human resources management is more developed in industry than in academia and may play a relevant role for the promotion of an inclusive work culture, with better career support, more transparent recruitment and promotion procedures and a tight focus on recruiting talent and diversity management. Recent studies show that rising numbers of women scientists are found to leave academia in order to take up careers in other science and technology related professions, which provide not only new career paths, but also more favourable work conditions.

Parallelly, literature shows an emergent trend towards the erosion of the hierarchy and individual competition in certain university departments and R+D firms which may also favour women's career prospects. A recurrent theme is the drastic change that scientific practice is experiencing and the obsolescence of individualistic reward criteria as science is increasingly complex and collective. From this point of view, it is argued that scientists of both sexes (and science itself) would benefit from systems of recruitment, assessment and promotion that took this collective dimension more properly into account. This trend may be seen as consistent with certain degendering of scientific institutions, driven by the fact that many young women and some young men nowadays appear to want a more balanced life and are not willing 'to pursue research as the main aim of life'.

However, these wishes collide with increasing competitive pressures in the academic institutions and R&D systems. Under current managerial approaches, the move towards greater transparency and accountability in academic assessment procedures is coupled with increasing competition for research funding among institutions and individuals. Whilst literature in Germany, Austria or Switzerland explores the ways in which these new approaches might serve to foster gender equality in academia, UK literature, where managerialism has been longer in place, rather focuses on its gendered impact on the academic profession. Professionalisation of hiring and selection procedures on the basis of transparent and gender-blind performance criteria can be viewed as a challenge to traditional academic practices of patronage and nepotism. However this trend is parallel to the intensification of work and individual competition and may exacerbate gender differences in career outcomes.

Research has developed steadily through the 1990s and 2000s. However a large bulk of literature is some countries is still mainly concerned with women's choices, barriers and deficits and fails to address the societal and institutional factors that are at play. The lack of consistent sex-disaggregated data is a major hindrance for research, but not the only one. More often than not, research focuses on academic careers and exacerbates the distinct trends of academia, envisaged as a specific labour market with its own universal and meritocratic values, norms and procedures that are seen to be identical over time and space. Literature on gender segregation in scientific careers should enlarge the scope of research. As regards academia, this means paying more attention to divergent patterns across national contexts and disciplinary fields. But it also entails fully accounting for the development of science-related professions in non-academic settings. A more consistent link between analysis and policymaking is also needed. This means focusing more consistently on institutional developments and reinforcing comparative research. Finally, research should take fully into account that gender does not mean women and that gender relations are changing. Further research on different femininities and masculinities is needed, particularly in addressing the career and family conflict.

Recommendations for further research can be grouped as follows:

1. Improving primary sources of statistical data

Improving statistical data is a sine qua non condition for improving both quantitative and qualitative research. The relationship between scientists' personal and professional lives remains largely under-researched. A major hindrance is the lack of sex-disaggregated data on personal and career developments, including demographic variables such as the number of children, marital status, etc. The systematic collection of such data is of utmost importance for

monitoring progress towards both family and career balance and gender equality in scientific institutions. Overall, further research on family and career tensions is needed, for both men and women, and not only dealing with parenthood but also other issues such as elderly care. More consistent data are also required to address intersectionality, how gender and other social inequalities interplay, which is a rather neglected issue. At the same time, research suffers from a lack of panel data which hinders the development of longitudinal research, which is the best way of analysing the pattern of cumulative advantages and disadvantages that shape gender differences in scientific careers. The same holds true for any analysis that aims to take the relationship and reciprocal influences of personal and professional lives seriously into account.

2. Enlarging the scope of research

Only a small percentage of PhD holders (5-20%) pursue an 'excellent' academic career that culminates in a full professorship or similar post and even to a lesser extent enter the restricted circle of the scientific elite. More research is needed to fully understand the complex mix of structural barriers, discrimination and cumulative disadvantages that account for women's under-representation in the highest scientific positions. This also includes well-grounded qualitative research on the gender dimension of the hidden power dynamics that govern access to the elite positions. However, the under-representation of women among the 'excellent' scientists also means that more women than men follow other scientific paths in universities, research institutes, industrial R&D, or other science and technology related professions. Yet research in this field is limited and reinforces gender bias in the analysis of scientific careers. Overlooking or branding any career path that is not considered excellent as a 'failure' or as 'unsuccessful' is tantamount to reinforcing gender bias in the analysis of the career paths of many women and some men. This does not only entail that more attention should be paid to scientists who leave academia, follow discontinued careers or work below potential. Research should also address the development of science-related professions in non-academic settings and its gender dimension, including technicians working as research staff and technology transfer professions. Overall, research on gender and science should be more embedded within the strand of literature that analyses divergent patterns of feminisation and change in highly-skilled professions.

3. Building more consistent links between analysis and policymaking

It is said that in spite of persistent efforts regards data collection, research and reflection over the last two decades, increasing knowledge about gender segregation in science has not significantly improved. This is a rather common view among policymakers and scientists committed to gender equality in science. In this report we have argued that we neither know that much nor has that little changed, although change has not been mainly driven by explicit institutional purposes. Yet building more consistent links between analysis and policymaking should, in our view, be the main priority for research. First and foremost, this means focusing more consistently on institutional developments. The literature refers to drastic changes in scientific production itself, which is increasingly competitive and built on research teams and institutionalised collaboration between different organisations. There is a parallel move towards professionalisation and transparency in assessment procedures. These trends may lend support to more inclusiveness in recruitment procedures and working cultures in scientific and research institutions, as documented for certain university departments and R&D firms. However, they may also exacerbate individual competition and gender inequality in spite of greater gender awareness in scientific institutions and the society at large. Elaborating more effective gender equality policies or improving the effectiveness of existing measures requires more consistent analysis of institutional change: this ranges from in-built monitoring of institutional practices (i.e. scientific evaluation of scientific evaluation) to the development of comparative research, since patterns of exclusion and inclusion vary across national contexts and scientific disciplines and what is effective in a certain context may not be in another.

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