Meta-analysis of gender and science research – Country group report

# Continental countries

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This is one of the thematic reports of the study *Meta-analysis of gender and science research*, a project of the 7th RTD Framework Programme of the European Union (RTD-PP-L4-2007-1), commissioned by DG Research to the consortium led by CIREM (Spain) and made up of Université Libre de Bruxelles (Belgium), Inova Consultancy Ltd. (United Kingdom), Fondazione Giacomo Brodolini (Italy), Bergische Universität Wuppertal (Germany) and Politikatörténeti Intézet KHT (Hungary). The study was carried out between 2008 and 2010.

The purpose of the study was to collect and analyse research on horizontal and vertical gender segregation in research careers, as well as the underlying causes and effects of these two processes.

The objectives of the study were to:

- Provide an exhaustive overview and analysis of research on gender and science carried out at the European, national, and regional levels.
- Make the study results accessible to researchers and policy-makers via an informed bibliography (online database) and a set of reports.
- Steer policy-making on gender and science and define future research priorities within the Framework Programme, in particular through good practice examples and gap analysis in the various research topics.

For the purposes of the study, 'science' was understood in its broadest meaning, including social sciences and humanities as well as research and technological development.

The study covered the research on gender and science produced between 1980 and 2008, in all European languages, in 33 countries: the 27 EU Member States as well as 6 Associated Countries to the Seventh Framework Programme for Research and Technological Development (FP7) (Croatia, Iceland, Israel, Norway, Switzerland, and Turkey).

The study produced five country-group reports, seven topic reports and the final synthesis report:

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| Gender wage gap and funding | Danièle Meulders, Síle O'Dorchai, Robert Plasman & Audrey Rigo |
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All the reports and the online database (Gender and Science Database, GSD) are available at the website of the study: **www.genderandscience.org**

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# Introduction

Although men still outnumber women in science and research women seem to be catching up as the proportion of female scientists and engineers or the share of women graduating at the PhD level in sciences is growing at a faster pace than that of men. However, gender segregation across economic sectors and fields of science persists, as does vertical segregation or a different distribution of women and men across the different stages of a typical academic career.

It thus seems that even though there are many positive signs, there is no natural or automatic move towards gender equality (and if there is it would take way too long to get there). More efforts are needed to increase women's participation in the decision-making process that shapes the entire scientific landscape.

The objective of this report is to present and analyze the studies in the Gender and Science database that deal with continental European countries.

The first part of the report is devoted to a statistical synthesis of the publications that deal with continental counties in the Gender and Science Database. It thus give a global overview of the gender and science research approach applied in continental countries. The second part is a review the GSD's literature under the following topic headings: horizontal segregation, vertical segregation, pay and funding, stereotypes and identity, science as a labour activity, scientific excellence, gender in research content, and policies towards gender equality in science. For each topic the questions which have so far not been adequately answered are described. These gaps in the literature are summarized in the conclusion.

# 1. Gender and Science Database Statistics on Continental Publications

This section provides a statistical overview of the publications on gender and science subjects. It gives the methodoligical and conceptual framework for an analysis of the gender and science publications. The objective is to filter out the most relevant points that can be learned from a global assessment of gender and science research that deal with continental countries. The relative importance of publications on continental countries is shown by the ratio Ccs/Acs. Ccs refers to publications on continental countries and Acs refers to all the Gender and Science database publications

*Countries analysed*

Out of 4549 entries in the Gender and Science database (GSD), 1477 of the publications are issued in continental countries (Table 1). An important part of the continental literature is published in Germany (43%). French and Austrian publications represent respectively 22% and 11%. The other countries contibute less: Switzerland (8%), the Netherlands (8%), Belgium (5%) and Luxembourg (4%). There are almost no publications produced in the German Democratic Republic (0.1%).

**Table 1 : Country of publication**

| | n | % GSD publications in Continental Cs |
|---|---|---|
| Austria | 162 | 11.0 |
| Belgium | 73 | 4.9 |
| France | 323 | 21.9 |
| Germany | 637 | 43.1 |
| German Democratic Republic | 1 | 0.1 |
| Luxembourg | 55 | 3.7 |
| Netherlands | 112 | 7.6 |
| Switzerland | 114 | 7.7 |
| **Continental Cs** | **1,477** | **100.0** |

Table 2 gives an overview of the number of publications that cover continental countries. One can note that 39% of the publications in the database concern continental european countries. Among continental countries, publications concerning Germany are the most present in the database (23%). The publications about France and Austria represent respectively 14% and 12% of the GSD publications. The publications on the Netherlands, Belgium and Luxembourg are less numerous (between 6% – 9%). There are very few publications that deal with Switzerland (3%).

**Table 2 : Geographical coverage**

| | n | % all GSD publications |
|---|---|---|
| Austria | 522 | 11.5 |
| Belgium | 358 | 7.9 |
| France | 648 | 14.2 |
| Germany | 1,040 | 22.9 |
| Luxembourg | 280 | 6.2 |
| Netherlands | 394 | 8.7 |
| Switzerland | 134 | 2.9 |
| **Continental Cs** | **1,780** | **39.1** |
| **Total** | **4,549** | **100.0** |

From Table 1 and Table 2 it can be noted that :

- publications on a specific continental country are not necessarily produced in that country ;
- an important part of the publications deal with more than one continental country.

*Trend in the number of publications between 1980 and 2009*

It can be observed from Table 3 that the number of entries concerning continental countries is low during the 80s (15 publcations per year) . This number starts to rise during the 90s and most significantely in the early 2000s when the number of publications (per year) attains a peak of 130. From 2005, the annual number of publications per year started to fall, down to 52 on the period 2008-2009. The publications dealing with continental countries represent 40% of the GSD publications for each period. However, one can note an exception over 2005-2009 (30%).

**Table 3 : Average number of publications per year**

| | Continental Cs | All Cs | Ratio CCs/ACs |
|---|---|---|---|
| 1980-1984 | 14.6 | 33.4 | 0.4 |
| 1985-1989 | 19.0 | 53.4 | 0.4 |
| 1990-1994 | 38.2 | 91.6 | 0.4 |
| 1995-1999 | 64.8 | 162.6 | 0.4 |
| 2000-2004 | 130.2 | 310.4 | 0.4 |
| 2005-2007 | 114.3 | 338.0 | 0.3 |
| 2008-2009 | 51.5 | 139.0 | 0.4 |

The majority of the publications dealing with continental countries in the GSD (52%) adress gender and science questions in the 90s (Table 4). When we go back in time, the share of publications steadily decreases: 36% in the 80s, 20% in the 70s and 14% in the immediate post-World War II period. 11% of the publications on continental countries cover the first half of the 20th century and 6% concern the 19$^{th}$ century. Almost no studies go back further in time. We can also note that the percentage of publications on continental countries that deal with the present day is 42%. The ratio Ccs/Acs is greater or equal to 1 (except for 2000s).

**Table 4 : Period analysed**

| | Continental Cs | All Cs | Ratio CCs/ACs |
|---|---|---|---|
| General / Not specified | 6.0 | 4.5 | 1.3 |
| Before the 18th century | 1.6 | 1.4 | 1.2 |
| 18th century | 1.6 | 1.4 | 1.1 |
| 19th century | 6.5 | 5.0 | 1.3 |
| 1900-1945 | 11.1 | 10.1 | 1.1 |
| 1946-1970 | 14.3 | 13.6 | 1.1 |
| 1970s | 20.4 | 19.5 | 1.0 |
| 1980s | 35.0 | 33.0 | 1.1 |
| 1990s | 51.5 | 49.5 | 1.0 |
| 2000s / Present-day | 41.8 | 46.4 | 0.9 |

*Cross-topical coverage*

Table 5 shows that an important part of the continental literature deals with vertical segregation (46%) and stereotypes and identity (41%). Horizontal segregation, science as a labour activity, policies

toward gender equality in research and gender in research content represent between 29% and 34%. Scientific excellence and pay and funding are scarcely topic treated (respectively 14% and 8%). The ratio of publications on continental countries over all GSD publications is about 1 for vertical segregation, science as a labour activity and policies. It is below 1 for all the other topics.

**Table 5 : Topic analysed**

| | Continental Cs | All Cs | Ratio CCs/ACs |
|---|---|---|---|
| Horizontal segregation | 34.3 | 43.2 | 0.8 |
| Vertical segregation | 46.1 | 44.7 | 1.0 |
| Pay and funding | 8.4 | 12.6 | 0.7 |
| Stereotypes and identity | 41.3 | 54.0 | 0.8 |
| Science as a labour activity | 32.9 | 32.6 | 1.0 |
| Scientific excellence | 14.2 | 19.8 | 0.7 |
| Gender in research contents | 29.3 | 31.5 | 0.9 |
| Policies towards gender equality in research | 31.0 | 28.5 | 1.1 |

*Institutional sector analysed*

The institutional sector studied in the publications on continental countries is presented in Table 6. The higher education sector is very often studied (90%). 26% of the publications deal with the government sector and 12% with the business enterprise sector. The private non-profit sector is scarcely studied (3%). The continental publications in terms of institutional sector are comparable to all GSD publications: the ratio Ccs/Acs varies between 0.9 (private non-profit sector) and 1.1 (business enterprise sector).

**Table 6 : Institutional sector**

| | Continental Cs (%) | All Cs (%) | Ratio Ccs/Acs |
|---|---|---|---|
| Business enterprise sector | 11.6 | 10.6 | 1.1 |
| Government sector | 26.5 | 26.0 | 1.0 |
| Higher education sector | 89.5 | 86.7 | 1.0 |
| Private non-profit sector | 3.2 | 3.4 | 0.9 |

*Coverage of scientific field of science*

Table 7 shows that the publications concerning continental countries are mostly in the field of science, mathematics and computing (52%). Social sciences, business and law and engineering, manufacturing and construction are often studied (32%). Health and social services, humanities and arts and education represent respectively between 17-14% of the publications. Publications on agriculture and veterinary science are scarce (6%). The ratio Ccs/Acs is bigger than 1 for science, mathematics and computing (1.1) and for engineering manufacturing and construction (1.3). It is below 1 for all other fields of study.

**Table 7 : Publications by scientific field**

| Scientific field – Other | Continental Cs (%) | All Cs (%) | Ratio Ccs/Acs |
|---|---|---|---|
| Education | 13.6 | 20.6 | 0.7 |
| Humanities and arts | 16.6 | 18.3 | 0.9 |
| Science, mathematics and computing | 51.8 | 46.6 | 1.1 |
| Agriculture and veterinary | 5.9 | 8.5 | 0.7 |
| Health and social services | 17.1 | 21.9 | 0.8 |
| Engineering, manufacturing and construction | 31.6 | 25.1 | 1.3 |
| Social sciences, business and law | 32.0 | 34.1 | 0.9 |
| Services | 0.3 | 0.7 | 0.5 |

*Life course stage coverage*

Gender and science can be studied at different stages of the life course. Table 8 shows that the studies on continental countries mostly concern the early-career stage (74%), mid-career scientists (70%) and late-career scientists (66%). Tertiary education is also often approached (44% at the second stage and 41% at the first stage). Lower stages of the life course are less studied. The ratio Ccs/Acs is bigger than 1 for the first stage of tertiary education. For the lower stages, this ratio is lower than 1.

**Table 8 : Life course stage**

| | Continental Cs (%) | All Cs (%) | Ratio Ccs/Acs |
|---|---|---|---|
| ISCED 0 | 1.4 | 2.0 | 0.7 |
| ISCED 1 | 4.2 | 6.8 | 0.6 |
| ISCED 2 | 8.3 | 11.0 | 0.8 |
| ISCED 3 | 11.0 | 13.8 | 0.8 |
| ISCED 4 | 5.1 | 6.4 | 0.8 |
| ISCED 5 | 41.3 | 36.2 | 1.1 |
| ISCED 6 | 44.2 | 38.4 | 1.2 |
| Early-career scientists | 74.6 | 67.6 | 1.1 |
| Mid-career scientists | 69.5 | 62.8 | 1.1 |
| Late-career scientists | 65.6 | 59.4 | 1.1 |
| Other | 4.7 | 6.5 | 0.7 |

*Methodological approach*

Table 9 shows that the methodological approach that is most used in the publications on continental countries is the state-of-the-art review of the literature (50%). 31% are conceptual, 28% are empirical qualitative research, 24% use empirical quantitative techniques and 26% are based on a compilation of statistics. Very few studies are based on building gender indicators (2%). The ratio Ccs/Acs is greater than 1 for the state-of-the-art review of the literature and compilation of statistics. It is lower than 1 for all other methodological approaches.

**Table 9 : Methodological approach**

| Approach | Continental Cs (%) | All Cs (%) | Ratio Ccs/Acs |
|---|---|---|---|
| Conceptual | 31.1 | 39.1 | 0.8 |
| State-of-the-art | 50.1 | 40.4 | 1.2 |
| Compilation of statistics | 26.1 | 20.7 | 1.3 |
| Building gender indicators | 2.0 | 2.8 | 0.7 |
| Empirical research. Quantitative techniques | 23.9 | 26.7 | 0.9 |
| Empirical research. Qualitative techniques | 28.0 | 31.5 | 0.9 |

Table 10 presents the type of empirical research carried out by researchers investigating gender and science subjects. 57% of the gender and science publications on continental countries are non-empirical studies. Empirical research using quantitative techniques is carried out in 20% of the publications whereas qualitative methods are applied in 15%. Finally, merely 9% of the publications on continental countries are both qualitative and quantitative. The ratio of Ccs/Acs varies from 1.1 (non empirical research) to 0.9 (empirical quantitative and quantitative research).

**Table 10 : Types of empirical research**

| | Continental Cs (%) | All Cs (%) | Ratio Ccs/Acs |
|---|---|---|---|
| Non empirical research | 56.6 | 50.6 | 1.1 |
| Empirical research. Quantitative techniques | 15.4 | 17.9 | 0.9 |
| Empirical research. Qualitative techniques | 19.5 | 22.7 | 0.9 |
| Empirical research. Quali-quantitative techniques | 8.5 | 8.8 | 1.0 |
| Total | 100.0 | 100.0 | 1.0 |

Among the use of quantitative technique (Table 11), micro-data (66%) and representative samples are used respectively in 66% and 56% of the publications on continental countries. 28% of the publications use multivariate techniques and 10% are longitudinal studies. The ratio Ccs/Acs varies from 0.9 (empirical quantitative and qualitative techniques) and 1.1 (non empirical research).

**Table 11 : Quantitative research techniques**

| Quantitative techniques | Continental Cs (%) | All Cs (%) | Ratio Ccs/Acs |
|---|---|---|---|
| Representative sample | 56.0 | 57.0 | 1.0 |
| Micro-data | 66.4 | 48.6 | 1.4 |
| Longitudinal/cohort | 10.1 | 8.2 | 1.2 |
| Multivariate analysis | 27.5 | 30.8 | 0.9 |

Concerning the use of qualitative techniques (Table 12), interviews are conducted in an important share of publications (69%). Biographical research and case studies represent 16% of the publications on continental countries. Content analysis and observation is applied in 9% of the publications. Biographical research, case studies and interviews are used in continental countries in almost the same proportion as in all the GSD studies. The proportion of Ccs/Acs is 0.6 for content analysis and observations.

**Table 12 : Qualitative research techniques**

| Qualitative techniques | Continental Cs (%) | All Cs (%) | Ratio Ccs/Acs |
|---|---|---|---|
| Biographical research | 15.7 | 17.6 | 0.9 |
| Case studies | 15.7 | 15.4 | 1.0 |
| Content analysis | 9.4 | 15.4 | 0.6 |
| Interviews | 69.3 | 64.8 | 1.1 |
| Observations | 9.4 | 15.2 | 0.6 |

*Limitations*

Gender and science is a subject that attracts more and more the interest of researchers as well as of policy makers. There are many publications on gender and science concerned with continental European countries (39% of the GSD publications). The analysis presented in this section shows that several types of research are missing in order to have a comprehensive overview of all questions related to gender and science:

- lack of empirical research :
  - quantitative studies would help to better understand the factors that explain gender discrimination in science and research. Futhermore, collecting longitudinal data would be necessary to track change over time;
  - qualitative research is necessary to understand women's perception of their situtation;
- lack of studies on fields that are considered to be female such as health services, humanities, art and social services;
- lack of studies on sectors other than higher education: too little research has examined the women's and men's experiences in the government sector and much less in private sector organisations(business and non-profit).

With the analysis of various subjects related to gender and science, the next section will give a more detailed view on the literature on gender and science in continental countries.

# 2.1. Analysis by topic

Horizontal segregation in science concerns the representation of men and women in the various fields of study and the various scientific professions and sectors of the economy (section 1.1). The explanation for horizontal segregation has been constructed mainly around education. It is closely linked to the topic of "stereotypes and identity" (section 1.4). This literature, which is characterised by a systematic dualism between the traits of men and women, looks at the process of gender socialisation (an individual's internalisation of gender stereotypes). It seeks to define stereotypes concerning the roles of men and women, and the way in which they influence the behaviour of girls and boys, by considering the role played by the education system and the family.

The research into vertical segregation analyses the progress made by women within a sexist hierarchy (section 1.2). By studying the topics of "stereotypes and identity" (section 1.4) and particularly "science as a labour activity" (section 5.5), the research helps us to understand the reasons why women give up their careers sooner or fail to progress to the higher echelons. It emphasises the dominant male culture within the scientific and research worlds, and the consequences of this domination, in terms of reconciling individual's private and professional lives. The study of scientific excellence in section 5.6 looks at the ways in which excellence is defined and attributed. This section helps to improve our understanding of differences between men and women in terms of promotion and career progress.

By putting into perspective the historical career paths and contributions made to science and its content by women (section 1.7), and policies towards gender equality in research (section 1.8), we move towards a better understanding of segregation that excludes women.

The effects of segregating men and women are taken into consideration in the analysis of "the gender pay gap and funding" (section 1.3). So far, these two topics are not very developed in the continental literature dealing with gender and science. Nevertheless, they merit detailed attention, insofar as the pay gap between men and women constitutes the hard core of gender inequalities in the employment market, and funding bodies determine the dynamics of the scientific community.

The analysis that follows is presented in 8 sections, corresponding to the various topics listed above, which have already been put into perspective in the statistical analysis presented in section 2:

- Section 1.1: Horizontal segregation
- Section 1.2: Vertical segregation
- Section 1.3: Gender pay gap and funding
- Section 1.4: Stereotypes and identity
- Section 1.5: Science as a labour activity
- Section 1.6: Scientific excellence
- Section 1.7: Gender in research content
- Section 1.8: Policies towards gender equality

The purpose of this section is to provide as comprehensive as possible a presentation of these various topics, based on the publications in the Gender and Science database. To this end, each subject is dealt with in two parts:

- Firstly, we present a brief statistical summary of publications concerning continental countries. This provides a global overview of the research relating to each topic. The statistics concern the country coverage, the cross-topical coverage and the trend in the number of publications between 1980-2009 [1].
- Secondly, the results are highlighted of the studies contained in the Gender and Science database. The analysis includes a brief presentation of the topic studied (Key issue), the questions studied (Research questions) and the empirical or non-empirical methods used by the authors (Research approach). The main results put forward in the publications (Findings) and any relevant points that are absent from the literature are also presented (Gaps).

[1] As the statistics about the institutional sectors, the scientific field and the period analysed for each topics follow the same tendency that were presented in section 2, they are not considered in the following analysis.

## 2.1. Horizontal segregation

### 2.2.1. Statistical analysis of the Gender and Science database

*Country coverage*

The number and proportion of publications dealing with gender and science that cover horizontal segregation are shown in Table 13. As we can see, 43% of the publications on gender and science contained in the database address the issue of horizontal segregation. The rate is lower if we consider only publications about continental European countries (34%). Within continental Europe, the highest percentage of publications on horizontal segregation concerns Belgium (50%). That country is closely followed by France, Luxembourg, the Netherlands and Austria, (between 39% and 44%). Germany and Switzerland stand on the lower level (21% and 28% respectively).

**Table 13 : Number and percentage of publications**

| | n | % |
|---|---|---|
| Austria | 208 | 39.8 |
| Belgium | 178 | 49.7 |
| France | 289 | 44.6 |
| Germany | 293 | 28.2 |
| Luxembourg | 113 | 40.4 |
| Netherlands | 157 | 39.8 |
| Switzerland | 28 | 20.9 |
| **Continental Cs** | **610** | **34.3** |
| All Cs | **1,965** | **43.2** |

*Cross-topical coverage*

Table 14 gives an overview of the other topics covered along with horizontal segregation in the publications concerned. A large proportion of the volumes on horizontal segregation address the issue of “vertical segregation” (61%), about half of them examine the question of “stereotypes and identity” (49%), and just over a third deal with “science as a labour activity” and “policies towards gender equality in research” (36% and 32% respectively). The other topics crop up very rarely in studies on horizontal segregation.

**Table 14 : Association with other topics**

| | % |
|---|---|
| Horizontal segregation | 100.0 |
| Vertical segregation | 60.7 |
| Pay and funding | 12.0 |
| Stereotypes and identity | 48.5 |
| Science as a labour activity | 36.4 |
| Scientific excellence | 15.1 |
| Gender in research content | 18.0 |
| Policies towards gender equality in research | 31.8 |

*Trend in the number of publications between 1980 and 2009*

Table 15 enables us to see at what point in time horizontal segregation really began to attract attention from researchers. It is clear that the number of publications was very limited until the start of the 1990s (between 3 and 6 publications per year). Only from the 1990s onwards did researchers begin to

demonstrate enthusiasm for this topic. We can see that the number of publications (>40) produced during the period 2000-2007 was almost nine times higher than the number at the start of the period. In the years 2008-2009, however, only 18 publications on horizontal segregation were entered in the database.

**Table 15 : Average number of publications per year**

| | *Average* |
|---|---|
| 1980-1984 | 3.4 |
| 1985-1989 | 5.6 |
| 1990-1994 | 13.4 |
| 1995-1999 | 21.0 |
| 2000-2004 | 43.4 |
| 2005-2007 | 46.7 |
| 2008-2009 | 18.0 |

### 2.1.2. Summary of the key literature on "Horizontal segregation"

*Key issues*

In continental Europe, the literature on horizontal segregation in science is mainly concerned with the representation of boys and girls in different fields of scientific study, the purpose being to gain a better understanding of the different levels of interest in science among boys and among girls. Women's participation in the various scientific professions, which may be viewed as a reflection of educational segregation, has aroused less interest.

**Research Areas**

- boys'/men's and girls'/women's representation in different scientific fields;
- causes of horizontal segregation;
- political initiatives to tackle horizontal segregation.

*Research questions*

- How well are girls and boys represented in scientific fields of study at school or university? What results do they achieve? How has this changed over time?
- Why are girls less interested in science than boys?
- Does the "gendered nature" of study orientation in the education system account for the persistence of gender segregation in technical and scientific professions?
- What initiatives have been undertaken to tackle horizontal segregation, or what measures can be taken to overcome ongoing horizontal segregation?

*Research approach*

The representation of girls/women and boys/men in the various scientific fields (such as mathematics, natural sciences and applied sciences, as well as human sciences and the health sector) at school and in the world of work has been a subject of investigation in continental Europe. Yet the main explanation for horizontal segregation has revolved around education.

Tables 16, 17, 18 and 19 give an overview of the methods used in the literature to tackle horizontal segregation.

As indicated by Table 16, two methodological approaches are widely used when studying horizontal segregation: 48% of publications are based on compilation of statistics, while 47% are state-of-the-art literature reviews. Qualitative empirical research makes up 30% of the publications. 26% of publications on horizontal segregation are conceptual and 21% are empirical studies based on a quantitative approach. Only 3% of publications are based on the building of gender indicators.

**Table 16 : Methodological approach**

| Approach | % |
|---|---|
| Conceptual | 26.2 |
| State-of-the-art | 46.9 |
| Compilation of statistics | 47.5 |
| Building gender indicators | 3.0 |
| Empirical research. Quantitative techniques | 21.1 |
| Empirical research. Qualitative techniques | 30.0 |

The empirical methods used to analyse the issue of horizontal segregation in science are shown in Table 17. It should be pointed out first and foremost that more than half of all studies are non-empirical (57%). Horizontal segregation in science has more often been approached qualitatively (21%) than quantitatively (12%). Research based on both quantitative and qualitative methods is rare (9%).

**Table 17 : Types of empirical research**

| Empirical research | % |
|---|---|
| Non-empirical research | 57.5 |
| Empirical research. Quantitative techniques | 12.5 |
| Empirical research. Qualitative techniques | 21.3 |
| Empirical research. Quali-quantitative techniques | 8.7 |
| Total | 100.0 |

Table 18 demonstrates that quantitative research is based in the main on micro-economic data (56%) and on a representative sample (52%). 25% of quantitative empirical research is based on a multivariate analysis. Very few studies are longitudinal (12%).

**Table 18 : Quantitative research techniques**

| Quantitative techniques | % |
|---|---|
| Representative sample | 51.9 |
| Micro-data | 55.8 |
| Longitudinal/cohort | 11.6 |
| Multivariate analysis | 24.8 |

The qualitative techniques used in publications on horizontal segregation are set out in Table 19. We note that the most commonly used qualitative method is the interview (62%). The other methodological approaches are used in roughly similar proportions: between 10% (content analysis) and 16% (case studies).

**Table 19 : Qualitative research techniques**

| Qualitative techniques | % |
|---|---|
| Biographical research | 15.3 |
| Case studies | 16.4 |
| Content analysis | 10.9 |
| Interviews | 62.3 |
| Observations | 14.8 |

*Findings*

a) Description of the situation

- Educational segregation

In this sub-section we present the conclusions on the representation of girls in different scientific disciplines that emerge from the continental literature. To this end, we have based ourselves on the conclusions reached in the various country reports[2].

Belgium:
- girls are under-represented in science faculties (especially in exact and applied and computing sciences);
- women prefer disciplines such as human sciences, medicine and pharmacy.

Switzerland
- women are under-represented in technical sciences (27%) and in technology and IT (6%);
- women are over-represented in the humanities, social sciences (65%) and health (86%).

The Netherlands
- women and girls in (advanced) science, mathematics and engineering courses show that gender equity is still far from a reality;
- some disciplines face an over-representation of female students, for instance medicine and psychology.

Austria
- science, mathematics and computing as well as engineering, manufacturing and construction are still male-dominated;
- female students predominate in the humanities, in social and economic science, and in veterinary/human medicine.

This analyse reveals that the various country reports arrive at similar conclusions regarding the representation of women in science. Generally speaking, girls are under-represented in highly scientific options (exact sciences, technology and IT). Women are better represented in social and human sciences and in health-related fields. The statistical analysis contributed by Meulders et al. (2009) (Topic report: horizontal and vertical segregation) confirms the limited presence of women in highly scientific fields in continental Europe[3].

- Professional segregation

One general remark is that horizontal segregation in the labour market (the distribution of researchers and scientists over scientific fields) is closely linked to educational segregation (the distribution of students by scientific field). The reality of traditional “male” fields, where the proportion of men is higher than that of women, and “female” fields, where the proportion of women is higher than that of men, is reflected in (scientific and research) occupations. In Switzerland, for example, there is an

[2] Meulders and al., 2009 - Belgian country report; van den Brink, 2009 - Dutch country report; Knobloch, 2009 - Swiss country report; Leitner and Wrobleski, 2009 - Austrian country report).

[3] The continental countries included in the analysis conducted by Meulders and al. (2009) are France, Belgium, Germany and the Netherlands.

ongoing under-representation of women in certain areas of science and technology in higher education, namely in mechanical and electrical engineering, in IT and in physics (Gilbert, 2005).

Several studies investigate the choice of specialisation in medical careers in order to underline possible differences between men and women. According to Jensen (1995), women are more present in less prestigious fields of work and research, such as paediatrics or gynaecology, while men dominate in surgery and internal medicine.

Segregation can also be approached by looking at the representation of women in science and research professions by sector. In this regard, Rehmann (2004) gives information concerning the case of Switzerland. He finds that the participation of women in education and research is increasing, but women still remain strongly under-represented. The percentage of women researchers is lowest in the private sector, at 16.5%. The percentage of women in management positions in these companies is approximately 8%. It is however worth noting that official data collection methods are not as finely tuned as those of universities. It is also estimated that women in the private sector earn at least 20% less than men in the same position. The report also mentions that some individual enterprises are concerned about equal opportunities: in particular, large chemical and pharmaceutical firms that need cohesive and innovative research teams place a high value on gender equality. In addition they are also striving to increase the participation of women at the management level and in research.

The French Ministry of Research carried out a study in 2002 on women in scientific careers. The main findings of this report are that there are more women researchers in the public sector (30%) than in the private sector (19%). Two thirds of women researchers work in the public sector. The proportion of women also varies according to the field of research. Physics and mathematics have the lowest proportions of women. The situation of women is more favourable in the Parisian region than in rural regions. Since 1992, the number of women in research occupations has grown at a faster rate than that of men, and also faster than female employment in the labour market in general. This is observed in both the public and private sector. In general, the employment growth rate is higher for women researchers (4.2%) than on average for researchers in total (1.5%). We can refer here to a general trend. However, the report also mentions that men are more easily promoted than women, and this is especially true for young men. There are significant differences across institutions and disciplines. Regarding promotion and evaluation, in France the institution-based culture is stronger than the culture by discipline. The proportion of female research directors in public research institutions is 25%. In universities this proportion is 7 percentage points lower (18%). Across all disciplines, promotion practices are less favourable towards women in universities. However, major differences exist between public research institutions.

In Austria it appears that the share of women has increased, especially in non-university research institutions (Kreetz, 2004). University and non-university research are two relatively separate labour market sectors in Austria, with very different working conditions for scientists and with hardly any institutionalised possibilities for transferring from one sector to the other.

In Belgium it appears that, over the past ten years, the proportion of women with degrees in applied science wanting to work in research has been rising (Meulders et al., 2010b – Topic report: horizontal and vertical segregation). In that same country, there has been an especially marked rise in the percentage of female scientific and academic staff in human science faculties. This rise appears to be sharper in human sciences than in applied sciences and computing sciences (de Henau and Meulders, 2003).

b) Causes of horizontal segregation

Horizontal segregation has mainly been explained in terms of education. The research examines the representation of girls and boys in scientific fields. It focuses on young people's belief in their cognitive ability, their styles of learning, their preferences and their perception of science as an occupation appropriate to their needs. The practices and prejudices of teachers and parents are examined so as to better understand the structures and environments contributing to the process of gender socialisation (an individual's internalisation of gender stereotypes). These various points are broadly linked with the topic of stereotypes and identity, presented in section 1.4.

- Influence of the reference group

The gender socialisation process during childhood has generally been treated as a factor that influences the educational "preferences" of boys and girls (Duru-Bellat and Terrail, 1995; Marry, 2000, Blättel-Mink, 2002). The influence of teachers, parents and peers, as well as their sometimes detrimental practices, has been studied in this light (Alaluf and Marage 2002; Meelissen and Luyten, 2008; Plateau et al*.,* 1991; Mosconi, 1989). According to Leemann (2002), children with highly educated parents are more likely to embark on a PhD than others. The study by Zwick and Renn (2000) concludes that, over and above career prospects and expectations of job security, educational preferences are governed by pupils' aptitudes/talents as well as by the influence of reference groups such as parents, teachers and friends.

**Box 1 : Access of young women to scientific and technical degree courses**

This report examines the circumstances whereby young women enter scientific and technological disciplines at university. It also attempt to identify the multiple factors that lead to differences in the degree courses chosen by boys and girls. The report is based on the results of a survey carried out among new students at the Free University of Brussels. In general, there are two groups of elements that influence the possibilities and choices of discipline: the socio-cultural characteristics of the family environment, and the school subjects studied. The researchers crossed two groups of factors with these elements: personal aspirations and professional intentions. These factors have a very different impact in the case of men and women. The majority of boys with the option of "strong maths" in secondary education will generally progress to scientific studies while girls with the same option will turn to a more varied range of fields of study. Several options are considered as offering good employment prospects, but real ignorance exists concerning the variety and quality of jobs available at the end of the university course. This ignorance is particularly significant in the choices made by girls.

Alaluf, M. and Marage, P. (2002), Newtonia. *Accès des jeunes femmes aux études scientifiques and techniques*, Université Libre de Bruxelles, mimeo.

- Lack of self-confidence

The under-representation of girls in scientific disciplines can be explained by their subjective perception of their own intellectual capabilities. Girls' lack of confidence in their intellectual faculties (a phenomenon less prevalent among boys) causes them to shun highly scientific disciplines in favour of a more modest career path (van Kalles, 1996; van Aerschot, 2003; Le Doeuff, 1998; Plateau et al, 1991; Wagner, 1987). This is true even when they are more successful at school than their male classmates (Alaluf and *al.*, 2003).

**Box 2 : Job offer: engineer (male/female). An investigation of study choices based on a gender perspective**

What study choices do boys and girls from scientifically-oriented secondary school courses make, and why do they make different choices? A survey of 1,000 pupils in their final year of secondary school provides some answers. Girls obtain better grades than boys in most subjects, including scientific ones. Nevertheless, girls think they have less aptitude for scientific subjects than boys. Girls systematically estimate themselves lower than boys, with respect both to their level of performance in scientific subjects and their chances of success in higher education. This explains, to a large extent, why girls are less inclined to choose a scientific field of study in higher education. Girls have less interest in a full-time job and in earning a lot of money, and are more interested in the opportunities for social contacts in their future profession. Moreover, girls have a less positive image of exact science subjects at university than boys. They find these subjects less fascinating and see fewer job opportunities and possibilities for personal development than boys. Apart from the survey, the report also includes proposals for making science more attractive to girls.

Van Aerschot, M (2003), *Gezocht: ingenieur (m/v). Een onderzoek naar studiekeuze vanuit genderperspectief*, Steunpunt gelijkekansenbeleid , Antwerpen.

- Rational choices

The poor representation of women within certain disciplines has also been viewed as the result of personal choice rather than the effect of discriminatory practices. From this perspective, girls' expectations in relation to social norms and the existence of a less than perfect labour market make their choices rational (Poglia, 2004). According to Gilbert et al. (2003), the aspirations and motivations of girls and boys are different. Girls are mainly interested in social and political issues, whereas men are driven by the desire for a high-profile career. Nevertheless, these studies indicating that girls operate a rational selection process do not dispute the influence of gender stereotypes in explaining the different educational preferences exhibited by girls and boys.

**Box 3 : Choice of study fields at Swiss universities: a survey among students of the exact, natural and technical as well as social sciences**

Poglia analyses the distribution of students across fields of study in order to learn more about the mechanisms and factors influencing women and men studying at Swiss universities, particularly in the natural, exact and technical, and social sciences. The study revealed that the schools attended before the "matura" greatly influenced the choice of study field: The type C Matura (and perhaps the constellation of subjects that will replace it in the future) was fundamentally decisive in the choice of natural sciences or exact and technical sciences, but so was the awareness of a personal aptitude for science, at least partially in relation to a track-record of high marks in these fields over the entire school career. In addition, the study emphasised that the choice of study direction was a fairly rational process that was especially influenced by the image the students had formed of their skills; their interest in the field they were studying; the – quite realistic – perceptions of the professions, their limitations and their opportunities; and also personal values the students considered important.

Poglia, E. (2004), *Le choix des études universitaires en Suisse: une enquête auprès des étudiant(e)s en sciences exactes, naturelles et techniques ainsi qu'en sciences sociales*, State Secretariat for education and research (SER), Bern, *Dossiers OFES 2004/3f*.

- Girls' attitudes towards science

The stereotypical image of science as a male preserve has been studied in relation to both educational segregation (Coradi et al*,* 2003; Van Aerschot, 2003; de Cheveigné and Muscinési, 2009 – French country report) and professional segregation (Thaler, 2006; Coste-Roy, 1981). Vouillot (2002) shows that women tend to remain within the norm and pursue female dominated jobs. This subject has likewise been addressed in the explanation of vertical segregation.

**Box 4 : Thinking of becoming a female engineer?**

Technological design is connected with power and influence, and women are therefore still largely excluded from this field. This survey discusses psychological constructs and the stereotype threat effect, as well as gender-specific cognitions and gender stereotypes, as factors influencing the decision to embark on a career as a female engineer. The close association of technology and maleness, together with a devaluation of women's technological achievements, are shown as reasons for hindering myths (women's adverseness to and distance from technology). The author's main thesis is that dual study courses at applied science universities support future female engineers because the students also obtain work experience and thereby overcome the hurdle of career entry. This thesis is analysed through a comparison of the first dual study courses in Austria and various courses of study in Germany and Austria. The survey showed that dual study programmes are not a sufficient supporting factor, as companies, where sexism is still very much present, also have a strong influence on student selection. Interdisciplinary, practically orientated courses and lectures for women are associated with success in reaching the goal of becoming a female engineer. The author points out that real equality in the company is essential for success as a female engineer. This research project has a qualitative focus and is complemented by input from the author's research journal.

Thaler, A. (2006), *Berufsziel Technikerin?*, Profil Verlag GmbH, Munich, Vienna.

c) Quantitative evidence

This sub-section presents some of the statistics contained in She Figure (2003, 2009) and in the report by Meulders et al. (2010b) (Topic report: horizontal and vertical segregation).

**Table 20 : Horizontal segregation (ID-index: Comparison of researchers with the total workforce, 2007)**

| | Total population | Researchers (ISCED 5A, 5B, 6) | Researchers with a PhD (ISCED6) |
|---|---|---|---|
| LU | 0.32 | 0.24 | 0.20 |
| FR | 0.34 | 0.29 | 0.19 |
| AT | 0.41 | 0.31 | 0.25 |
| BE | 0.28 | 0.32 | 0.14 |
| NL | 0.41 | 0.32 | 0.29 |
| DE | 0.31 | 0.33 | 0.30 |

*Source*: Meulders and *al.* (2010b)
Note: the figures in the last column relating to researchers who hold a PhD should be interpreted with caution due to small sample sizes

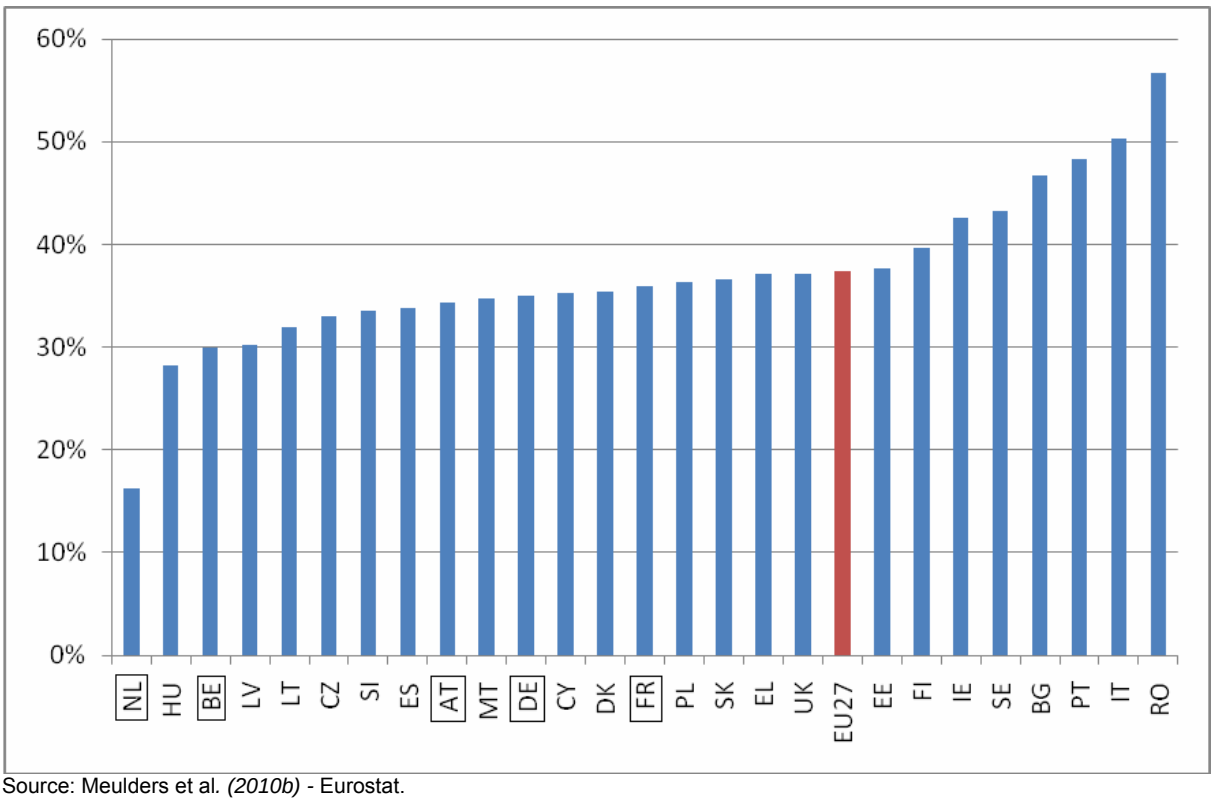
Table 20 shows the ID index - a gauge of horizontal segregation (see Box 6) - for all the continental countries belonging to the European Union. The ID index was calculated for three types of population (the total labour force, researchers and researchers with a PhD). We find that horizontal segregation among researchers (column 2) is weakest in Luxembourg and strongest in Germany. Looking only at highly qualified researchers, segregation is lowest in Belgium and highest in Germany. Two groups of countries can be distinguished here: on the one hand, in Luxembourg, Austria, France and the Netherlands segregation is more pronounced among the total labour force than in research, and least pronounced when considering only highly qualified researchers. On the other, in Germany and Belgium there is greater segregation in research but it remains less marked in the case of researchers with a PhD.

**Box 5 : Dissimilarity index**

The dissimilarity index is the most used indicator to measure inequalities (ID Index) defined as: the "sum of the minimal proportion of women and minimal proportion of men that should change profession so that the proportion of women is identical in every profession" (Anker, 1998). The Index of Dissimilarity (ID) is arguably the most widely used for international comparisons because it was proposed as early as 1955 (Duncan and Duncan, 1955). This indicator calculates the professional or sectoral repartition of employment by gender, associated with vertical and horizontal segregation respectively (Anker, 1998). This index measures the distance from an equal distribution of men and women across occupations, the hypothesis being that segregation implies a different distribution of men and women over all professional occupations. The more this distribution is equal, the lower is segregation. The index lies between 0 and 1: 0 in the case of no segregation, and 1 in the case of total segregation, each profession being entirely dominated by women or by men. It also allows calculating the number of men or women that need to change sector/occupation in order to have an equal distribution of gender on the labour market. The value of the ID index depends on the level of female employment, but only indirectly, via changes in the occupational structure that accompany increases or decreases in the proportion of women in the workforce. This index can however present some limits since it is based on the hypothesis that there should be an equal distribution of men and women in every sector or occupation.

Meulders, Plasman, Rigo and O'Dorchai (2010b), *Topic report on Horizontal and vertical segregation.*

**Figure 1 : The proportion of female students (ISCED 5-6) in science, mathematics and computing in the EU27 in 2007**




Source: Meulders et al. *(2010b)* - Eurostat.

In the continental European countries included in Figure 1, women are found to be under-represented in science, mathematics and computing (<40%). The percentage of women in France, Germany and Austria in these subject areas is around 35%. Belgium, for its part, barely reaches 30%. The Netherlands are at the bottom end of the scale, with fewer than 20% of women in these subject areas.

*Gaps*

There is an apparent imbalance between the topics investigated: educational segregation has been the subject of considerably more research than professional segregation. What is more, a comparison of the reasons why pupils/students refrain from pursuing scientific courses of study, and the reasons lying behind women's career choices, would help greatly in furthering our understanding of horizontal segregation.

Research needs to be carried out on girls/women who opt for non-traditional (male) courses of study and occupations, so as to reveal their experiences, performance and attitudes.

Horizontal segregation has been explained solely in terms of comprehending the representation of women in scientific fields. There has been no research attempting to understand why men are under-represented in "female disciplines" such as social sciences and human sciences.

## 2.2. Vertical segregation

### 2.2.3 Statistical analysis of the Gender and Science database

*Country coverage*

Vertical segregation is a topic that crops up in almost half (46%) of the publications on gender and science concerning continental Europe (cf. Table 21). This is most striking for Switzerland and Belgium[4] (59% and 51% respectively). For the remaining countries too, vertical segregation accounts for a not insignificant proportion of publications on gender and science. France, with a rate of 38%, is in fact the country where vertical segregation is covered least in publications on gender and science. Looking at all the countries included in the database, the topic of vertical segregation is amply covered in the literature (45%).

**Table 21 : Number and percentage of publications**

| | n | % |
|---|---|---|
| Austria | 253 | 48.5 |
| Belgium | 184 | 51.4 |
| France | 247 | 38.1 |
| Germany | 481 | 46.3 |
| Luxembourg | 126 | 45.0 |
| Netherlands | 192 | 48.7 |
| Switzerland | 79 | 59.0 |
| **Continental Cs** | **821** | **46.1** |
| **All Cs** | **2,035** | **44.7** |

*Cross-topical coverage*

Table 22 illustrates the extent to which other gender and science-related topics are addressed in publications relating to vertical segregation. 50% of all publications on vertical segregation tackle matters connected with “science as a labour activity”, while 45% deal with “horizontal segregation”. The two topics covered least often are “gender in research content” (18%) and “pay and funding” (14%).

**Table 22 : Association with other topics**

| | % |
|---|---|
| Horizontal segregation | 45.1 |
| Vertical segregation | 100.0 |
| Pay and funding | 14.0 |
| Stereotypes and identity | 33.0 |
| Science as a labour activity | 49.9 |
| Scientific excellence | 20.2 |
| Gender in research content | 17.7 |
| Policies towards gender equality in research | 35.9 |

[4] In Germany and Belgium, vertical segregation is in fact the most widely covered topic in the GSD (Sagebiel and Dahmen, 2009 - German country report; Meulders and al., 2009 – Belgian country report).

*Trend in the number of publications between 1980 and 2009*

Table 23 demonstrates how rare it was for studies to be devoted to vertical segregation in science during the period 1980-1990. The average number of publications was less than nine per year. Throughout this period, as we can see, the number of publications grew quite significantly. By 2000 it was almost 13 times higher than at the start of the period. The number did however decline from 2005 onwards, totalling just 26 publications in the years 2008-2009. Overall, therefore, the figures indicate growing interest in this topic on the part of researchers.

**Table 23 : Average number of publications per year**

| | Average |
|---|---|
| 1980-1984 | 4.8 |
| 1985-1989 | 8.6 |
| 1990-1994 | 17.0 |
| 1995-1999 | 26.6 |
| 2000-2004 | 63.0 |
| 2005-2007 | 56.3 |
| 2008-2009 | 26.0 |

### 2.2.2. Summary of the key literature on "Vertical segregation"

*Key issues*

Research into vertical segregation in science examines the ascent of women within academia, the role model being a full-time male employee who has no breaks in his career.

The progression of women in scientific professions has generally been described, analysed and illustrated in the continental literature in terms of the "leaky pipeline" concept: the further one rises up the hierarchy, the fewer women there are. Particular attention has been devoted to the personal and institutional barriers restricting women's opportunities for career advancement in academia.

Various conceptual models and metaphors are used to analyse vertical segregation issues. We might mention the following concepts[5]:

- **"leaky pipeline"** – to describe women's attrition in science: the pipeline leaks women disproportionately on each rung of the academic ladder (van de Brink, 2009 – Dutch country report).
- **"glass ceiling" –** phenomenon whereby women aspiring to more senior positions within an occupational hierarchy find their way blocked by informal practices/invisible barriers (e.g. male networks, promotion criteria based on stereotypes) (Meulders et al*.,* 2010b – Topic report: horizontal and vertical segregation).
- **"Mathew effect" –** mechanism that describes the strengthening of initial differences throughout the professional careers of women and men (de Henau and Meulders, 2003).
- **"Matilda effect" –** hidden mechanism of male hegemony in academic organisations that keeps women away from the better aspects of the career (Marry and Jonas, 2005).
- **"sticky floor" –** describes the forces that tend to maintain women at the lowest levels in the organisational pyramid.
- **feminisation –** describes those disciplines that female employees are diverted into. Nevertheless, the growth in female employees remains marked by differences and inequalities with respect to their careers, wages, and access to power and decision-making functions (Marry, 2001).

[5] Bennett and al. (2010) (UK and Ireland country-group report) give also an overview of general concepts used in the literature on vertical segregation.

**Research Areas:**

- Men's and women's representation at different hierarchical levels in scientific professions;
- Causes of vertical segregation;
- Political initiatives to tackle vertical segregation.

*Research questions*

- What is the level of representation of women in scientific position in academia?
- How important is the turnover rate of women from professional scientific career?
- What obstacles do women have to overcome in order to advance in their a career?
- What initiatives have been undertaken? How can society, as well as the academic system, be changed to become more inclusive?

*Research approach*

Studies on vertical segregation are geared to understanding the progression of women and men in scientific professions, especially in academia. Over the period 1980-2009, there was a shift in the subjects researched in continental Europe:

- 1980-1990: these studies set out to analyse the numerical representation of women in the various echelons of the academic hierarchy;
- Late 1990s - early 2000s: authors began to focus on the causes of the gradual disappearance of women.

A detailed picture of the methods used to research the issue of vertical segregation in science is provided in Tables 24, 25, 26 and 27.

Table 24 shows that state-of-the-art literature reviews (52%) and compilation of statistics (40%) are the methods most generally used to analyse vertical segregation in science. Empirical methods based on qualitative techniques are used in 33% of cases, and quantitative techniques are deployed in 25% of publications on vertical segregation. As for conceptual studies, these account for 22% of publications. The building of gender indicators is rarely used (3%).

**Table 24 : Methodological approach**

| Approach | % |
|---|---|
| Conceptual | 22.2 |
| State-of-the-art | 51.6 |
| Compilation of statistics | 40.2 |
| Building gender indicators | 3.0 |
| Empirical research. Quantitative techniques | 25.2 |
| Empirical research. Qualitative techniques | 32.8 |

Table 25 reveals that more than half of all publications are non-empirical studies (52%). 22% and 15% respectively of publications on vertical segregation rely on qualitative and quantitative techniques. Only 11% of publications use both qualitative and quantitative techniques.

**Table 25 : Type of empirical research**

| Empirical research | % |
|---|---|
| Non-empirical research | 52.7 |
| Empirical research. Quantitative techniques | 14.5 |
| Empirical research. Qualitative techniques | 22.0 |
| Empirical research. Quali-quantitative techniques | 10.7 |
| Total | 100.0 |

The different quantitative techniques used to analyse vertical segregation are indicated in Table 26. A large majority of studies are based on a representative sample (66%) and on micro-economic data (64%). A multivariate analysis is carried out in 20% of cases. Few studies are longitudinal (10%).

**Table 26 : Quantitative research techniques**

| **Quantitative techniques** | **%** |
|---|---|
| Representative sample | 66.2 |
| Micro-data | 64.3 |
| Longitudinal/cohort | 10.1 |
| Multivariate analysis | 20.3 |

Table 27 demonstrates that most of the qualitative studies are interview-based (71%). The other techniques are little used: 18% of studies are based on biographical research and the same percentage on case studies, 10% on content analysis and just 6% on observations.

**Table 27 : Qualitative research techniques**

| Qualitative techniques | % |
|---|---|
| Biographical research | 18.2 |
| Case studies | 18.2 |
| Content analysis | 10.0 |
| Interviews | 71.4 |
| Observations | 5.9 |

*Findings*

This sub-section provides an overview of the literature on the numerical representation of women and the causes of vertical segregation. Quantitative evidence on the scale and nature of vertical segregation is also presented.

a) Description of the situation

The gradual disappearance of women at each echelon of the academic hierarchy (the “leaky pipeline” phenomenon) has been widely observed in the continental literature, despite the increased presence of women in higher education institutions and universities (Marry, 2001; Rombouts and Godin, 2004; Leitner and Wrobleski (2009) – Autrian country report; van de Brink, 2009 – Dutch country report; Knobloch , 2009 – Swiss country report ). For example, the German study by Majcher et al. (2003) reveals that, even though more than 50% of students at European universities are women, the professional sphere is still structured vertically. The Belgian study by de Henau and Meulders (2003) shows that more than half of first and second-year undergraduates are women, and that their numbers gradually decline as the level of study advances. This gradual disappearance of women mainly begins at postgraduate and PhD level. This finding appears to be valid in the majority of cases (Meulders et al., 2010b) - Topic report: horizontal and vertical segregation). Women’s progressive disappearance is also evident in disciplines where the number of female graduates exceeds that of male graduates. In

Belgium and the Netherlands, for example, the exit rate is highest in subject areas where women have a greater numerical presence than men (Meulders et al., 2009 – Belgian country report; van den Brink, 2009 - Dutch country report).

Vertical segregation, which is commonly observed in the academic sector, likewise exists in the private sector (Valgaeren, 2005) and in the public sector (Crance, 2002). The public and private sectors have however attracted less attention.

It would therefore seem that women's career paths less often result in sufficient professional recognition for them to be able to reach the top of the university or non-university hierarchy. These findings have substantiated the notion that a glass ceiling exists, i.e. that there are curbs and obstacles to the advancement of women in academia (research and teaching), both at the point of entry and at the various stages along the way. Such findings have also led to the carrying out of studies on the causes of vertical segregation.

b) Causes of vertical segregation

Several explanatory factors have been analysed with a view to understanding the causes of vertical segregation. As the various country reports indicate, personal, institutional and cultural obstacles have all been investigated. Research projects have not been confined to the idea that women are either "work-oriented" or "family-oriented", but take into account many other factors that make it difficult for women with family commitments to compete successfully in the race for promotion. These different factors are presented in the analysis below. It immediately becomes apparent that they are closely connected with the topics that we shall examine later, namely "stereotypes and identity" (section 1.4), the structure of the labour market in science (section 1.5), "scientific excellence" (section 1.6).

- Scientific assessment criteria

Scientific assessment criteria frequently go hand-in-hand with the constant obligation to increase the number of publications (often used as an indicator of academic productivity). They therefore require a considerable investment in terms of working time, which is harder to achieve in the case of women who have family commitments (Benschop and Brouns, 2003). Consequently, the failure of assessment criteria to take account of gender can impede the progression of women in scientific careers (Portegijs, 1998; de Henau, 2003). Moreover, the lack of transparency and objectivity in the assessment of scientific quality also contributes to the under-representation of women in senior positions in the hierarchy (von Haegendoren et al., 2000; Matthies et al., 2001; van der Burg et al., 1998). According to Valgaeren and Noelanders (1999) a first - but not the last – step to put management by diversity into practice is to pay special attention to selection and promotion procedures.

**Box 6 : Equality soon: barriers to the upward mobility of women into senior scientific positions**

This book focuses on the bottlenecks that women are confronted with during their academic careers. The study consist of two parts. The first part of the book deals with identifying differences in the careers of male and female scientists, and tries to explain these differences. The study's findings show that the upward mobility of women is less extensive than that of their male counterparts. Also, women leave academia to a larger extent. These differences do not seem to be caused by differences in ambition or commitment. Nor were any differences found in the amount of support or participation in networks and boards. The authors put forward some explanations. Women have fewer publications because differences in position are not taken into account (e.g. contractual terms, international experience, access to funding). The second part of this book makes some policy recommendations. The author suggests a three-fold approach: policies aimed at the upward mobility of women (special funding, removing barriers); policies aimed at keeping women in academia and preventing dissatisfaction; policies aimed at upward mobility in general (for men and women), making more positions available at senior levels.

Portegijs, W. (1998), *Eerstdaags evenredig: belemmeringen ten aanzien van de doorstroom van vrouwen naar hogere wetenschappelijke functies*, Ministerie van Onderwijs, Cultuur en Wetenschappen, Zoetermeer.

- The male culture in scientific work

The culture in scientific work is frequently cited as a factor explaining the poor progression of women in the field of science (Matthies et al*.,* 2001; Gschwandtner et al*.,* 2002; Vogel and Hinz, 2004). This culture, of which long working hours and constant availability are a typical feature (Haffner et al*.,* 2006; Wimbauer, 2000), reduces the definition of an "ideal employee" to the vision of a man (who has no commitments outside of work) (Gorgani, 2008; Buchmayr and Neissl, 2006).

**Box 7 : Women in science and research. Searching for reasons for the under-representation of women at universities. A qualitative survey of female and male scientists at the faculty of philosophy of the University of Fribourg, Switzerland**

Women are still under-represented in science and research. Their under-representation increases the higher their level of qualifications. Women seem to be less successful than their male colleagues in mastering the selection mechanisms of a highly competitive science system. Based on 15 themed interviews with female and male researchers in the Department of Philosophy at the University of Fribourg in Switzerland, the publication studies how universities recruit young researchers and what strategies the interviewees pursue to foster their scientific careers. The analysis of the interviews shows, on the one hand, that the employment market in research is highly competitive and characterised by many uncertainties. Apparently women are less prepared to work under these conditions. On the other hand, universities still remain to this day a male-dominated cultural space where traditional structures of thought and action continue to be valid and to negatively influence the careers of women researchers.

Immoos Gorgani, M. (2008), *Frauen in der Wissenschaft und Forschung. Auf Spurensuche nach Gründen für die Unterrepräsentanz von Frauen im Wissenschaftsbetrieb. Eine qualitative Befragung von Wissenschaftlerinnen und Wissenschaftlern der Philosophischen Fakultät der Universität Freiburg i.Ü.*, University of Fribourg, Fribourg.

- Male networks

Several authors have investigated the existence of male networks enabling their members to secure advancement through information sharing and support for members (Van Balen and Van Vianen, 2002; Bütow, 1993; Van den Brink, 2009b). Van Balen and Van Vianen (2002) demonstrate that men tend to work among themselves and women among themselves. However, given that there are more men than women in senior positions, male networks are more efficient. The effects of men's better representation in senior positions on the career progression of women have likewise been illustrated by several authors (Van Haegendoren et al*.*, 2000; Delavault et al*.*, 2000).

**Box 8 : Exclusion of women in the transformation of the Saxony higher education system**

The author attempts in her contribution to analyse the situation of female scientists in Saxony, which is currently a problematic issue because no statistics exist, for instance, on dismissed female scientists; neither is there any information on women in appointment procedures. Many processes are not transparent and thus often cannot be factually proved. The author starts by describing the exclusion mechanisms in the former German Democratic Republic as the science system there had hierarchical, male structures and offered worse career possibilities for women. Women were more involved in teaching tasks than in research, and were prepared to sacrifice their own career advancement to that of their partners. The typical female 'science pyramid' existed in the GDR too, even though more women were to be found among scientific staff and in technical and engineering faculties. During the transformation process, male networks were essentially used to stabilise patriarchal structures and at the same time the exclusion mechanisms. The author goes on to list some mechanisms for women's exclusion and explains how potential intervention strategies could be developed.

Bütow, B. (1993), "Ausgrenzungen von Frauen bei der Neugestaltung des Hochschulwesens in Sachsen" in M. Arndt and M. Deters, eds. *Ausgegrenzt und mittendrin. Frauen in der Wissenschaft*, Edition Sigma, Berlin, pp. 45-55.

- Stereotypes

Stereotypes about men's and women's roles within couples and within society are broadly perceived as a phenomenon that gives men a significant advantage, especially in the higher echelons of science. According to de Henau (2003), the main stereotype needing to be overcome is that mothers are less productive. Indeed, the very strong association made between *woman* and *organising family life* contributes to the reason why women are described and perceived as finding it very difficult to cope with their professional obligations; hence they are offered fewer professional opportunities (Fassa and al*.,* 2008). These stereotypes have a major impact on the formation of women's identities and contribute the spread of a stereotypical (male) image of science.

Based on the diagram produced by Bennett et al*.* (2010) (UK and Ireland countries group report, p.41), we have summarised the various conclusions on the causes of vertical segregation that emerge from the literature (cf. Table 28). Each of these points will be elaborated upon further in the following sections.

**Table 28 : Main conclusion on vertical segregation**

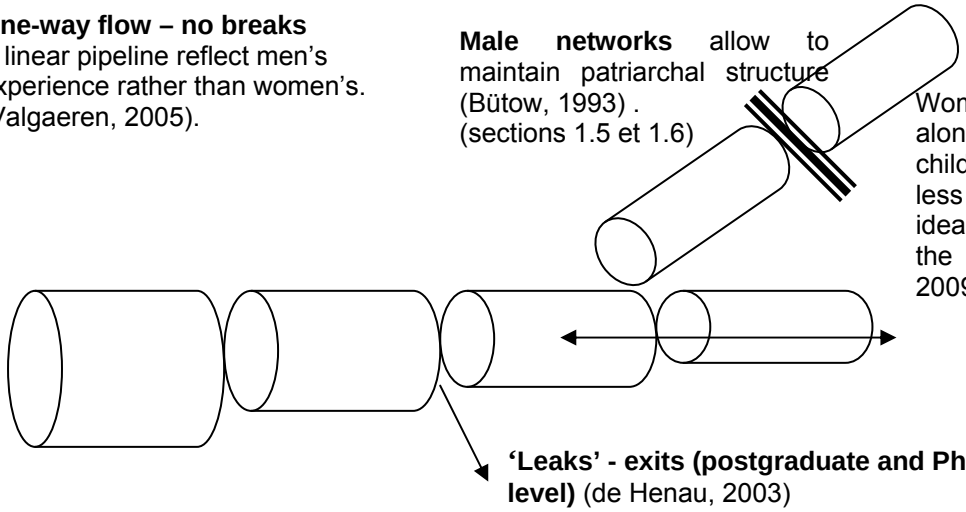
**Women follow different career paths**
Women's career development is much slower and stagnates earlier than that of men (Haffner and al., 2006).

**System of attribution**
Stereotype that associates men with objectivity, reason and science and women with family, emotion and nature (Section 1.4)

**Evaluation process**
Women are less likely than men to reach senior positions and achieve promotion as their work is not objectively/fairly evaluated (section 1.6)

**One-way flow – no breaks**
A linear pipeline reflect men's experience rather than women's. (Valgaeren, 2005).

**Male networks** allow to maintain patriarchal structure (Bütow, 1993) . (sections 1.5 et 1.6)



Women may **move backwards** along the pipeline –. Women with children can freely choose to work less and by implication, to be "non-ideal" workers by not conforming to the male model of work (Lewis, 2009)

**'Leaks' - exits (postgraduate and PhD level)** (de Henau, 2003)

**Scientific working culture -** spending long hours at work, and the requirement to be available all the time are incompatible with commitments outside work (Haffner and al., 2006)
Science is a mission that cannot readily be combined with other aspects of life, such as family (Buchmayr and Neissl, 2006). (Section 1.5)

*Source :* Bennett et al. (2010)

Findings – Quantitative evidences

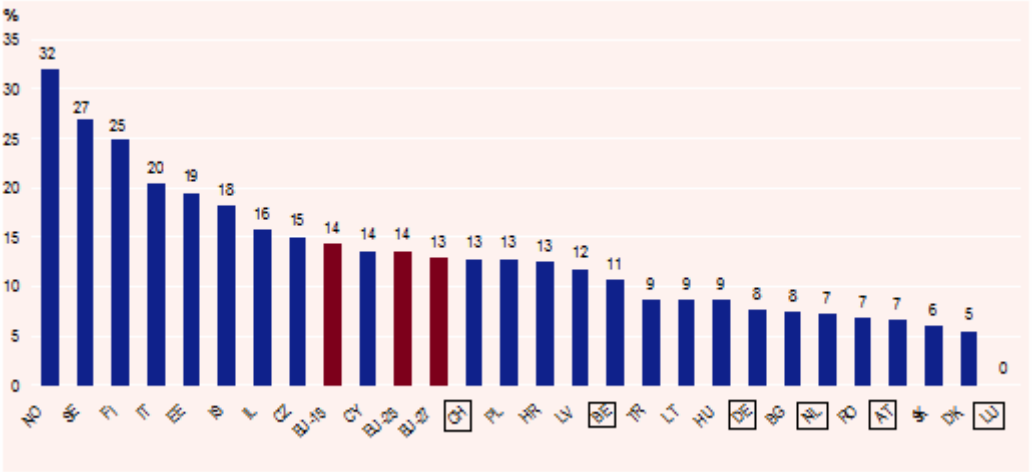
**Table 29 : Vertical segregation (ID-index): comparison of researchers with the total workforce, 2007**

| | Total population | Researchers (ISCED 5A, 5B, 6) | Researchers with a PhD (ISCED6) |
|---|---|---|---|
| BE | 0.45 | 0.26 | 0.14 |
| LU | 0.45 | 0.27 | 0.10 |
| NL | 0.46 | 0.27 | 0.19 |
| AT | 0.49 | 0.30 | 0.27 |
| FR | 0.33 | 0.34 | 0.16 |
| DE | 0.47 | 0.35 | 0.32 |

*Source*: LFS 2007, own calculations
Note: the figures in the last column relating to researchers who hold a PhD should be interpreted with caution due to small sample sizes

Table 29 presents the values of the ID index (see Box 6) measuring vertical segregation (across occupational categories – ISCO88, 3-digits) for 3 populations: the total workforce, the population of researchers and the population of the most highly qualified researchers (those with a PhD) for continental countries belonging to the European Union. Vertical segregation among researchers should be understood as a different distribution of male and female researchers within the professional hierarchy. The table shows that vertical segregation in the population of researchers is lowest in Belgium, Luxembourg and the Netherlands, and highest in France and Germany. Austria lies between these two groups. In all the countries (except France), the ID index is lower among researchers than on the labour market as a whole, and it drops even further when the total population of researchers is compared with the subsample of the most highly qualified researchers. In France, the level of dissimilarity in the distribution across occupational categories is higher when only researchers are concerned than when the total labour force is analysed. In this country, the ID index, although higher for researchers than for the total workforce, is lower among the most highly qualified researchers (ISCED 6) than among researchers with all levels of education (ISCED 5A and 5B) and than for the total workforce.

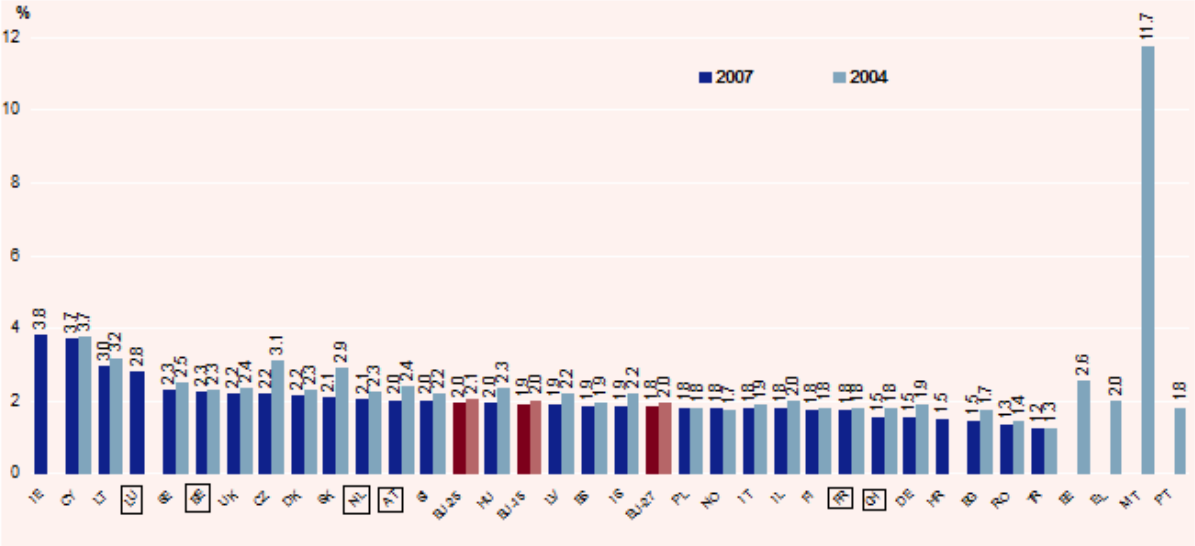
**Figure 2 : Proportion of female heads of institutions in the HES, 2007**




*Source*: She Figure, 2009, [EC, 2009, p. 97], on the basis of the WiS database (DG Research)
*Exceptions to the reference year:* IT: 2009; BE (Dutch-speaking community), DE, EE, HU, AT, PL, SK, FI, SE, HR, CH, IL: 2008; DK, CY: 2008/2007; RO: 2007/2006
*Data unavailable*: BE (French-speaking community), IE, EL, ES, FR, MT, PT, SI, UK
*Data estimated*: EU-27, EU-25, EU-15 (by DG Research)
BE data refer to Dutch-speaking community

Women's under-representation in the higher echelons of the academic hierarchy is reflected in the composition of the decision-making committees and leadership positions that are mainly composed of men. Consequently, one observes a strikingly low presence of women in very senior positions such as at the head of universities or other higher education institutions. Figure 2 illustrates this phenomenon clearly. The countries with the highest proportion of women are Switzerland and Belgium (13% and 11% respectively). By contrast, in Luxembourg not a single university is headed by a woman. In Germany, the Netherlands and Austria the percentages of female heads of institutions are 8%, 7% and 7% respectively. Austria, the Netherlands, Belgium and Germany also have very small proportions of women rectors (7%-8%).

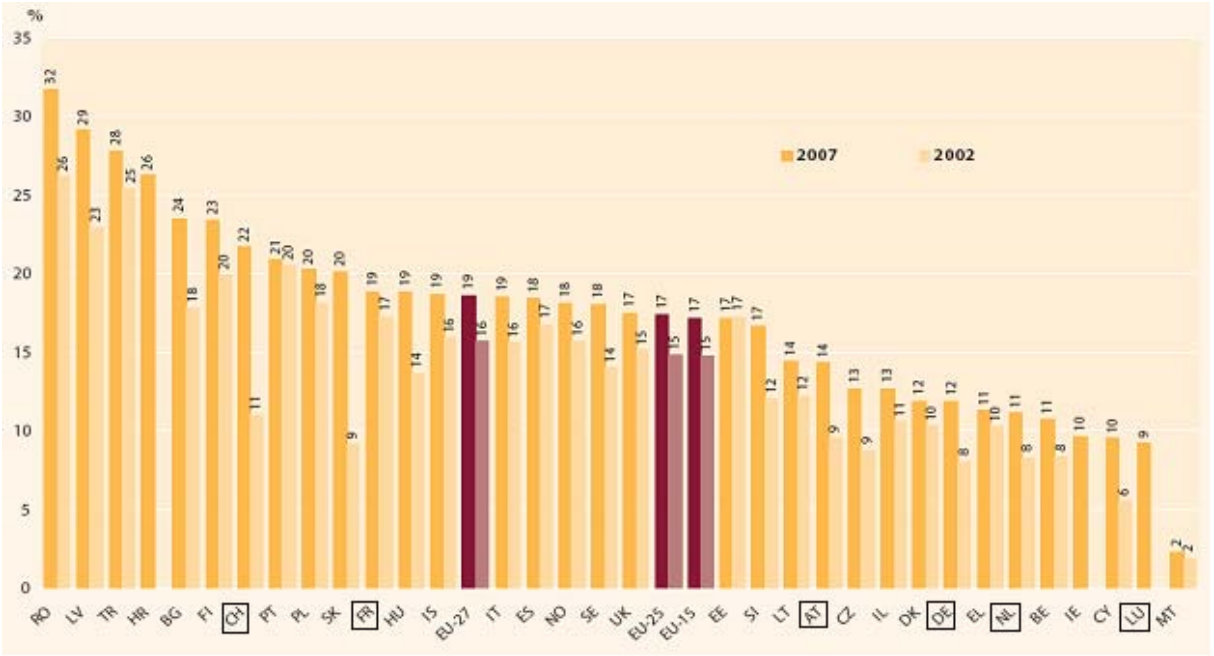
**Figure 3 : Glass Ceiling Index, 2004/2007**




*Source*: She Figure, 2009, [EC, 2009, p.78], on the basis of the WiS database (DG Research); Higher Education Authority for Ireland (Grade A)
*Exceptions to the reference year (s):* **2007** HR: 2008; UK: 2007/2006; DK, IE (except for grade A: 2002-2003), FR, CY, LU, AT, IL: 2006; **2004** PT, NO: 2003; IL: 2001; EL: 2000
*Data unavailable*: **2004**: LU, IE, HR; **2007**: EE, EL, MT, PT; Grade C unavailable for BG, RO (included in B)
*Break in series*: CZ (2005)
*Provisional data*: ES
*Data estimated*: EU-27, EU-25, EU-15 (by DG Research), SI
Head count
Some differences exist between countries in terms of coverage and definitions
Country with small numbers of academic staff: CY, MT, LU, IS
NO: before 2007 biannual data

The glass ceiling index (GCI) (Figure 3) illustrates the difficulties that women have in accessing the highest levels of the hierarchy and measures their relative likelihood, as compared with men, of reaching a top position. The GCI "*compares the proportion of women in grade A positions (equivalent to Full Professors in most countries) to the proportion of women in academia (grades A, B, and C), indicating the opportunity, or lack of, for women to move up the hierarchical ladder in their profession. The value runs from 0 to infinity. A GCI of 1 indicates that there is no difference between women and men being promoted. A score of less than 1 means that women are over-represented at grade A level, and a GCI score of more than 1 points towards a glass ceiling effect as women are under-represented in grade A positions. In other words, the interpretation of the GCI is that the higher the value, the thicker the glass ceiling and the more difficult it is for women to move into a higher position"* (She Figures 2009, p. 68). No country has a GCI equal to or below 1. The index is highest in Luxembourg (2.8). In Belgium, the Netherlands and Austria the GCI is 2.3, 2.1 and 2 respectively in 2007. In France and Switzerland it is below 2 (1.8 and 1.5 respectively).

**Figure 4 : Proportion of women in grade A academic positions, 2002/2007**




Source: She Figures 2009, p. 77; WiS database (DG Research); Higher Education Authority for Ireland
Exceptions to the reference year (s): 2007 HR: 2008; UK: 2007/2006; DK, FR, CY, LU, AT, IL: 2006; EE, MT: 2004; PT: 2003; IE: 2002-2003; EL: 2000; 2002 NO, UK, NL: 2003; IL: 2001; EL: 1999
Data unavailable: HR, LU, IE: 2002
Break in series: CZ (2005)
Provisional data: ES
Data estimated: EU-27, EU-25, EU-15 (by DG Research), SI
Head count
NO: before 2007 biannual data
Data for Ireland on Grade A professors does not include the Institutes of Technology

Figure 4 shows the trend in the proportion of women in grade A academic positions for the years 2002-2007 and by country. In all the continental countries represented in the figure we can see that the percentage of women at grade A decreased between 2007 and 2002. Switzerland shows a very marked progression in the proportion of women at grade A.

*Gaps*

The previous section, “Findings”, examined the main conclusions drawn in the continental literature concerning vertical segregation. There has been little coverage, or none at all, of certain facets in the continental literature:

- One may readily conclude that studies dealing with occupational sectors other than academia are relatively few;

- The link between vertical segregation and horizontal segregation has not been addressed directly. Yet horizontal segregation could to some extent compound the effects of the glass ceiling (Fassa et al, 2008);

- As far as we know, the characteristics of women and men who manage to reach senior positions have never been compared with those of women and men who experience a flatter career profile. It would therefore be interesting to undertake this exercise so as to gain a deeper insight into the issue.

## 2.3. Gender pay gap and funding

### 2.3.1.Statistical analysis of the Gender and Science database

*General coverage*

Relatively few studies on continental Europe have dealt with the question of "pay and funding" (either in terms of the number or proportion of all GSD studies). In point of fact, Table 30 shows us that just 13% of publications relating to gender and science deal with this subject, and that this low percentage is characteristic of all the publications on continental countries (8%). In continental Europe, the proportion of studies of "pay and funding" in relation to all of the publications dealing with gender and science is highest in Luxembourg, yet even here, it is only 15%.

**Table 30 : Number and percentage of publications**

| | n | % |
|---|---|---|
| Austria | 77 | 14.8 |
| Belgium | 53 | 14.8 |
| France | 57 | 8.8 |
| Germany | 87 | 8.4 |
| Luxembourg | 43 | 15.4 |
| Netherlands | 54 | 13.7 |
| Switzerland | 10 | 7.5 |
| **Continental Cs** | **149** | **8.4** |
| **All Cs** | **571** | **12.6** |

*Cross-topical coverage*

Table 31 shows the other subjects covered in publications dealing with "pay and funding". It is apparent that the majority of these publications also cover other subjects: vertical segregation (77%), science as a labour activity (54%), horizontal segregation (49%) and policies towards gender equality in research (41%). The other topics are covered less extensively, but nonetheless appear in more than one quarter of publications: scientific excellence (32%), stereotypes and identity (28%) and gender in research content (26%).

**Table 31 : Association with other topics**

| | % |
|---|---|
| Horizontal segregation | 49.0 |
| Vertical segregation | 77.2 |
| Pay and funding | 100.0 |
| Stereotypes and identity | 28.2 |
| Science as a labour activity | 54.4 |
| Scientific excellence | 32.2 |
| Gender in research content | 25.5 |
| Policies towards gender equality in research | 40.9 |

*Trend in the number of publications between 1980 and 2009*

It is easy to see that "pay and funding" is a very recent subject (Table 32). In point of fact, before the mid-1990s, there had been virtually no publications on this subject. And we have to wait until the early 2000s to reach the figure of slightly over 10 publications per year.

**Table 32 : Average number of publications per year**

| | Average |
|---|---|
| 1980-1984 | 0.6 |
| 1985-1989 | 0.8 |
| 1990-1994 | 1.6 |
| 1995-1999 | 3.8 |
| 2000-2004 | 12.2 |
| 2005-2007 | 13.7 |
| 2008-2009 | 6.5 |

### 2.3.2. Summary of the key literature on "Pay and Funding"

*Key Issues*

"Pay and funding" is the subject relating to gender and science which is tackled least in continental Europe. Moreover, as revealed by the statistical analysis carried out in the previous section, this is a relatively recent subject of study, with most of its publications dating from the early 2000s. Several factors may explain the paucity of research into the subject: the lack of available data on differences in income, the way in which salaries in research institutions are determined by grade and seniority, the hidden (taboo) nature of wages and salaries in some countries (e.g. France) (Meulders et al., 2010a – Topic report: Gender Wage Gap and Funding). It may also reflect the feeling that in career terms, sex discrimination claims are not always seen as legitimate (de Cheveigné and Muscinési, 2009 – French country report).

As its name indicates, the subject of the "gender pay gap and funding" encompasses two main topics:

The first one, that of the **"gender pay gap"**, constitutes the final and summary indicator of the gender inequalities that structure the employment market, and can therefore be viewed as the hard core of gender inequalities in the employment market (Meulders et al., 2005). The work of Meulders et al., 2005) shows that the gender pay gap is created by factors other than direct sex discrimination. These factors include:

- Differences in pay based on the level of study, training or professional experience
- The various study orientations
- Sectoral and professional segregation or concentration
- The size of the public sector and the relative level of pay within it
- The definition of equal value: job classification and grading
- Working time: full-time or part-time, overtime
- The various forms of flexible working
- The way in which pay is structured: overtime, seniority, performance-related pay, individualised pay
- Difficulties in gaining access to senior positions within the hierarchy
- The level and coverage rate of industrial relations
- The existence and level of minimum wages
- Access to in-house training and to training courses financed by the authorities, organisation of training time
- Industrial organisation systems and structures: the size of firms, subcontracting, etc.
- The under-representation of women in trade unions, employers' associations and on negotiating or representation bodies

  etc.

Although the gender pay gap in the employment market in general is extensively covered in the literature, this topic is dealt with rather sparsely in publications on gender and science. Consequently, many of the factors listed above are absent from the research. Generally speaking, this topic is dealt with indirectly in the continental literature, with a view to emphasising the effects of horizontal and vertical segregation. At the present time, it does not constitute a key question in the research.

The second topic, that of "**Funding**", is better served in GSD publications. It focuses on access for men and women to research funding[6]. Funding bodies and programmes occupy a position of strategic importance in research. By determining the opportunities for mobility, the research fields, the job opportunities in research, the composition of assessment committees, etc., they play a key role in the dynamics of the scientific community (Meulders et al., 2010a – Topic report: Gender Wage Gap and Funding). Consequently, this is a significant topic in analysing gender discrimination in the field of science. From this perspective, the main objective of research into funding is to determine whether or not funding is granted on an egalitarian basis.

These two topics are listed together in the GSD. However, in the sub-sections that follow, we shall systematically mention the topic we are referring to.

**Research Areas**

- Explanation of gender pay gap in scientific occupation
- Gender bias in access to research funding

*Research questions*

Gender pay gap

- Is there a gender wage difference in a scientific academic career? Is there a link with scientists' occupational position?
- Why are women more represented in low paid occupations?

Funding

- What proportions of women and men apply for and obtain research funding?
- What barriers are there to women successfully obtaining research funding? Are these different from those encountered by their male counterparts?

*Research approach*

The **gender pay gap** is seen as a facet of discrimination that women suffer from. The benchmark studies treat the subject as the outcome of horizontal segregation and vertical segregation. An understanding of the phenomenon is also accompanied by an in-depth analysis of the theory of human capital, and the effects of the feminisation of certain professions and sectors of the economy. Personal and organisational aspects have also been subjects of investigation.

Analysing the access to **funding** enjoyed by men and women is not only a question of the existence of a gender-related bias in the granting of research funding: it also highlights the complicity of institutions in the persistence of inequalities affecting the career path followed by women in the academic world (Meulders et al., 2010a – Topic report: gender wage gap and Funding). The work on this subject is focused on whether or not there is a difference between the number of male and female applicants, and between their respective success rates, and seeks to understand the reasons for this.

Tables 33, 34, 35 and 36 provide an insight into the approaches used to study access to **funding and the gender pay gap** in the literature.

[6] As far as we know, no studies of research funding have been performed in France (de Cheveigné and Muscinési, 2009 – French country report).

Table 33 shows us that "state-of-the-art" reviews of the literature are the approach most often used (55%). A significant number of publications also use compilation of statistics to tackle the issue (44%). 32% of publications are empirical studies based on quantitative techniques, while 28% of publications are conceptual studies. Just 18% of publications are based on qualitative empirical techniques.

**Table 33 : Methodological approach**

| Approach | % |
|---|---|
| Conceptual | 28.2 |
| State-of-the-art | 55.0 |
| Compilation of statistics | 43.6 |
| Building gender indicators | 6.7 |
| Empirical research. Quantitative techniques | 32.9 |
| Empirical research. Qualitative techniques | 18.8 |

Most of the publications dealing with "pay and funding" are non-empirical (56%). If Table 34 is examined more closely, it can be seen that 25% of publications use empirical methods based solely on quantitative techniques, 11% rely on exclusively qualitative techniques and just 7% are based on both quantitative and qualitative approaches.

**Table 34 : Type of empirical research**

| Empirical research | % |
|---|---|
| Non-empirical research | 55.7 |
| Empirical research. Quantitative techniques | 25.5 |
| Empirical research. Qualitative techniques | 11.4 |
| Empirical research. Quali-quantitative techniques | 7.4 |
| Total | 100.0 |

Quantitative approaches are based mainly on a representative sample (67%) and on micro-economic data (63%). One third of quantitative studies are based on a multivariate analysis. Very few publications are longitudinal studies (16%).

**Table 35 : Quantitative research techniques**

| Quantitative techniques | % |
|---|---|
| Representative sample | 67.3 |
| Micro-data | 63.3 |
| Longitudinal/cohort | 16.3 |
| Multivariate analysis | 32.7 |

A significant majority of the qualitative studies are interview-based (68%). The other types of techniques are used very little: 21% of qualitative studies are based on biographical research, and 14% on case studies and content analysis. The number of publications based on observation is negligible (14%).

**Table 36 : Qualitative research techniques**

| Qualitative techniques | % |
|---|---|
| Biographical research | 21.4 |
| Case studies | 14.3 |
| Content analysis | 14.3 |
| Interviews | 67.9 |
| Observations | 3.6 |

*Findings – Gender pay gap*

a) Causes of gender pay gap

- Vertical and horizontal segregation

In the continental literature, the gender pay gap in the field of science is mainly perceived as the result of segregation and women being excluded from highly paid jobs and disciplines (horizontal and vertical segregation). The research underlines the fact that part of the blame for the gender pay gap can be directly attributed to vertical segregation: women are less well remunerated because there are fewer of them than men in senior positions within the hierarchy (Van Doorne-Huiskes and Luijkx, 1988). This type of research is often limited to particular institutional sectors (Papouschek, 2004; Kreetz, 2004; Ministère délégué à la recherche et aux nouvelles technologies, 2004; Scheuring, Burkhardt, 2006) and to specific scientific professions (Mixa, 2000; Sagebiel and Dahmen, 2009 – German country report). Other research has shown that there is an indirect gender pay gap: women earn less because they receive fewer promotions (Daune-Richard et al., 2004). Ackers' study (2007), which relates to Austria, links the progress made by women in their scientific careers to growing gender pay gaps in the scientific fields that they work in.

**Box 9 : Legislating for equality? Working hours and progression in science careers**

This article presents some recent research on the progression of women in science careers in five EU Member States — the UK, Italy, Austria, Portugal, and Greece — examining the growing gender pay gap in science careers. It focuses on the recruitment and participation of women, but also on their retention and progression. The interviews with scientists highlighted the importance of various dimensions of 'time-use' to have a greater understanding of the progression of women and men in science careers. This article focuses on three dimensions of time: (1) time over the working day; (2) time over the working week; and (3) time over the working year. It describes the typical working schedules of the respondents, the functional use of that time and the particular challenges this presents for scientists with caring responsibilities. The results confirm previous findings that highlight the importance of working hours in science both for the attractiveness of science careers — and the ability to recruit and retain men and women — and for career progression. Within this context, the article considers the potential of recent European legislation designed to regulate working time (Council Directive 93/104), create a more level playing field and improve the progression of women in science.

Ackers, L. (2007), "Legislating for Equality? Working Hours and Progression in Science Careers", *European Law Journal*, vol. 13, no. 2, pp. 169-185

Gender pay gaps may also be the outcome of horizontal segregation: the unequal distribution of men and women within the various scientific disciplines explains the differences in remuneration levels (Funken, 1997). In Belgium, the gender pay gap varies significantly from one profession to another: from 28% among physicists and chemists to 14% among mathematicians and statisticians. On the other hand, women with a PhD in computer science earn more than their male colleagues. It seems to be a fact that among scientists and engineers, women earn more (in terms of their salary) than men, once they have a PhD (Meulders and Caprile, 2003).

**Box 10 : Functional equality – social difference**

In her contribution, Funken reports questions why huge gender gaps in the proportion of people involved in computer science can be observed, although science and technology are presumed to be gender-neutral. Her first chapter introduces some theoretical reflections on the genderedness of science, and explanations for the low number of women in these fields. Specific selection processes are illustrated. Investigations in schools revealed that girls in single-sex classes showed a similar degree of self-confidence and successful handling of computers as boys, but with increasing numbers of male classmates, the self-confidence, motivation and acceptance of girls declines. The results of the study of the "Situation of female junior researchers in computer science" showed that the organisational structure and the prevailing male culture at university contribute to the facts that women do not decide to follow a university career as much as men, and that women quit science after doing a PhD. In economics, gender pay gaps of 12% to 32% were detected by two different studies. The worse the career options, the more women can be found working in these fields.

Funken, C. (1997), "Fachliche Gleichheit - Soziale Differenz" in C. Hartmann and U. Sanner, eds. *Ingenieurinnen: Potential für die Gesellschaft*, HoHo Verlag, Kirchlinteln, pp. 203-216

The gender pay gap, vertical segregation and horizontal segregation have also been linked to the feminisation of certain professions/sectors of the economy. The growing integration of women into the field of research or into particular professions does not always coincide with a reduction in inequality. For example, the study by Laufer and Fouquet (2001) concludes that the feminisation of the engineering profession continues to be characterised by differences and inequalities in terms of careers, salaries and access to decision-making positions. A similar study was performed by Kreetz (2004) on the Austrian, German and French non-university sectors. He concludes that the process of women's integration into research is accompanied by greater flexibility in recruitment methods and by growing pay inequality between the two sexes.

- Personal factors

Personal factors were also examined. For example, Need and de Jong's analysis (2008) shows that the various typologies, and particularly the differing degrees of emotional stability displayed by men and women, significantly affect the pay gap between the two sexes. This effect may be either indirect – linked to study orientation – or direct, regardless of the subjects chosen for study. The importance of the educational choices made, in terms of determining the gender pay gap, has also been emphasised by several authors (Machin and Puhani, 2003; Delavault et al., 1999).

Reconciling people's private life and professional life is another personal aspect that has been a subject of investigation (Majcher, 2007 Hoff et al., 2003; Gerlach, 1987). In an article entitled "Flexible working policies, gender and culture change", Lewis (2009) finds that women with children freely choose to work less and thus to be "non-ideal" workers by not conforming to the role model of the male worker. Mothers also have to choose between sacrificing time for the family and sacrificing their earnings. *"Earnings are viewed as less important to mothers, whose partners, it is assumed, will be the main providers. The idea that mothers could both have time for family and accomplish a full week's workload in less time with full time pay is rarely considered. This is not viewed as, in any way discriminatory, but as giving women choices to opt out of "ideal" careers to be what is widely perceived as good mothers. […] One impact of the ideal worker norm is that mothers themselves often assume that they are lucky to be able to "deviate" from the male norm. Thus despite the loss of pay associated with condensing work into four days they regard this very favourably (p. 43)".* According to German study of Hohner et al. (2003), the relationship between career development and earnings demonstrates that the women who manage to achieve an optimum combination of their private life and professional life are the ones who are most successful (in terms of their earnings and position reached). Other authors have looked at the impact on pay of the transfer of human capital within the family (Brynin and Schupp, 2000).

- Human capital

According to the theory of human capital advanced in the 1960s, the gender pay gap arises from differences in productivity linked to human capital endowments: women are less well paid because

they acquire either less human capital than men, or different types of it. This rather simplistic theory has been undermined by the fact that in recent years, women have more or less caught up with men, in terms of education levels. In the continental literature relating to the gender pay gap in the field of science, the theory of human capital has been widely discussed. In particular, Reimer and Schröder (2006) compared it with discrimination theory: people with equal capabilities and the same qualification are treated differently, depending on their sex. They show that, contrary to what is predicted by the theory of human capital, the pay differential between men and women graduates is higher in cases where women and men have similar human capital endowments. Consequently, this result refutes the theory of human capital, by showing that women graduates encounter discrimination in the German market. The incomplete nature of the theory of human capital has been emphasised by Need and de Jong (2008), who demonstrate how far the differing personality traits of men and women may throw light onto the income potential advocated by the theory of human capital.

- Discrimination

Measuring discrimination is a delicate task. In reality, discrimination is not directly visible or empirically measurable (Meulders et al., 2010a – Topic report: gender wage gap and funding). Nevertheless several authors mention discrimination in relation to understanding the gender pay gap (Reimer and Schröder, 2006). The existence of indirect discrimination linked either to an institution's promotion system (Daune-Richard et al., 2004) or its organisational practices (Van Doorne-Huiskes and Luijkx, 1988) affects the gender pay gap. Women's experience and perception of how pay is awarded have also been subjects of investigation within higher education institutions (de Henau and Meulders, 2003).

**Box 11 : Wage differences between women and men in academia**

In general, women's capacities are under-estimated, as compared with men's, in the institution studied. The reasons for women lagging behind men in rank (the factor to which wage differences are due) are complex. These differences are partly caused by the attitudes and "choices" made by female staff members. At the same time these differences raise the issue of how much freedom of choice women have in a society where the division between unpaid and paid labour still coincides to a large degree with that between women and men. A significant proportion of these 'unjust' differences in position can be ascribed to the indirect discriminatory effects of the customary rules and procedures of almost every academic institution. The lack of systematic forms of career planning, for instance, has particularly negative effects on people in lower positions. Where the organisation's educational policy stresses individual initiative, and possibilities for further education within an organisation are linked to present function, this tends to consolidate the existing relations between men and women. The same applies to forms of internal recruitment.

Van Doorne-Huiskes, A. and Luijkx , R. (1988), "Wage differences between women and men in academia", *Netherlands Journal of Sociology*, vol. 24, no. 2, pp. 146-158.

- Organisational factors

The organisational practices of scientific institutions are seen as an obstacle to the progression of women in scientific careers, and thus to obtaining higher salaries. For example, Van Doorne-Huiskes and Luijkx (1988) shows that the usual rules and procedures applied by institutions prevent women from reaching the best-remunerated positions. Marry's analysis (2001) of the impact of the feminisation of the engineering profession in France and Germany, reveals various factors – companies' practices, the division of household tasks and women's multiple responsibilities – combining to prevent women from reaching the "last circle", which is characterised by high salaries and senior positions.

The interference of stereotypes and the university structure with the hierarchical position and pay of women was studied by Van Doorne-Huiskes (1983).

**Box 12 : Career paths of women and men: an analysis. Research at the University of Utrecht**

This book refers not only to academic careers of men and women, but also to non-academics working in university institutions. In the period 1972-1982, the relative number of women non-academics decreased, as the number of women working part-time increased. The number of academic women has slowly increased. Women are over-represented in the lower salary groups and men in the higher salary groups (academics and non-academics). Furthermore, women do earn less, even when their level of education, age and years of employment are taken into account. The opportunity for women to increase their salary is lower than for their male counterparts. Women are strongly under-represented in the technical functions and over-represented in administrative functions. The mechanisms underlying these outcomes mainly have to do with gender stereotypes, gender role expectations and the university structure. The book concludes that the situation of female academics and non-academics has not changed that much over the last ten years.

Van Doorne-Huiskes, A. 1983, *Posities van vrouwen en mannen aan de Rijksuniversiteit Utrecht*, Rijksuniversiteit Utrecht, Utrecht

b) Quantitative Evidence

A recent report "Remuneration of researchers in the public and the private sector" (2007)[7] gives us data on researchers' pay and on the gender pay gap in this particular occupation. The authors define a researcher as any person who devotes at least 50% of her/his time to carrying out research activities. The report provides a scale of net and gross remunerations of researchers in the public and private commercial sectors in the EU 25 and Associated Countries at the various stages of their career. Information on the remuneration scheme of researchers was gathered by means of an on-line survey. The percentage of researchers covered by the sample is 3.49% (N=6110). The weighted average of researchers' remunerations for each gender has been calculated based on data on the country's total annual salary earned by researchers, in purchasing power standards.

Even if the sample used in this analysis is relatively small and even if the reliability of the data may be questioned, the study is worth mentioning since it is the only existing investigation of pay in scientific occupations in Europe. Here, we only show the data concerning the continental European countries.

**Table 37 : Average weighted total annual salary of researchers in the EU 25 and Associated Countries by country and gender**

| Country Gender | Female | Male | Difference Male-Female (%) |
|---|---|---|---|
| **Austria** | 45.689 | 65.647 | 30.40% |
| **Belgium** | 42.161 | 62.326 | 32.35% |
| **France** | 40.317 | 52.111 | 22.63% |
| **Germany** | 46.134 | 56.385 | 18.18% |
| **Luxembourg** | 45.758 | 60.093 | 23.86% |
| **Netherlands** | 43.317 | 64.691 | 33.04% |
| **Switzerland** | 48.462 | 63.334 | 23.48% |

Source: European Commission, 2007, p. 48

[7] European Commission 2007, *Remuneration of researchers in the Public and the Private sectors*, European Commission, Luxembourg.

It can be seen from Table 37 that in most countries, men are paid more than women. The countries with the highest pay differences (over 30%) are the Netherlands, Belgium and Germany. In the other countries the wage gap is below 25%. The smallest gap is observed in Germany (18%).

**Table 38 : Average total annual salary of researchers in the EU 25 and Associated Countries by sector of activity[8]**

| Country/sector | Business Enterprise Sector | Government | Higher Education |
|---|---|---|---|
| **Austria** | 65.805 | 49.182 | 62.069 |
| **Belgium** | 68.228 | 63.306 | 46.507 |
| **France** | 40.705 | 52.058 | 50.881 |
| **Germany** | 49.723 | 54.036 | 45.893 |
| **Luxembourg** | 52.344 | 52.802 | 63.995 |
| **Netherlands** | 64.080 | 46.208 | 65.923 |
| **Switzerland** | 51.548 | 66.396 | 62.337 |

Source: European Commission, 2007, p. 49.

In Table 38, researchers' pay is presented by sector of activity. It gives an idea of the differences in remuneration by sector and by country. Huge differences are observed. For example, in some countries, wages are higher in the private sector (Austria, Belgium) while in others, they are higher in the government sector (Switzerland, Germany, France) or in the higher education sector (Luxembourg, the Netherlands) Consequently, there are important national differences in the pay of researchers from one sector to another.

**Table 39 : Total annual salary of researchers in the EU 25 and associated countries, by gender and by level of experience**

| Country/ Level of experience | 0-4 years | | 5-7 years | | 8-10 years | | 11-15 years | | > 15years | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Female | Male | Female | Male | Female | Male | Female | Male | Female | Male |
| Austria | 34.473 | 37.244 | 41.921 | 50.446 | 49.369 | 63.648 | 56.817 | 76.850 | 64.266 | 90.052 |
| Belgium | 27.767 | 26.802 | 35.079 | 40.933 | 42.392 | 55.064 | 49.705 | 69.195 | 57.018 | 83.326 |
| France | 30.223 | 30.726 | 38.859 | 39.225 | 47.494 | 50.075 | 56.129 | 63.926 | 64.765 | 81.608 |
| Germany | 22.143 | 25.716 | 35.969 | 38.731 | 49.795 | 51.746 | 63.621 | 64.761 | 77.447 | 77.776 |
| Luxembourg | 24.742 | 43.578 | 40.365 | 53.864 | 55.988 | 64.150 | 71.611 | 74.436 | 87.234 | 84.722 |
| Netherlands | 22.518 | 31.921 | 35.655 | 47.095 | 48.792 | 62.269 | 61.929 | 77.443 | 75.066 | 92.617 |
| Switzerland | 39.599 | 40.862 | 55.711 | 61.075 | 71.823 | 81.288 | 87.935 | 101.501 | 104.047 | 121.714 |

Source: European Commission, 2007, p. 47.

Table 39 shows pay differences by level of experience. In most countries, the wage gap increases with level of experience. At lower levels of experience (0-4 years), researchers' pay is higher for women than for men in Belgium. Then, as experience rises, men's pay tends to surpass that of women except in Luxembourg and Germany. At the highest level of experience (more than 15 years), women earn more than men in Luxembourg and about the same as men in Germany.

[8] The publication does not provide sex-disaggregated data for the different sectors of economic activity.

*Findings – Gender dimension of research funding*

a) Access to research funding

The access obtained by men and women to research funding and subsidies has been a subject of investigation in continental Europe. The results vary from one country to another, as they depend on each country's institutions (see Table 40).

**Table 40 : Access to research funding (summary)**

| Country | Application rate | Success rate |
|---|---|---|
| Belgium | Propensity of women to apply is lower than that of men | The percentage of demands accepted is equally distributed between men and women.<br><br>The fund allocation process operates differently in the various academic fields |
| Switzerland | Fewer women apply for grants<br><br>Women submit applications just as frequently as men | Women researchers have a lower chance of being approved<br><br>Men and women have the same success rate |
| Netherlands | More male than female scholars apply for research grants | Same chance of success |
| Germany | Application behaviour does not differ | Women have a lower chance of receiving funding |
| Austria | Female professors submit more than their male colleagues | Women are under-represented in funding |

*Sources:* Meulders et al., 2009 – Belgian country report; van den Brink, 2009 – Dutch country report; Knobloch, 2009 – Swiss country report; Leitner and Wrobleski, 2009 – Austrian country report; Sagebiel and Dahmen, 2009 – German country report.

In the analysis that follows, we illustrate each conclusion to which the literature of these countries leads, by summarising the work of a number of the most highly-regarded authors in the literature of these countries.

- The situation in the Netherlands

In her article, Noordenbos (1999) considers the assessment system used to evaluate applications submitted to the Dutch Science Foundation (NWO) and the Royal Dutch Academy of Sciences (KNAW). The authors examine the percentage of applications submitted to these institutions, and reach the conclusion that many more male academics than female academics submit applications for research grants. Several factors explain this disparity: the low percentage of women holding senior positions at universities in the Netherlands, the differences between men and women from one research field to another, the unequal distribution of family responsibilities among men and women, and the small number of women sitting on the committees responsible for examining funding applications.

Although the Dutch studies usually conclude that male and female applicants enjoy a similar success rate, Brouns' study (2000) emphasises the fact that considering the success rate at a global level masks significant variations from one discipline to another (van den Brink, 2009 – Dutch country report).

- The situation in Switzerland

Jänchen and Schulz's pilot study (2005) reaches the conclusion that there are differences in the success rates enjoyed by men and women. In point of fact, the in-depth examination of the Swiss National Science Foundation (SNSF) shows that, in two of the three disciplines (political sciences, psychology and chemistry), applications submitted by women are less likely to succeed. Their analysis also highlights the fact that the problem lies not with the evaluation procedures themselves, but rather in differences in the ways in which men and women submit their applications.

The recent study by Leemann and Stutz (2008) finds no proof of such discrimination within the SNSF. The latter performed a vast study, on 3,017 emerging researchers (between the levels of PhD student and professor with tenure). They show that for a period of up to five years after gaining a PhD, women submit applications for individual funding and projects to the SNSF and other institutions as frequently as men do. Among those who submitted their first application to the SNSF between 2002 and 2006, women are no different from their male colleagues, either regarding the type of application (total amounts applied for, number of applications) or their chances of success (amount received, number of applications approved). Leemann and Stutz (2008) also found no proof that female researchers are less well informed about the possibilities of obtaining funding than men are, that they are less inclined to submit funding applications, or that they find the SNSF less accessible and less understanding than men do. Nevertheless, some gender-linked losses have been noted. To this end, the study reveals a low percentage of female PhD students, a low level of support with their career and women experiencing the greatest difficulty in reconciling their scientific and family responsibilities (Knobloch, 2009 – Swiss country report).

- The situation in Germany

The study by Allmendinger and Hinz (2002) is based on the idea that the proportion of women employed in academic professions and research institutions is low, and is not about to change. They performed a purely empirical investigation into three aspects: the chances of the manuscripts submitted being published, the chances of the projects submitted being approved, and job opportunities in higher education. The study is limited to the analysis of a single discipline, *viz.* sociology. The investigation shows that women's behaviour is similar to that of men in terms of submitting their application. However, their chances of success in these three fields are lower.

- The situation in Belgium

In Belgium, via a quantitative analysis of the data relating to disparities between men and women in the country's French-speaking academic world, de Henau and Meulders (2003) studied the question of access to funding awarded by the Fonds de Recherches Scientifiques (FNRS) [Scientific Research Fund]. The analysis shows that in cases where they are eligible, women are less inclined to apply to the FNRS for research grants. On the other hand, their success rate is similar to that of their male colleagues. De Henau and Meulders' study (2003) also reveals that it is harder for women than men to gain access to a long-term position.

- The situation in Austria

The study of scientific excellence by Schacherl et al. (2007) shows that women professors submit applications to the Austrian Science Fund more frequently, but with a lower chance of success than their male colleagues. This can be explained by the fact that women more frequently submit projects that are considered too vague, so their applications are rejected.

b) Causes of the gender gap in access to research funding

Different types of factors are highlighted in the literature to explain the differences between men and women in terms of access to funding. *The under-representation of women on councils*, and on assessment committees and panels is a factor often advanced in the literature. A European Commission report (2009) shows that in all countries of continental Europe, women are under-represented on the decision-making body and the assessment committees of the main institutions responsible for research funding: applicants are selected by a committee made up primarily of men.

This situation may influence the direction and priorities of the research undertaken, as well as policies aimed at gender equality within funding bodies. Such an absence or marked under-representation of women in positions of influence reveals a picture of an organisational structure that is biased against women. This problem, and its harmful effects on access to funding for women, has been highlighted by numerous authors in continental Europe, including Noordenbos (1999), Hinz et al. (2008), Janchen and Schulz (2005) and de Henau and Meulders (2003). The lack of women among the ranks of assessors and decision-makers also means that women have fewer opportunities to understand the internal workings of the funding system; and the absence of women during the processes of providing information and coaching, together with the modest scale of their social networks, only exacerbates the problem (Lemann and Stuts, 2008).

**Box 13 : The gender gap in the application for research grants**

Recently, 'fairness' in the evaluation of applications for research grants has been seriously questioned by two Swedish researchers, Wenneras and Wold, who published their study in 1997 in the renowned journal 'Nature'. Their study led to a debate concerning the existence of gender bias in awarding grants. This article examines the situation in the Netherlands. It looks at the percentage of applications by men and women to the Dutch Science Foundation (NWO) and the Royal Dutch Academy of Sciences in the Netherlands (KNAW), and at the percentage of successful applications. The main conclusion is that many more male than female scholars apply for research grants. Several factors explain this gender asymmetry: the low percentage of women in senior positions at the universities in the Netherlands, the gender difference between research fields, the skewed distribution of caring responsibilities between men and women, and the low number of women on the committees reviewing applications. This article ends with suggestions for increasing the number of female applicants for grants.

Noordenbos, G. (1999), 'Genderasymmetrie in de aanvraag van onderzoekssubsidies', *Tijdschrift voor Genderstudies*, vol. 2, no. 4, pp. 36-45

The *system used for peer assessment of applications*[9] is often opaque. Assessment is usually based on applying scientific quality criteria to researchers and their projects. A sexist understanding of scientific excellence (choices and selection criteria) leads to men and women having differing chances of securing funding and gaining career advancement (Schacherl et al., 2007). The Dutch study by Brouns and Scholten (1999) emphasises the existence of a bias in the assessment criteria used to judge scientific excellence in men and women: women are assessed more harshly than men.

**Box 14 : The quality of assessment. Gender in the awarding of grants**

Brouns and Scholten (1999) investigated the assessment procedures of the Dutch Organisation for Scientific Research (NWO), and more specifically grants awarded to talented young researchers who are expected to become the future 'top-10' scientists in their field. The authors found that women and men had equally high productivity scores and that women were more often characterised as 'good researchers', while men were described as 'brilliant researchers'. In the exact sciences, women have a success rate of 84% (significantly higher than men's). In other disciplines, biology for instance, women had great difficulty in obtaining a grant (women's success rate is 26%, significantly lower than men's). Female applicants in the exact sciences were highly qualified, more so than their male colleagues, but in biology, male and female applicants hardly differed. A marked difference is observed between disciplines. Women have higher success rates in the exact sciences but are disadvantaged in biological and earth sciences, realms where they are more numerous.

Brouns, M. and Scholten, M. (1999), *De kwaliteit van het oordeel. De rol van sekse in de toekenning van KNAW/NWO subsidies*, NGV, Utrecht

[9] This topic will be examined in greater depth in section 1.5, dealing with scientific excellence.

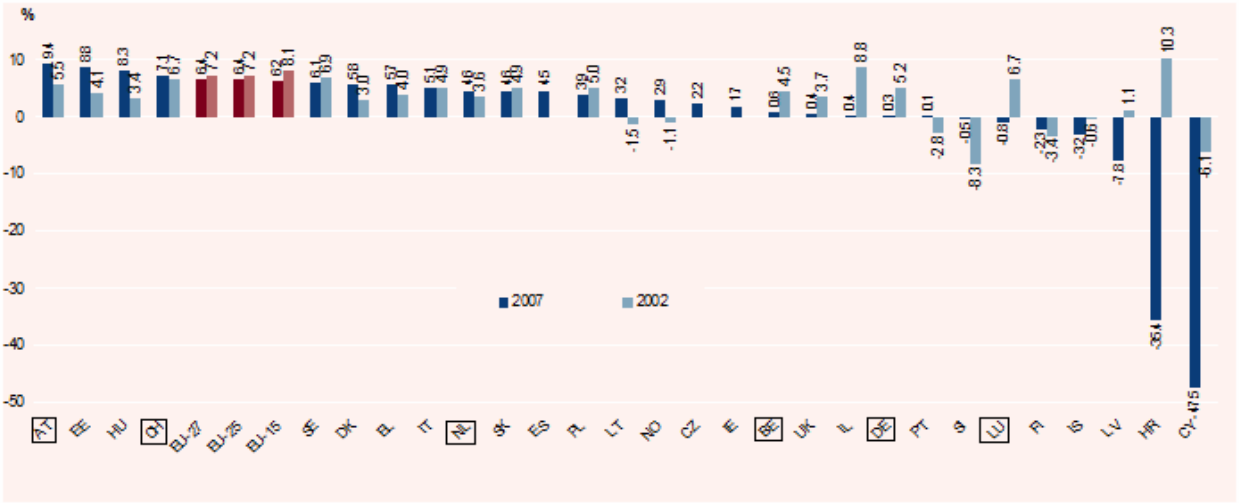
The *age limit* imposed for the submission of subsidy applications and the fact that actual research experience is not taken into consideration (academic age versus biological age) were highlighted in the literature (Brouns and Scholten, 1999). Women are faced with a heavier burden when it comes to reconciling family life and science, given that they are more often the ones who look after the children and the housework. *The unequal distribution of family responsibilities* (childcare and housework) among men and women helps to explain the lower rate of applications among women (Noordenbos, 1999). Belser believes that *flexibility* (funding period and the option of taking a career break) enables women to progress more easily in their career.

A few authors have focused on the link between the *research subjects proposed* by men and women, and the differences of opportunity observed among the latter (Schacherl et al., 2007; Noordenbos, 1999; Allmendinger and Hinz, 2002). Their studies reveal that differences in access to research funding are partly linked to the sexual division of research fields. For example, in Germany, the majority of applications submitted by women relate to a research subject linked to the question of gender (Allmendinger and Hinz, 2002).

c) Quantitative evidence

In this sub-section we take the data published by She Figures (2009) for continental countries, as these appear to be the most relevant data for analysing gender-related aspects in research funding.

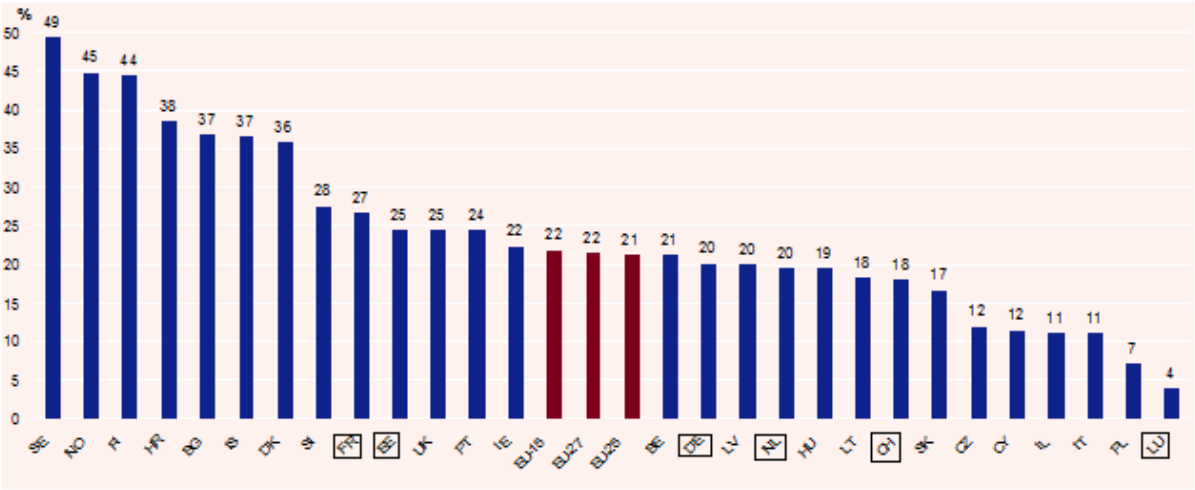
**Figure 5 : Trend in research funding success rates among women and men 2002/2007**




*Source*: She Figures, 2990, p. 100; on the basis of WiS database (DG Research)
*Exceptions to the reference year(s):* 2007 CZ, IE, LV: 2003; EL, PT: 2002; SE: 1999; 2002 UK, HR: 2005; NL, SK: 2003; LV, SI: 2001; IL: 2000; EL, PT: 1999; SE: 1995
*Data unavailable*: BE (French-speaking community), BG, CZ (2002), IE (2002), ES (2002), FR, MT, RO, TR
*Break in series*: DK (2004)
*Data estimated*: EU-27, EU-25, EU-15 (by DG Research)
Some differences exist in coverage and definitions between countries
The total numbers of funds varies considerably over countries and period considered
Success rate men minus success rate for women
BE data refer to Dutch-speaking community

Figure 5 enables us to compare the success rates of men and women who submitted an application for research funding in 2002 and 2007. A positive difference means that applications submitted by men succeeded more often than those submitted by women. In 2002, in all of the continental countries (shown in Table 20), men's applications succeeded more frequently than women's. In 2007, differences in success rates between men and women decreased in all countries (except Switzerland, where they rose). In Luxembourg, there was even a negative difference in 2007: women obtained funding more often than men.

**Figure 6 : Proportion of women on boards**




*Source*: She Figures, 2009, p. 99; on the basis of WiS database (DG Research)
*Exceptions to the reference year:* CZ, SK, IL: 2008; IT: 2005; IE: 2004; PT: 2003; FR, PL: 2002
*Data unavailable*: BE (Dutch-speaking community), EL, ES, MT, AT, RO, TR
*Data estimated*: EU-27, EU-25, EU-15 (by DG Research)
Some differences exist in coverage and definitions between countries
The total numbers of boards varies considerably over countries
BE data refer to French-speaking community

Figure 6 shows the representation of women sitting on scientific decision-making committees (commissions, R&D commissions, boards, councils, committees and foundations, academy assemblies and councils, and also different field-specific boards, councils and authorities). These bodies have a significant impact on the direction taken by research. In continental Europe, the level of women's representation on these decision-making bodies is low (<30%). France, with 27%, is the country where women have the strongest presence on decision-making bodies. Switzerland, French-speaking Belgium, Germany and the Netherlands all have relatively similar rates (between 19% and 21% are women). Luxembourg has few women sitting on decision-making committees (4%).

*Gaps*

The research conducted into the gender pay gap and funding in the field of science does not yet provide a full picture of the scale and degree of inequality in the different scientific disciplines. This can be explained in part by the recent nature of this subject and also the limited number of research projects undertaken thus far.

<u>The gender pay gap</u>

In the context of publications relating to the gender pay gap, we find that authors focus primarily on understanding the phenomenon rather than quantifying it. Several elements also appear to be absent from the literature, or covered very little:

- The impact of part-time work on the gender pay gap[10];
- The role of the social partners in pay negotiations and consequently their impact on equal pay for men and women;
- The effects, on the scientific professions, of policies aimed at reducing pay inequality between men and women.

In general terms, empirical research into the factors explaining the gender pay gap should be carried out for the employment market of each continental country and for each scientific profession. Using

[10] The lack of consideration of working time in studies of the gender pay gap has also been mentioned in the Dutch literature (van den Brink, 2009 – Dutch country report).

similar approaches would enable a comparison to be made between the different countries and would highlight best practice. Special attention should be paid to the relationship between the number of publications, mobility options, social networks, etc. and the gender pay gap. This type of analysis would provide a more comprehensive picture of pay inequality between men and women in the fields of science and research[11].

Funding:

In general terms, a wide variety of institutions are responsible for awarding research funding. Nevertheless, authors usually concentrate on a limited number of institutions (one or two). Based on the available data, we cannot conclude that women experience systematically lower success rates than men. Moreover, the existence of a number of contradictory studies on the subject merely emphasises the need for work to be undertaken more systematically and exhaustively on the subject of inequalities in research funding (see Table 19).

It is apparent that certain crucial points are not sufficiently addressed in the continental literature.

- Differences between the types of subsidies/amounts granted to men and women;
- A comparison of the characteristics of the men and women who manage to obtain this type of subsidy, and those who do not;
- Initiatives that might be taken to restore parity.

[11] These recommendations also apply to all countries in the database (Meulders and al., 2009 – Gender Wage Gap and Funding). In point of fact, analysis of the statistics in the database has shown that the lack of research into the subject is not characteristic of the continental countries only.

## 2.4. Stereotypes and identity

### 2.4.1 Statistical analysis of the Gender and Science database

*Country coverage*

The question of "stereotypes and identity" in the field of science has been the subject of numerous studies (see Table 41). In all of the countries included in the database, more than one half of publications dealing with gender and science address the question of stereotypes and identity. However, this percentage is lower when we consider only publications concerning continental Europe (41%). Among the continental countries, the percentages of publications relating to stereotypes and identity are relatively similar (between 43% and 46%), except for Germany and Switzerland[12] (38% and 34% respectively).

**Table 41: Number and percentage of publications**

| | n | % |
|---|---|---|
| Austria | 234 | 44.8 |
| Belgium | 163 | 45.5 |
| France | 291 | 44.9 |
| Germany | 396 | 38.1 |
| Luxembourg | 121 | 43.2 |
| Netherlands | 180 | 45.7 |
| Switzerland | 45 | 33.6 |
| **Continental Cs** | **736** | **41.3** |
| **All Cs** | **2,458** | **54.0** |

*Cross-topical coverage*

When Table 42 is analysed, it is apparent that publications relating to stereotypes and identity often deal with horizontal and vertical segregation (40% and 37% respectively). Nearly one third of these publications also discuss the questions of "gender and research content" and "science as a labour activity". Few works deal with "policies on gender" (19%) and "scientific excellence" (15%). Publications dealing with "stereotypes and identity" in the field of science which discuss "pay and funding" are virtually non-existent (6%).

**Table 42 : Association with other topics**

| | % |
|---|---|
| Horizontal segregation | 40.2 |
| Vertical segregation | 36.8 |
| Pay and funding | 5.7 |
| Stereotypes and identity | 100.0 |
| Science as a labour activity | 29.8 |
| Scientific excellence | 14.7 |
| Gender in research content | 31.7 |
| Policies towards gender equality in research | 18.8 |

[12] Most publications relating to Switzerland are produced in an international context. Very few publications deal with the case of Switzerland alone (Knobloch, 2009).

*Trend in the number of publications between 1980 and 2009*

Table 43 shows that in the early 1990s, the question of stereotypes and identity began to attract attention from researchers, with an annual average figure of 19 publications. This interest in the subject became more pronounced over the course of time, with more than 45 publications per year appearing over the period 2005-2007. However, a downward trend has been observed since 2008 (with an annual average of 17 publications).

**Table 43 : Average number of publications per year**

| | Average |
|---|---|
| 1980-1984 | 8.2 |
| 1985-1989 | 11.0 |
| 1990-1994 | 18.8 |
| 1995-1999 | 29.6 |
| 2000-2004 | 45.0 |
| 2005-2007 | 46.7 |
| 2008-2009 | 16.5 |

## 2.4.2. Summary of the key literature on "Stereotypes and identity"

*Key issues*

The topic of "stereotypes and identity" is linked to an understanding of male and female behaviours in the face of science. In the majority of cases, this is the reason put forward to explain differences in study orientation between men and women (educational segregation). The development of stereotypes relating to women's role in society, and the consequences of these stereotypes for women, are also examined with a view to explaining vertical segregation[13].

The literature is characterised by a systematic dualism between the traits of men and women in understanding the reasons for educational segregation and the differences in the career "choices" they make:

- The presence of a male/female dualism in popular images and discourses promoted by society, and especially by the education system and the family circle (parents) has given rise to several studies. These emphasise how stereotypes regarding the position of men and women in society are perceived by individuals and incorporated into their behaviour (through the adoption of a particular identity) (social construction of identity).

- The existence of different professions and fields of study that are "male" or "female" in nature is often discussed (see section 1.1). The way in which certain social norms and values are reflected in the way science has been constructed and practised, represents the starting point of these analyses**.** The male/female dualism then refers to the contrast established between rationality and subjectivity in science (social construction of science).

- The existence of cognitive biological differences between men and women, reflecting a viewpoint totally at odds with constructivist approaches, in the explanation given for differences in study orientation between men and women, is not the most widespread factor in the continental literature. The authors appear to concern themselves more closely with stereotypes advocating the intellectual inferiority of women compared to men, and how these stereotypes affect women's actual performance (cognitive ability).

[13] Research into this last point is often linked to the subject of "science as a labour activity", which will be dealt with in section 1.5.

**Research areas**

- Detecting gender stereotypes and their influence on girl's and boy's study and career orientation;
- The social structures and context that contribute to passing on gender stereotypes in girls.

*Research questions*

- How does gender socialisation ( at school and in the family) influenceis girl's and boys'study orientation?
- Are there gendered cognitive abilities that predispose girls and boys towards scientific subjects? How do stereotypes and the attribution process influence girls' and boys' behaviour and performance?
- Does the construction of science encourage male dominance?Do men and women think differently when it comes to individual benefits?

*Research approach*

Stereotypes in science, the way they persist and their impact on male and female study orientations and access to the professions have been studied, both quantitatively and qualitatively. These methodologies are presented in Tables 44, 45, 46 and 47.

Table 44 shows that the approach most widely used to study this subject is the state-of-the-art review of the literature (43%). Conceptual studies (34%), and empirical techniques, both qualitative (33%) and, to a lesser extent, quantitative (27%) are also performed. Compilation of statistics is a method little used (22%) in this type of research. Building indicators is used only in rare instances to examine the question of stereotypes and identity in science.

**Table 44 : Methodological approach**

| Approach | % |
|---|---|
| Conceptual | 34.0 |
| State-of-the-art | 42.5 |
| Compilation of statistics | 21.5 |
| Building gender indicators | 1.5 |
| Empirical research. Quantitative techniques | 26.8 |
| Empirical research. Qualitative techniques | 32.9 |

Empirical and non-empirical methods are present in the same proportions in publications dealing with stereotypes and identity (see Table 45). We also find that 24% of publications are based on a qualitative empirical method, 18% on quantitative methods and just 9% on a combination of these two techniques.

**Table 45 : Type of empirical research**

| Empirical research | % |
|---|---|
| Non-empirical research | 49.3 |
| Empirical research. Quantitative techniques | 17.8 |
| Empirical research. Qualitative techniques | 23.9 |
| Empirical research. Quali-quantitative techniques | 9.0 |
| Total | 100.0 |

In the case of publications based on quantitative empirical techniques (see Table 46), the analysis is based mainly on micro-economic data (67%). A representative sample is used in 48% of publications and a multivariate analysis is carried out in 38% of cases. Longitudinal data seems to be lacking in the analysis of stereotypes and identity in science (10%).

**Table 46 : Quantitative research techniques**

| Quantitative techniques | % |
|---|---|
| Representative sample | 47.7 |
| Micro-data | 66.5 |
| Longitudinal/cohort | 9.6 |
| Multivariate analysis | 37.6 |

Table 47 shows that qualitative techniques are based mainly on interviews (72%). The other techniques are present only to a very limited extent in the literature on identity and stereotypes in science. In point of fact, the maximum extent to which they appear in publications (observations) is just 15%, while content analysis is the least-used method (7%).

**Table 47 : Qualitative research techniques**

| Qualitative techniques | % |
|---|---|
| Biographical research | 14.5 |
| Case studies | 13.6 |
| Content analysis | 7.4 |
| Interviews | 71.9 |
| Observations | 14.9 |

*Findings*

*Society helps to pass on stereotypes* – the image of men and women as promoted by society has been mentioned on numerous occasions in the literature to explain the unequal presence of girls and boys in scientific disciplines. Researchers have been particularly interested in the channels via which stereotypes are transmitted, prompting them to analyse the role played by school and the family in the process of constructing girls' identity (Meulders et al., 2009 – Belgian country report; van den Brink, 2009 – Dutch country report; Leitner and Wrobleski, 2009 – Austrian country report; Sagebiel and Dahmen, 2009 – German country report; de Cheveigné and Muscinési, 2009 – French country report):

- The intuition behind all of the continental literature dealing with the role played by the education system can be summarised by the following sentence: "*through the role models it offers, and in contrast to all of its official directives, school helps to undermine the confidence of little girls as they seek out their personal identity*" (Plateau and al., 1991, p.68). In point of fact, the authors are all agreed that, thanks to its content and the education methods it uses, the education system makes an active contribution to the task of reproducing future men and women (Plateau et al., 1991; Meelissen and Luyten, 2008; Baudelot, 1992; Falkinger, 2006). Personality traits such as self-deprecation, under-estimation, lack of confidence in their own abilities, etc. which are more

pronounced among girls than boys, are all signs of a fragility among girls created by the education system (Plateau et al., 1991; Birmily et al., 1991, Meelissen and Luyten, 2008; Duru-Bellat, 2004; Le Doeuff, 1998). The research shows that the communication methods employed by teachers vary according to the sex of their students, and that boys and girls communicate differently in class (Jungwirth, 1991; Mosconi and Loudet Verdier, 1997).

**Box 15 : Inequalities of treatment between girls and boys**

This article deals with the differences in the ways that girls and boys are treated at school. It shows that co-education reproducing gendered relations of domination, reinforces the differences between the sexes. Using the concept of the "hidden curriculum", the author shows how subconscious and involuntary learning comes from the transmission of values and sociability models which, in turn, contribute to the permanency and transmission of gender relations. In this work, an analysis of teachers' and pupils' discourse is used to reveal greater interaction between teachers and boys: teachers question boys more, pay more attention to their work, and encourage them more. Finally, teachers give favourable assessments to boys for content and criticise them for the way they present their work. On the other hand, they criticise girls for content but give favourable assessments for their presentation. Moreover, in the author's opinion, this effect is likely to be even greater in scientific disciplines.

*Source:* Mosconi, N. and Loudet Verdier, J. (1997), « Inégalités de traitement entre les filles et les garçons » in *Variations sur une leçon de mathématiques*, L'Harmattan, Paris - France, pp. 129-000.

- The role played by the family, and more particularly by parents, in passing on a role model, has been highlighted. This research emphasises how the family context, the profession concerned, social benefits and the support of parents all influence the behaviour of girls with respect to science options (Duru-Bellat, 2004; Baudelot, 1992; Ferrand et al., 1999).

**Box 16 : Come on, girls!**

After four years of investigation, the authors show that while girls now prevail, both quantitatively and qualitatively, at all levels at school, the paths to success and gaining access to jobs remain very unequal. In part one of the book, the authors analyse the number of girls and boys who obtain their baccalaureate, and in part two, they note that despite girls' success being a worldwide phenomenon, sexism still remains part of people's thinking, despite co-education. The authors also highlight the fact that girls and boys have the same abilities in mathematics. In France, although girls outperform boys from primary school onwards, and although girls' abilities in mathematics are the same as boys', they receive different vocational guidance. Gender and social origin are two different systems of inequalities. In the field of professional training, co-education creates problems. Nevertheless, the authors explain that school is less discriminatory than the family or private companies. They conclude by underscoring the importance of achieving a balance between school, family and the labour market.

Baudelot, C. (1992), *Allez les filles!*, Seuil, Paris - France.

*Women are not as intellectually gifted as men* – Based on the finding that only a small proportion of girls opt to study science at school, a few researchers analysed the differences between men and women in terms of competences. It is the cognitive process, in association with stereotypes and attribution systems, which influences the behaviour and performance of girls and boys, rather than any biological intellectual predispositions (Meelissen and Luyten, 2008; Duru-Bellat, 1993; Croizet et al., 2001). For example, Alaluf et al. (2003) reveal that in Belgium, girls are more successful at school than boys. However, among pupils studying mathematics at secondary school, a higher proportion of boys than girls opt to study highly scientific subjects at university. According to Van Aerschot (2003), this phenomenon can be explained by girls' lack of confidence in their own abilities. Dutch academics stress that differences between genders, in terms of educational level, are minimal. Moreover, even if

girls are more successful at school than boys (notably in science options), they are also faced with a lack of self-confidence that prevents them from going further down this type of path (van den Brink, 2009a).

**Box 17 : Success in mathematics: harder for a girl?**

Boys' global superiority in mathematics has not been proven. Numerous studies show that the direction and intensity of differences in success between boys and girls varies according to the exercises used. Only a slight handicap is observed in the case of geometry. Moreover, most studies do not observe this difference before the age of 12-13 years, and even then, only slightly. During the teenage years, the difference is greater, and it continues to grow throughout the time spent in school education. This handicap appears to have a cultural explanation. Among these cultural factors, the author invokes, as a hypothesis, the dominant conception of mathematics favoured in many countries. In France, this handicap appears earlier and is more marked than in most countries. No evidence has been found showing different aptitudes between the sexes. Consequently, attitudes seem to be the best explanatory factors, as well as socialisation at school, derived from interactions between teachers and pupils. Finally, the author puts forward the hypothesis that the difference is linked not to vocational guidance, but to students' own view of their future "choice" of a professional career. According to the author, girls anticipate their family role and are therefore forced to avoid careers they cannot easily combine with their family life.

Duru-Bellat, M. (1993), "*Réussir en maths : plus dur pour une fille?"*, *Les cahiers pédagogiques*, vol. 310, pp. 55-57.

*Women are less available* – Women's work and the family's future development are frequently seen as inseparable issues: women are incapable of becoming good scientists, because they will become less productive as soon as they have children. This persistent stereotype influences women's behaviours and the options open to them, in terms of making "choices". Knowing the requirements of the scientific professions, they "prefer" not to commit themselves to going down a road that they think they will be unable to sustain, and research promoters prefer not to take the risk of losing their researchers. Consequently, children do not even have to be present: the mere potential for women to have children already raises questions regarding their capacity to occupy jobs as scientists (de Henau and Meulders, 2003, and Duru-Bellat, 2004). This topic will covered more fully in the next section "Science as a labour activity".

*Scientific norms and values are male-orientated* – The association made between scientific quality and men's image is often studied in order to demonstrate the deep-seated dominance of men in the field of science. The way in which certain social norms and values are reflected in the way science has been constructed and is practised represents the starting point for such analysis. Authors highlight the historical exclusion of girls in the construction of science, thus enabling men to hold sway in the field (Gardey, 2005; Beaufays and Krais, 2005). Gorgani (2008) shows that thus far, university culture continues to be a male culture whose structures of thought and action continue to have a negative effect on women. Buchinger et al. (2004) emphasise that the representation of women in universities is highly stereotyped: few women are represented – there is a natural link between men and science – and women are synonymous with non-scientific activities. It is therefore the stereotype of science as a male preserve that reduces girls' enthusiasm for scientific studies (Coradi et al., 2003; Van Aerschot, 2003).

The neutrality and objectivity of science are also called into question because they enable the dominant position of male culture to be maintained (European Commission, 2009). According to de Henau and Meulders (2003), the image of science as a neutral subject is leading to the adoption of identical criteria for everyone, and these are introducing an element of discrimination, as they fail to take account of the fact that family responsibilities are not shared.

**Box 18 : Crumbling ivory towers: Academic organizing and its gender effects**

The under-representation of women at the top levels of academia is a persistent and fascinating issue, mostly analysed as a result of women's "choices" or as an issue of personnel management. In this article, the focus is on the functioning of universities as social institutions, where gender is 'done' in a specific way. The authors analyse how the structural, cultural and procedural arrangements of academic organisation constitute gender relations and are specifically interested in the social construction of scientific quality. The 'normal' standards for scientific quality reflect the traditions of the natural sciences, with the Olympus as the dominant image: the excellent scientist as a lonely hero at the top, far-removed from everyday practices. This conception reflects a hegemonic position that favours male culture. Alternatively, in an Agora model, science is not an autonomous institution, but becomes a societal practice tightly bound to other societal practices concerning the production, transmission, translation and exchange of knowledge. The scientific ideal of the Agora entails greater public accountability, social responsibility and transparency. This model reflects to a certain extent the scientific activities and achievements of female scientists, and the authors expect that gender will be 'done' differently in it. In the authors' view, the integration and mainstreaming of gender issues within academia will serve as a strong impetus to the necessary modernisation of academia and academic organisation. But this implies critical reflection on the socially constructed nature of any conception of 'quality'.

Benschop, Y. and Brouns, M. (2003), "Crumbling ivory towers: Academic organizing and its gender effects", *Gender Work and Organization*, vol. 10, no. 2, pp. 194-212.

Table 48 summarises the ideas on which the continental literature is based. The lesser extent to which women are available because they are also mothers, the lesser extent of their competences due to cognitive/psychological characteristics attributed to them, and the existence of "male" fields of study/careers are all stereotypes that are promoted by society and affect women's behaviour (i.e. their "choice" of studies and careers).

**Table 48 : The main stereotypes**

| Consequences | Stereotypes | Attribution | Context |
|---|---|---|---|
| Self-exclusion<br>Less favourable image of women scientists | Women do not have the same competences as men<br>+<br>Women are less available<br>+<br>Science is a man's career | Psychological and cognitive predispositions<br>+<br>Family obligations<br>+<br>Male norms/values | Social environment |
| **Under-representation of women in the scientific field and positions of power** | Illegitimacy | Sexual division, segmentation, discrimination | |

*Gaps*

The existing research has led to a certain understanding of the under-representation of women in scientific disciplines and senior academic positions, by identifying individual "preferences", gender stereotypes, and structural and cultural barriers encountered by women during the recruitment process, and as their careers progress. However, several points have yet to be explored in greater depth in the literature:

- An analysis of questions such as why these barriers are there, who they benefit, and questions such as when and how stereotyped images affect decisions to appoint people to jobs (van den Brink, 2009 –Dutch country report);
- The role of the media and the Internet, especially in the propagation of gender stereotypes and role models;
- It is important that studies of the subject of stereotypes are performed in an international context (Knobloch; 2009), insofar as the importance of stereotypes depends on a country's culture, and may therefore vary from one country to another;
- Research relating to the social construction of human and social sciences, together with health-related fields, to gain a better understanding of the reasons for the pronounced under-representation of men in these disciplines.

## 2.5. Science as a labour activity

### 2.5.1. Statistical analysis of the Gender and Science database

*Country coverage*

Table 49 shows that the topic of "science as a labour activity" is often dealt with in the literature entered in the database (33%). This finding is equally valid for the literature on continental countries in its own right (33%). The propensity among publications on this topic varies little from one continental country to another. Germany, with 34% of the publications, is the country where this topic is covered most often in the literature on gender and science. Luxembourg, with 21%, comes bottom.

**Table 49 : Number and percentage of publication**

| | n | % |
|---|---|---|
| Austria | 142 | 27.2 |
| Belgium | 103 | 28.8 |
| France | 157 | 24.2 |
| Germany | 348 | 33.5 |
| Luxembourg | 60 | 21.4 |
| Netherlands | 87 | 22.1 |
| Switzerland | 38 | 28.4 |
| **Continental Cs** | **586** | **32.9** |
| **All Cs** | **1,483** | **32.6** |

*Cross-topical coverage*

Table 50 shows that research into science as a labour activity deals almost systematically with the issue of vertical segregation (70%). Horizontal segregation, and stereotypes and identity are topics that frequently crop up in publications (37%-38%). The other questions concerning gender and science receive little coverage: policies (24%), scientific excellence (18%), gender in research content (15%) and the gender pay gap and funding (14%).

**Table 50 : Association with other topics**

| | % |
|---|---|
| Horizontal segregation | 37.9 |
| Vertical segregation | 70.0 |
| Pay and funding | 13.8 |
| Stereotypes and identity | 37.4 |
| Science as a labour activity | 100.0 |
| Scientific excellence | 18.4 |
| Gender in research content | 15.0 |
| Policies towards gender equality in research | 23.9 |

*Trend in the number of publications between 1980 and 2009*

Until the early 1990s, the annual average number of publications was below 10. The literature on "science as a labour activity" cannot be considered to have really begun to emerge until after the mid-1990s, with an annual average of 20 publications. We also find that between the mid-1990s and the late 2000s, the annual number of publications doubled (from 20 to 40 publications per year), though it should also be noted that in 2008-2009, the number of publications declined sharply (to 11).

**Table 51 : Average number of publications per year**

| | Average |
|---|---|
| 1980-1984 | 5.0 |
| 1985-1989 | 9.0 |
| 1990-1994 | 14.8 |
| 1995-1999 | 20.2 |
| 2000-2004 | 40.6 |
| 2005-2007 | 39.0 |
| 2008-2009 | 10.5 |

### 2.5.2. Summary of the key literature on "Science as a labour activity"

*Key issues*

The subject of "science as a labour activity" concerns the scientific professions, the workplace and the practices associated with it. This topic is primarily linked to the issue of vertical segregation and the career paths followed by women in the academic world. The literature focuses mainly on how scientific work is organised, and the challenge of reconciling private life and professional life.

In the context of sexual division of labour, the cumulative burden shouldered by women in combining maternity with a scientific career, has been extensively described and analysed in the literature. The conflicting relationship between work and private life is one of the factors most commonly cited to explain the under-representation of women in science (especially in the most senior positions). This issue has also been tackled indirectly via an analysis of the conditions/requirements of scientific work (organisation within the workplace, long working hours, mobility, etc.)

Studies of women's experience in these areas, which are heavily impregnated by a male culture, emphasise the subdivision, supervision and professional networks that characterise their workplace.

The scientific careers of men are tackled implicitly in the literature. As mentioned by Bennett et al.(2010) (UK and Ireland country-group report), men are seen as the "norm", against which women's progress is measured. The research recognises men's greater capacity to cope with the requirements/constraints of scientific work, because of implicit ideas concerning the sexual division of

domestic work: the characteristics of the "ideal worker" correspond more closely to those of men than of women.

**Research areas**

- Analysing the early career path of women scientists in order to illustrate the factors behind success in their careers;
- Discussion of the progression of scientific careers versus private life;
- Structure of work based on the "male as the ideal worker": long working hours and 24/7 availability;
- Identifying sexist practices that work against women.

*Research questions*

- What is the history of women in science?
- Is it a problem to combine private life and with a career?
- How does male scientific culture works against women?

*Research approach*

Research into science as a labour activity helps us to understand the reasons why women give up their careers sooner or fail to progress to the higher echelons. The male culture that associates the image of the "ideal scientist employee" with someone leading a male life-style (who has either fewer family responsibilities or none at all) defines the context in which women have to operate.

Tables 52, 53, 54 and 55 provide an insight into the methods used in the literature to deal with questions relating to science as a labour activity.

Table 52 shows that several methods are often used to tackle this subject: quantitative empirical techniques (43%), state-of-the-art reviews of the literature (42%), qualitative empirical techniques (34%) and compilation of statistics (35%). Conceptual approaches are little used (16%), and the number of studies based on building indicators is negligible (2%).

**Table 52 : Methodological approach**

| Approach | % |
|---|---|
| Conceptual | 15.7 |
| State-of-the-art | 42.0 |
| Compilation of statistics | 34.6 |
| Building gender indicators | 2.0 |
| Empirical research. Quantitative techniques | 33.6 |
| Empirical research. Qualitative techniques | 42.7 |

Unlike the topics studied so far, science as a labour activity has primarily been the subject of empirical studies. In point of fact, Table 53 shows that just 36% of publications are non-empirical. 30% are quantitative empirical studies and 21% are based on qualitative techniques. It can also be noted that 13% of publications use both qualitative and quantitative techniques.

**Table 53 : Empirical research technique**

| Empirical research | % |
|---|---|
| Non-empirical research | 36.5 |
| Empirical research. Quantitative techniques | 20.8 |
| Empirical research. Qualitative techniques | 29.9 |
| Empirical research. Quali-quantitative techniques | 12.8 |
| Total | 100.0 |

Quantitative studies are based in large measure on micro-economic data (80%). They are often based on a representative sample (57%). Multivariate and longitudinal analyses are performed in only 23% and 14% of quantitative studies respectively.

**Table 54 : Quantitative research techniques**

| Quantitative techniques | % |
|---|---|
| Representative sample | 56.9 |
| Micro-data | 79.7 |
| Longitudinal/cohort | 13.7 |
| Multivariate analysis | 23.4 |

Table 55 shows that qualitative studies are largely interview-based (73%). The other techniques are little used. 28% of publications are biographical and 13% are case studies. Observation and content analysis are techniques seldom used (6% and 3% respectively).

**Table 55 : Qualitative research techniques**

| Qualitative techniques | % |
|---|---|
| Biographical research | 22.8 |
| Case studies | 13.2 |
| Content analysis | 3.2 |
| Interviews | 73.2 |
| Observations | 6.0 |

*Findings*

- The first women scientists

Historical and biographical analysis of the careers of the first women scientists (who enjoy differing degrees of fame) has provided us with a better understanding of their working conditions, career options and the contributions they made to changes in society. It also demonstrates the continuity of the problems encountered by women scientists of different generations (Ingrisch and Lichtenberger, 2000; Keintzel and Korotin, 2002). For example, Simon- Van der Meersch's study (2000), which looks at the position of women in the academic world since the beginning of the 20th century, shows that the possibilities for building a career have improved over the course of time, but they still remain non-egalitarian. Frakele et al. (1987) analyse the living conditions that form the basis of scientific work and the pressures placed on women from different generations. As the first woman professor at the *École polytechnique* in France, Hermann (1995) describes her own career path (from secondary school to her position as a physicist). Via an analysis that may be described as subjective (as it is based on her own experience), she stresses the need to introduce measures to promote access for women to this type of profession, and to enhance their image in the scientific world.

- Reconciling professional life and private life

The theories concerning the organisation of labour have examined the degree of compatibility between women progressing in the academic world and maintaining a family life (Gerl, 1992; Mixa, 2000; Gschwandtner et al., 2002). The potential or actual presence of children has been put forward by many women as a factor in abandoning their career or as a source of tension (de Henau and Meulders, 2003; Poppenhusen, 1986). The authors emphasise the fact that scientific work is not always geared to reconciling private life and professional life (Metz-Göckel, 1999; Haffner et al., 2006). The working conditions, the intensive nature of the work, its location (Marry and Jonas, 2005), combined with the lack of childcare arrangements, important meetings being held in the evening, and above all the fact that family tasks are not shared (de Henau, 2003), are all factors that make life difficult for women seeking to reconcile "work" and "family". Although the family may also represent an impediment to men's career progress, this is predominantly seen as a problem faced by women (Meyer and Nyffeler, 2001). It is associated with the idea that there is an implicit acceptance of the unequal distribution of family responsibilities among men and women (de Henau, 2003). Here, the work of Young et al. (2009) may be cited, showing that women invest a greater proportion of their time in domestic work than men do..

**Box 19 : Promotion of young scientists in the field of tension between profession and vocation: Special federal measures to promote young scientists at Swiss universities. Report on the qualitative survey 2000**

This report was part of set of programs to evaluate the special measures introduced by the Swiss federal administration to promote young academics. Up to that point, quantitative evaluation had taken precedence, so this report attempted to add qualitative depth to the quantitative results. The detailed conversations with nearly two dozen formerly sponsored students and more than a dozen supervisory professors reflected an enormous diversity of individual promotion situations and contexts. In two ways, it was striking how deep the difference was between "feminine" and "masculine" attitudes to careers. On the one hand, even at the advanced stages of their career, women were more focused on fundamentally personal and technical interests than men. On the other hand, women tended to keep several career options open in parallel for longer than men. In several respects, this was closely connected with the question of reconciling their family and their career. Firstly, these facilitated conversations demonstrated absolutely clearly that the question of compatibility was primarily a "women's question," including within an academic environment. Whereas men either did not make "family and career" a subject of discussion at all or viewed it from a "having both" perspective, women who wanted both a family and a career felt under tremendous pressure both to achieve success and to justify their actions. Secondly, there were objective obstacles to compatibility, such as extremely high (implicit) demands in terms of prioritising the different spheres of life (the scientific community's demand for 'exclusivity'), which required virtually unlimited availability. From the perspective of reconciling family and career, this situation, coupled with the extremely high risk of failure contained in this professorial career option, rightly allowed for the appearance of a "survival commandment:" Keep alternative career paths open, other than becoming a professor.

Meyer, T. and Nyffeler, B.(2001), *Akademische Nachwuchsförderung im Spannungsfeld zwischen Beruf und Berufung: Sondermassnahmen des Bundes zur Förderung des akademischen Nachwuchses an den schweizerischen Hochschulen. Bericht zur qualitativen Befragung 2000*, State Secretariat for Education and Research (SER), Bern, *Schriftenreihe BBW 2001/4d*.

- The structure of scientific work

Long working hours, the need to be constantly available (24/7), geographical mobility and competitiveness are all widely observed phenomena in the field of science (Haffner et al., 2006; Wimbauer, 2000). Women find it harder than men to cope with these requirements, insofar as they are trying to reconcile "work" and "family life" (Gorgani, 2008, and Buchmayr and Neissl, 2006). This

culture maintains the definition of the "ideal scientist employee" as someone who leads a male lifestyle.

**Box 20 : Job world on the move. Equal opportunities in science and technology jobs as an impetus for enterprises**

About 9,000 working female and male graduates of the Technical University of Darmstadt, with degrees in chemistry, computer science, physics and engineering, were asked about their private and professional circumstances for the purpose of this study. The results show that female careers develop more slowly and stagnate earlier compared to men's careers. In contrast, women who are self-employed are comparatively more successful, although women and men are equally well-educated. The analysis of the sample revealed that the business sector is most important for the employment of university graduates, but in this sector, female chemists and engineers are especially under-represented. There are remarkable differences in the circumstances of people's private life: women's private relationships are characterised by the dual-career couple situation. Results show that mothers (38.4 percent) are on average more successful in their jobs than childless women (27.3 percent). This is true, though working mothers are also mainly responsible for childcare – only four percent of them live with a jobless partner. The authors conclude that the prevailing working culture, with its demand for full-time-availability, already hinders, in advance, the employment of highly-skilled women in particular. This working culture acts a hindrance to having commitments outside work, and supports the conventional family and parenthood role models, consisting of a male breadwinner with a financially dependent wife and some kind of 'virtual' fatherhood.

Source: Haffner, Y., Könekamp, B. and Krais, B. (2006), *Arbeitswelt in Bewegung. Chancengleichheit in technischen und naturwissenschaftlichen Berufen als Impuls für Unternehmen*, Bundesminiterium für Bildung und Forschung, Downloaded on 16/11/2008, Available at: www.bmbf.de/pub/arbeitswelt_in_bewegung.pdf.

- Women in a male hierarchy

The research conducted within several male-dominated organisations identified a significant number of sexist practices characterising the scientific workplace, and operating to the detriment of women. The social capital that men obtain via social networks and informal relationships, offers them an insider knowledge of informal rules, which proves vital for career progress (Langfeldt, 2006; Goebel, 1997). For the most part, women are excluded from these networks, as they are built around sociability among men (de Henau, 2003). According to the European Commission's report (2004), the literature emphasises that "*merit and talent are not sufficient conditions to become a successful scientist. Resources, time, social networks, encouragement – unevenly distributed between the sexes – are necessary prerequisites*" (European Commission, 2004, p.12). Novelle's study (2006) shows that working conditions and work supervision are non-egalitarian in nature (to the disadvantage of women). Similar conclusions emerge from Portegijs' study (1993).

In the university world, women appear to be intolerable outsiders. Comments on how they look, or the length of their hair or skirt, which go hand in hand with undervaluing their work and their capabilities and aspirations, are all little things that hold women back from flourishing within their workplace (Benschop and Brouns, 2003). Gender segregation tends not to diminish even when a larger number of women enter the university world. This can be explained by the fact that their contracts expire, and they find it harder to obtain a permanent job (Portegijs, 1993).

*Gaps*

In Continental Europe, empirical studies prevail in the analysis of science as a labour activity. Historical and biographical research is scarcer. Further studies must therefore be undertaken, to gain a better overview of how women scientists have dealt in the past with issues concerning their career and their private life.

Further research should also be performed into the difference between the perception of women, who regard family responsibilities as an impediment to career progress, and the actual impact of this burden on women's careers.

Research into the "work-life balance" is limited in most cases to the issue of reconciling people's private and professional lives. Other aspects, such as health risks posed by overworking, are neglected (Leitner and Wrobleski, 2009 – Austrian country report).

The experience of women in a workplace dominated by a male culture has been the subject of numerous studies. However, the way in which men cope with this environment (long working hours, the need to be available for so much of the time, etc.) is not really documented.

## 2.6. Scientific excellence

### 2.6.1. Statistical analysis of the Gender and Science database

*General coverage*

As Table 56 shows, scientific excellence is a topic little covered in the collective literature dealing with gender and science (20%). When we consider the literature on continental country only, we find that the percentage of publications dealing with gender and science and discussing the question of scientific excellence is even lower (14%). Austria, the Netherlands and Belgium are at the top of the list, with publication rates of 20%, 19% and 18% respectively. At the bottom of the table, we find Germany and Switzerland, with very low publication rates (11.9% and 8.2% respectively). France and Luxembourg lie between these two groups.

**Table 56 : Publications dealing with scientific excellence**

| | n | % |
|---|---|---|
| Austria | 104 | 19.9 |
| Belgium | 66 | 18.4 |
| France | 85 | 13.1 |
| Germany | 124 | 11.9 |
| Luxembourg | 47 | 16.8 |
| Netherlands | 76 | 19.3 |
| Switzerland | 11 | 8.2 |
| **Continental Cs** | **252** | **14.2** |
| **All Cs** | **900** | **19.8** |

*Cross-topical coverage*

Several other subjects are often discussed in publications relating to scientific excellence (see Table 57). First of all, we find that in the majority of these works, authors deal with vertical segregation (66%). Several publications address questions relating to “stereotypes and identity” (43%), “science as a labour activity” (43%), “policies towards gender equality”, “horizontal segregation” (37%), and to a lesser extent, “gender in research content” (30%). Only the question of the gender pay gap and funding is little studied, together with scientific excellence.

**Table 57 : Association with other topics**

| | % |
|---|---|
| Horizontal segregation | 36.5 |
| Vertical segregation | 65.9 |
| Pay and funding | 19.0 |
| Stereotypes and identity | 42.9 |
| Science as a labour activity | 42.9 |
| Scientific excellence | 100.0 |
| Gender in research content | 29.8 |
| Policies towards gender equality in research | 39.3 |

*Trend in the number of publications between 1980 and 2009*

Prior to the 1990s, the field of scientific excellence had almost never been investigated in continental Europe. During the 1990s, a number of publications began to appear (on average, 5 or 6 publications per year). However, it was not until the early 2000s that the subject really began to attract attention

from researchers, with nearly 20 publications appearing every year. However, between 2008 and 2009, this number declined to 9.

**Table 58 : Association with other topics**

| | Average |
|---|---|
| 1980-1984 | 0.8 |
| 1985-1989 | 1.6 |
| 1990-1994 | 5.0 |
| 1995-1999 | 6.6 |
| 2000-2004 | 21.6 |
| 2005-2007 | 18.7 |
| 2008-2009 | 9.0 |

### 2.5.2. Summary of the key literature on "scientific excellence"

*Key Issues*

Scientific excellence plays a key role in access to the most senior and prestigious positions within the scientific hierarchy. It is also a significant factor in determining how funding and subsidies are allocated. Research into this subject is focused on the existence of a gender-related bias in the definition, process and assessment criteria used to evaluate scientific excellence. In this sense, the debate revolves around topics such as scientific productivity and the social construction of science. In continental Europe, this subject has only been investigated very recently, and the number of publications is still very limited.

According to the European Commission (2005), a possible gender-related bias may be found in the following areas:

- the characteristics and assessment criteria used to evaluate scientific excellence;
- the explicit and implicit choices contained in indicators of scientific excellence;
- the way in which the criteria are applied to men and women;
- the difficulty encountered by women in gaining access to professional scientific networks.

These points are covered in the continental literature, mainly in relation to the institutionalisation of a male style of working that associates the ideal scientist (scientific excellence) with a man. However, many of these have yet to be explored in greater depth.

**Research areas**

- Gender bais in the evaluation criteria used for excellence, and the institutional practices;
- Scientific male culture's influence on performance evaluation;
- Practices of the different bodies and scientific committees that assess scientific excellence

*Research questions*

- How does the "normal standard" for scientific excellence favour men more than women?
- Are methods of assessment transparent? Are they applied to men and women in the same way?
- Who are the gatekeepers of excellence and how they operate?

*Research approach*

The continental contribution to the literature on this subject is limited to the past ten years (see section 1.6.2), and concerns three topics in particular:

- the *validity of the assessment procedures/criteria* used to evaluate academic excellence;
- *objectivity in the way scientific quality criteria are applied* to men and women;
- the role of the *gatekeepers*.

The methods employed to study each of these topics are presented in Tables 59, 60, 61 and 62.

Table 59 shows that many of the publications dealing with scientific excellence are based on a state-of-the-art review of the literature (46%), and to a lesser extent on conceptual approaches (36%) and qualitative empirical methods (36%). Compilation of statistics and quantitative techniques are used in 15% and 23% of cases respectively. Gender indicators are seldom used.

**Table 59 : Methodological approach**

| Approach | % |
|---|---|
| Conceptual | 36.1 |
| State-of-the-art | 46.8 |
| Compilation of statistics | 24.6 |
| Building gender indicators | 4.0 |
| Empirical research. Quantitative techniques | 23.4 |
| Empirical research. Qualitative techniques | 35.7 |

The subject of “scientific excellence” has been covered by similar numbers of empirical and non-empirical studies in continental Europe (see Table 60). Table 33 also shows that 25% of publications dealing with scientific excellence are based on qualitative empirical techniques and 14% on quantitative techniques. Only 9.9% of studies combine these two techniques.

**Table 60 : Type of empirical research**

| Empirical research | % |
|---|---|
| Non-empirical research | 50.8 |
| Empirical research. Quantitative techniques | 13.5 |
| Empirical research. Qualitative techniques | 25.8 |
| Empirical research. Quali-quantitative techniques | 9.9 |
| Total | 100.0 |

Table 61 shows that qualitative empirical studies are based in large measure on analysis of micro-economic data (81%) and a representative sample (70%). Multivariate or longitudinal analyses are not often performed (19% and 17% respectively).

**Table 61 : Quantitative research techniques**

| Quantitative techniques | % |
|---|---|
| Representative sample | 69.5 |
| Micro-data | 81.4 |
| Longitudinal/cohort | 16.9 |
| Multivariate analysis | 18.6 |

More than one half of qualitative empirical publications are interview-based (see Table 62). Other types of techniques are little used: 27% of qualitative studies are based on biographical research, 18.9% on case studies and 12% on content analysis and observation.

**Table 62 : Quantitative research techniques**

| Qualitative techniques | % |
|---|---|
| Biographical research | 26.7 |
| Case studies | 18.9 |
| Content analysis | 12.2 |
| Interviews | 63.3 |
| Observations | 12.2 |

*Findings*

The criteria used to define and quantify academic performance, promotions and the funding granted to individuals have been investigated. According to the study of Benschop and Brouns (2003), the criteria commonly used in science – volume of articles published in prestigious international reviews, international activities, age – reflect the ideal norm of the natural sciences and are regarded as an ideal for all sciences. The comments on the definition of excellence show that these dominant concepts are based on a traditional understanding of science (male ideals) which maintains and reinforces the effects of horizontal and vertical segregation, and thus the under-representation of women in technical disciplines (Schacherl et al., 2007; Ferrand et al., 1999; Matthies et al., 2001).

Box 21 : Who are the best? Equal opportunities in recruitment procedures

Appointments to universities are exceedingly complex personnel decision-making processes. Increasingly, there is also a striving toward what has been termed “excellence”: excellent scientists are young, multilingual, flexible, and linked up; they are independent, original yet not too exotic, recognised on all accounts by the scientific community, and in a sense, their reputation is waiting for them; they know how to acquire funding, they publish and present themselves confidently, and at the same time, they express their interest in interdisciplinary work. They have received prizes and stipends and have researched and taught at prestigious institutions, perhaps as a fellow with people with known names. Ideally, these attributes are complemented by distinctions in the areas of good teaching and experience in the self-management of university institutes. In appointment procedures, it has been demonstrated that such attributes of excellence that are normally unintentionally thrown into the procedure must be applied carefully. It is precisely women who often do not pursue the linear way from assistant to further positions on the scientific career path. Also, at times, a woman’s path is interrupted or is subject to detours, whether because of motherhood, partners on the move, alternative professional possibilities or research plans. In addition, experience shows that in the appointment procedure, special attention must also be given to judgmental and comparative statements. No one is immune to the use of gender stereotypical attributions. A balanced, attractive composition of the teaching staff is of great importance to any university. Increasingly, it is recognised that the composition concerning gender also represents a criterion of quality.

Müller, B., Obexer, G. and von Salis, K. (eds.) (2007), *Wer sind die Besten? Chancengleichheit in Berufungsverfahren*, State Secretariat for Education and Research (SER), Bern.

Criteria defining excellence are endowed with male characteristics that are harder for women to achieve, on account of their family responsibilities (Marry and Jonas, 2005; Benschop and Brouns, 2003). Consequently, adopting identical criteria for everyone entails a dimension of discrimination, if these fail to take account of the unequal distribution of family tasks (de Henau, 2003) or working conditions. For example, Van Vianen et al. (1997) show that the higher number of publications among Dutch men compared to women can be explained by the fact that men are co-authors in more cases, work full-time more ofte n and occupy more senior scientific positions than women. Yet if men and women were to work under the same conditions, no difference would be observed in terms of

publications (Van Vianen et al., 1997). Scientific norms thus incorporate a gender-related bias: where women are assessed against these criteria, they are condemned to occupy more or less mediocre positions (Benschop and Brouns, 2003).

A growing number of researchers are questioning the objectivity of the judgments that underpin the standards governing scientific excellence (Rectoraal Adviseur Gelijke Kansen, 1999, Van Haegendoren et al., 2000; Matthies et al., 2001). They emphasise the lack of transparency and explicit criteria in the processes involved in recruitment and promotion. Dutch researchers have gathered evidence of the existence of double standards based on gender, in the way in which competences are evaluated: women are judged more harshly than their male colleagues (Van der Burg et al., 1998 and Brouns, 2000).

**Box 22 : Gender and promotion in the academic labour market**

Several hypotheses are put forward with respect to promotion differentials between males and females in the academic labour market. These hypotheses are tested on the basis of a longitudinal data set of academic staff members at Utrecht University. The methods applied include Poisson regression, Negative Binomial analysis and Probit analysis. The results show that tenure and a PhD had positive effects on the likelihood of being promoted. Working part-time did not have an effect on the likelihood of men being promoted, although it did negatively affect the likelihood of women being promoted. Working full-time and having a PhD proved to be efficient but not sufficient instruments for women in the academic labour market to catch up with men with respect to promotions.

Van der Burg, B., Siegers, J. and Winter-Ebmer, R. (1998), "Gender and promotion in the academic labour market", *Labour*, vol. 12, no. 4, pp. 701-713.

Research concerning the influence of gatekeepers of excellence in the evaluation process emphasises the extent to which the under-representation of women on executive councils and decision-making committees penalises the access they enjoy to funding and promotions. Gatekeepers of excellence such as external funding bodies and institutional hierarchies dominated by men influence the selection process in favour of men. Van den Brink (2009a) reveals various gender practices linked to recruitment and selection (e.g. recruitment by invitation, women being excluded from the process of providing information, which is given to men via their networks) used by gatekeepers of excellence to recruit new members to their male networks. Other studies have highlighted similar practices (Leemann and Stutz, 2008; Van den Brink, 2009b, Bütow, 1993, de Henau, 2003; Beaufays and Krais, 2005; Van Balen and Van Vianen, 2002). "*Male candidates are preferred because they are closer to the majority of the members making up the selection panel; similarity generates confidence and empathy, and also gives continuity to decision-makers for their creations and ideas, in the way things should be done*"(de Henau, 2003).

**Box 23 : boys' networks in academia. Social closure in universities**

The number of women in top academic positions in universities in the Netherlands is extremely small: barely 5 percent. In this study, three universities in different countries have been compared, in order to find the main reasons for the disadvantaged position of women in Dutch universities. First, they assumed that several characteristics of universities would hamper women in gaining access to those universities. Therefore the characteristics of universities with a relatively small proportion of women in higher academic positions were examined and compared with the characteristics of universities with a larger proportion of women in senior positions. Secondly, gender differences in academic networking were analysed, based on theories about social closure. Gender specific mechanisms of social closure were found. Furthermore, the results showed that social closure within organisations flourishes under certain conditions. These conditions are: the magnitude of social inequality between the various groups, scarcity of positions and room for bias in selection procedures such as less objective selection criteria, room for decentralised policy freedom in the use of regulations and extensive autonomy for middle management in the organisation.

Van Balen, B. and Van Vianen, A. (2002), ''Old boys' networks' in de academie. Sociale sluiting in universiteiten", *Tijdschrift voor Genderstudies*, vol. 5, no. 1, pp. 18-27

The research calls into question the validity of the dominant position held by men in the evaluation of excellence, by analysing women's contribution to science (Ingrisch, 1993, Ingrisch and Lichtenberger-Fenz, 2000; Muller, 1993, 1983). Marry (1995) evaluates the situation of former female students of Ecole Polytechnique in comparison with male ones. The author argues that even if the situation is far from being really positive, the presence of women in École Polytechnique calls into question the validity of the hegemonic male pattern of social success: the presence of women creates a new relationship at the workplace that can be attractive to men.

**Box 24 : The displacement of women from scientific historiography and their banishment from science**

In her article, Maurer shows that women are of much greater importance than is shown in technical and scientific historiographies. She gives examples of successful female scientists in the natural and technical sciences, including biology, chemistry, medicine, mathematics, physics, astronomy, mining, entomology and apparatus technology. Several mechanisms are responsible for the under-estimation of women's achievements. The total concealment of women is the simplest of them, but more often only one or a few women are mentioned, or women are shown as mere appendages to male scientists in their role as their wife, assistant or muse. A subtle way in which they are discriminated against is through under-estimating the scale of their achievements. This can be seen not only in historiographies but also in the real exclusion of women from science. The absence of women in historiography is often used to argue that women are incapable of becoming technical or natural scientists. To show that women have considerably influenced the development of technology and science in the past, Maurer describes the role of women during the early years of modern chemistry.

Maurer, M. (1983), "Die Verdrängung der Frauen aus der wissenschaftsgeschichtsschreibung und ihre Vertreibung aus der Wissenschaft", *Zeitschrift für Hochschuldidaktik*, vol. 7, no. 4, pp. 539-557

*Gaps*

The debate on gender and scientific excellence is only beginning in continental Europe. The influence exerted by gender on research committees and assessment committees has yet to be explored in greater depth.

Studies similar to those of Schacherl et al (2007) and Brouns (2000), relating to Austria and the Netherlands respectively, should be carried out in each continental country because they contribute to an understanding of how gender influences the system of awarding research funding. However, they need to be enriched by other empirical studies, to underline all formal and informal factors that contribute to gender inequality in access to funding and promotion. To this end, regular statistics, broken down by sex, on the allocation procedures of funds and grants should be compiled and made available on an annual basis.

Research into the practices of the different bodies and scientific committees that assess scientific excellence is needed. Only scarce and scattered information exists on recruitment practices to gate-keeping positions.

Data relating to men's and women's productivity potential should be systematically compiled and published.

## 2.7. Gender in research content

### 2.7.1 Statistical analysis of the Gender and Science Database

*Country coverage*

Table 63 shows that "gender in research content" is a topic that appears in 32% of GSD publications. When we consider the publications on continental countries only, this percentage rate is slightly lower (29%). Publications on Luxembourg, Austria, Belgium, the Netherlands and France dealing with gender and research content represent between 39% and 46% of publications, while on the other side, we find Germany and Switzerland, with lower percentages of publications (24% and 20% respectively).

**Table 63 : Number and percentage of publications**

| | n | % |
|---|---|---|
| Austria | 227 | 43.5 |
| Belgium | 153 | 42.7 |
| France | 275 | 42.4 |
| Germany | 253 | 24.3 |
| Luxembourg | 129 | 46.1 |
| Netherlands | 155 | 39.3 |
| Switzerland | 27 | 20.1 |
| **Continental Cs** | **521** | **29.3** |
| **All Cs** | **1,434** | **31.5** |

*Cross-topical coverage*

Table 64 indicates that publications on gender in research content often deal with the topic of "stereotypes and identity" (45%). Policies towards gender equality in research (29%), vertical segregation (28%) and horizontal segregation (21%) also appear in a significant number of these publications. The other subjects (science as a labour activity, scientific excellence, the gender pay gap and funding) are not covered very much in the literature on gender in research content.

**Table 64 : Association with other topics**

| | % |
|---|---|
| Horizontal segregation | 21.1 |
| Vertical segregation | 27.8 |
| Pay and funding | 7.3 |
| Stereotypes and identity | 44.7 |
| Science as a labour activity | 16.9 |
| Scientific excellence | 14.4 |
| Gender in research content | 100.0 |
| Policies towards gender equality in research | 28.6 |

*Trend in the number of publications between 1980 and 2009*

Table 65, indicating the number of works published in continental Europe, shows that on average, over the period 1980-1984, there were 8 publications per year on the subject of gender in research content. However, there were fewer publications over the period 1985-1989 (around 4 per year). From the mid-1990s onwards, the average number of publications rose sharply, to 19. The annual average number of publications is highest (37) during the period 2000-2004. Thereafter, however, this number declined to 14 publications per year over the period 2008-2009.

**Table 65 : Average number of publications per year**

| | Average |
|---|---|
| 1980-1984 | 8.4 |
| 1985-1989 | 4.4 |
| 1990-1994 | 11.8 |
| 1995-1999 | 19.2 |
| 2000-2004 | 37.2 |
| 2005-2007 | 29.7 |
| 2008-2009 | 13.5 |

### 2.7.2. Summary of the key literature on "gender in research content"

*Key Issues*

The topic that lies at the heart of this literature is the institutionalisation of gender in research. Here, attention is no longer limited to women in their roles as scientists or researchers, but is also paid to research methods and the theories guiding them (Goldschmidt et al, 1995). In studying this subject, the authors provide an insight into feminist thinking with regard to the practices that have guided scientific work over the past century, and emphasise the unequal balance of power that exists between men and women in the academic world, and the consequences of this imbalance for the scientific agenda. They also provide evidence of the scale of the contribution made by women to science, and highlight what science may have missed by being dominated by men, and the priorities involved in a women's agenda.

**Research Areas:**

- Gender-blindness in scientific knowledge;
- Reflection on women's relationship with knowledge and the possible role of women in the scientific community

*Research questions*

- What contributions have women made throughout history to the advancement of scientific knowledge? Why has their contribution been neglected?
- What are the advantages of incorporating a gender perspective into scientific research? How can a feminist point of view contribute to this change?
- Are the scientific epistemology male-biased?

*Research approach*

The research into gender in research content lays particular emphasis on three things: the improvements that may be made by taking gender into account in the theories and methods guiding the different scientific disciplines; the role played by feminist movements in creating awareness of identity and their contributions to science; and gender aspects linked to teaching at university level and in the school system.

The methods used to deal with these subjects are shown in Tables 66, 67, 68 and 69.

Two types of methodological approach are used extensively to deal with the question of gender in research content (see Table 66): conceptual methods (65%) and state-of-the-art reviews of the

literature (58%). The other methods are little used: qualitative (19%) and quantitative (14%) empirical techniques, and data compilation (10%). Gender indicators were almost never built to deal with the question of gender in research content (3%).

**Table 66 : Methodological approach**

| Approach | % |
|---|---|
| Conceptual | 64.5 |
| State-of-the-art | 57.6 |
| Compilation of statistics | 10.4 |
| Building gender indicators | 2.5 |
| Empirical research. Quantitative techniques | 14.2 |
| Empirical research. Qualitative techniques | 19.4 |

Table 67 shows that many of the publications on gender in research content are based on non-empirical methods (74%). 12% of publications are based on qualitative empirical techniques and 7% on quantitative empirical techniques. The remaining percentage (7%) is based on both quantitative and qualitative techniques.

**Table 67 : Empirical research techniques**

| Empirical research | % |
|---|---|
| Non-empirical research | 73.5 |
| Empirical research. Quantitative techniques | 7.1 |
| Empirical research. Qualitative techniques | 12.3 |
| Empirical research. Quali-quantitatives techniques | 7.1 |
| Total | 100.0 |

The few quantitative studies carried out on gender in research content are based mainly on a representative sample and on micro-economic data (57% and 53% respectively). 30% of them are based on multivariate analyses. Just 8% of publications are longitudinal studies.

**Table 68 : Quantitative research techniques**

| Quantitative techniques | % |
|---|---|
| Representative sample | 56.8 |
| Micro-data | 52.7 |
| Longitudinal/cohort | 8.1 |
| Multivariate analysis | 29.7 |

An analysis of Table 69 shows that the majority of qualitative empirical works on the question of gender in research content are interview-based (55%). The other techniques – case studies, content analysis, observation and biographical research – are used less frequently (between 23% and 15%)

**Table 69 : Qualitative research techniques**

| Qualitative techniques | % |
|---|---|
| Biographical research | 14.9 |
| Case studies | 22.8 |
| Content analysis | 18.8 |
| Interviews | 54.5 |
| Observations | 15.8 |

*Findings*

- Women and the history of science

Research has shown how far women are under-represented in the historiography of science: the history of science, such as it is written, is a story from which women are absent (Vanpaemel, 2000). This absence is often used as an argument to justify the idea that women are incapable of making good scientists (Maurer, 1983). In order to demonstrate that women have exerted a considerable influence over the progress of science and technology in the past, Maurer (1983) describes their role during the early years of chemistry. Thys-Clement's study (2000) symbolically retraces the careers of women who significantly influenced the history of feminism. This type of research offers visibility for, and a recognition of, the scientific contribution made by women (which has hitherto been overlooked or ignored). The various feminist movements (Marxist, liberal and radical) have been reviewed in the work of Parini (2006) and Ingrisch and Lichtenberger-Fenz (2000). Perrot (2001) emphasises the gradual influence of feminist movements on creating awareness of identity among women, and on the application of these claims to other strata of the population.

**Box 25 : Writing the history of women : reviewing an experiment**

In this article, the author wants to show how the history of women has developed over the past 25 years. She shows how, moving from a position of political exclusion, women have become subjects of history, and discusses the reasons for this transformation. She presents the steps involved in the construction of this history, its consequences, results and the discussions it provoked, in order to conclude on the current state-of-the-art. For the author, the conclusion is clear: although the history of women has never produced the abrupt change it intended to bring about, it still manages to discover new sources, promote multidisciplinarity, ask questions about chronology and events in a different way, make the network of interactions that produce change more complex, modify some answers, and to generally broaden the field of history. It has received more public than academic recognition. In summary, the history of women has accompanied the women's movement and it has created a consciousness of identity that now extends to men and homosexuality.

Perrot, M. (2001), "Faire l'histoire des femmes : bilan d'une expérience" in *Masculin-féminin : questions pour les sciences de l'homme*, PUF, Paris - France, pp. 229-244.

- Teaching

The publications on stereotypes and identity presented in section 1.4 have already emphasised the influence of the education system on the study orientation of girls and boys. In the context of research into gender in research content, the need to take gender into account in teaching methods and content is once again highlighted (Jungwirth, 1991; Lassnigg and Paseka, 1997, Plateau et al., 1991, Volman et al., 1995). The study by Verdonk et al. (2008) shows that creating awareness of gender in the study of medicine would help to achieve fairness and equality in medical care and improved health for both men and women.

**Box 26 : Girls in Science and Technology: the development of a discourse**

This article discusses the contribution made by educational research to the emergence of a discourse on the issue of girls in science and technology in the Netherlands. Research has not only produced findings and recommendations, but also a conceptualisation of the problem. The authors argue that it has gradually become self-evident to think of the attitudes, achievements and choices pertaining to science and technology made by girls as the cause of gender inequality in education. The results of many studies focusing on connections between teacher behaviour, subject matter and school characteristics on the one hand, and the attitudes, achievements and choices of girls on the other, appear to be disappointing. The authors suggest that both the questions that were asked and the way they were investigated are responsible for the disappointing results. The authors propose that research into gender and education should not be limited to the investigation of statistical correlations between school characteristics and student outcomes, but should also study the mechanisms and processes that mediate between these factors. Insight from women's studies on the social construction of gender and on the development of gendered identities could be useful in addressing this issue.

Volman, M., Van Eck, E. and Ten Dam, G. (1995), 'Girls in science and technology: the development of a discourse', *Gender and Education*, vol. 7, no. 3, pp. 283-291

- Gender and scientific research

The relevant aspects of gender that are neglected during the normal course of male-led research have been widely discussed in feminist literature. For example, Maihofer (2003) stresses the importance of carrying out research into gender, based on both male and female approaches. The study by Staheli and Torra-Mattenklott (2001) considers the relevance of gender in research and what it can contribute to or withhold from science. In general terms, the work emphasises the existence of a male bias in the way scientific research and analysis are conducted. A great deal of research is focused on a particular field such as:

- science and engineering. Wagner's study (1987) stresses the myth of scientific methodology, which associates the natural sciences and engineering with emotional neutrality and rationality. In his work, he emphasises the important role that school-teaching can play in the demystification of scientific methodology. Stadler's study (2005), relating to physics, links gender stereotypes more directly to scientific research content in physics.

**Box 27 : Dualism and science - physics as a male domain**

Helga Stadler's contribution thematises the situation of women in physics. At the beginning of this contribution, the author uses the data available from university statistics to give an idea of women's involvement in physics. She also presents the *status quo* of gender research in physics and poses the question of how gender is thematised in research and in physics. She then introduces the idea of studying gender in physics. The author emphasises the self-representation of physicists, i.e. the image projected by physicists, both inside and outside of their discipline. She goes on to show the socialisation of female scientists, i.e. she minimises the influence of home and school in forming role models and stereotypes. School education plays an extraordinarily important role in explaining the (lack of) interest in physics displayed by women. Finally, the author describes experience with existing interventions and possible future interventions.

Stadler, H. 2005, "Dualismus und Wissenschaft - Physik als männliche Domäne." in M. Bidwell-Steiner and K. Wozonig, eds. *Die Kategorie Geschlecht im Streit der Disziplinen* , Studienverlag, Innsbruck; Vienna; Bolzano, pp. 206-222

- Social and political sciences, and law (Mairhuber, 1999). Sauer's study (2006) stresses the importance of having a democratic reorganisation of labour, which takes account of the needs of both men and women, and the constraints they operate under, while Flossmann's study (1997) shows the potential influence on social policies of taking gender into account.

**Box 28 : Feminism and science**

In this book, four renowned female scientists give their opinions and a state-of-the-art review of their disciplines: political science, law and economics. These academic disciplines are assumed to be gender-neutral and objective, as politics is neither masculine nor feminine. In the discipline of law, making a distinction between men and women is simply 'not done' and the 'homo-economicus' has no gender either. The authors deal with subjects such as the under-representation of women in political positions, the question as to what extent the universalism of human rights is incompatible with women's rights and the current economic inequality between the sexes. By discussing these topics, the authors paint a picture of the meaning of feminist thinking on current scientific practice. The book also includes a triad of theoretical contributions illustrating how the goal of research has developed over the years. They show that the central focus of attention is no longer only on women as scientists or research subjects, but also on research methods and theories.

Goldschmidt, J., Gustafsson, S. and Maassen van den Brink, H. 1995, *Feminisme en wetenschap*, Prometheus, Amsterdam.

- Life sciences (including health) and biotechnology (Abels et al., 2003). The article by Verdonk et al. (2008) shows that the relevant aspects of gender have long been neglected in medicine. The methods employed in medical care are biased in favour of men, as they are based on knowledge relating to men's health. This viewpoint is also encountered in the article by Klinge (2002). According to Maurer (1993), reaching parity in terms of male/female representation within the scientific community would improve the performance and expertise of biological scientists.

**Box 29 : Women, gender and the life sciences: research for and about women**

Focusing on health-related research, the author points out the under-representation of women, especially in pharmacological research. She highlights the fact that males are still taken as the norm in research. To illustrate this point, she shows that cholesterol-reducing drugs have not been tested on women for long and that the under-diagnosis of cardiovascular disease among women and inadequate medication are the results of this under-representation. Attention is paid to sex differences in drug metabolism, risk factors, and the symptoms and course of disease. As another issue, research into sex-specific diseases needs to be stimulated, and this can be seen as a way to fill knowledge gaps. The Quality of Life (QoL) programme has a broad scope, organised into 13 action lines: 6 key actions and 7 generic activities. To assess the integration of the gender dimension into the Work programme, she composed a literature resource against which the assessment could be made. This literature resource was based on searches in two international databases. One database specialised in gender literature (IIAV database), and the other in health-related literature (MEDLINE). She focused on retrieving literature that addressed the gender aspects of a particular phenomenon. A specific tool was developed to assess the integration of the gender dimension into projects. The tool's development was inspired by a number of existing tools, including the tool for evaluating policies from a gender perspective, which was developed in the Netherlands. The tool, called the Gender Impact Assessment Protocol (GIA-Protocol), was attuned to specifically assess QoL research projects.

Klinge, I. 2002, *Women, gender and the life sciences: research for and about women*, European Commission, Downloaded on 19/12/2008, available at: ftp://ftp4.cordis.lu/pub/improving/docs/women_conference_proceedings_08112001.pdf#page=75

A few authors have looked at what changes would be necessary to make scientific practices and research more gender-sensitive (Draulans, 2003; Lowy, 2000).

*Gaps*

Numerous studies have been performed on the status of research into gender within scientific institutions or disciplines. However, for the most part these are descriptive or based on theoretical/conceptual discussions relating to the way in which gender in research is put into perspective. Few works exist that deal with the factors encouraging or preventing gender institutionalisation in research, but are not based on conventional lines of argument. Consequently, empirical research is still necessary, to gain a better understanding of the factors supporting or preventing gender institutionalisation in research.

With a view to raising the awareness of gender bias in scientific practice, an in-depth analysis of the contributions made by women (teachers or researchers) should be pursued, both for science in general and for particular scientific disciplines. Moreover, since the disciplines studied vary widely from one country to another, it is essential that these studies be extended to encompass all scientific fields in all of the continental countries.

It may be noted that research into gender in research content has a limited impact on the small circle of experts “in women’s and gender studies”. Consequently, it might be appropriate to widen this circle to include all of the players concerned.

## 2.8. Policies towards gender equality in research

### 2.8.1. Statistical analysis of the Gender and Science Database

*General coverage*

Table 70 shows that 29% of GSD publications examine policies towards gender equality in research. This rate is higher when only the publications on continental European countries are taken into consideration (31%). Publication rate on gender equality in research in Switzerland, Belgium and Luxembourg are the highest percentages of publications (46%, 44% and 40% respectively). For the Netherlands, Germany and Austria, the percentages of publications dealing with policies towards gender equality are around 35%. The rate is lowest for France (24%).

**Table 70 : Number and percentage of publications**

| | n | % |
|---|---|---|
| Austria | 177 | 33.9 |
| Belgium | 158 | 44.1 |
| France | 158 | 24.4 |
| Germany | 377 | 36.3 |
| Luxembourg | 111 | 39.6 |
| Netherlands | 142 | 36.0 |
| Switzerland | 62 | 46.3 |
| **Continental Cs** | **552** | **31.0** |
| **All Cs** | **1,296** | **28.5** |

*Cross-topical coverage*

Most of the publications dealing with policies towards gender equality examine vertical segregation (53%). 35% of them discuss horizontal segregation, 27% gender in research content and 25% stereotypes and identity, and science as a labour activity. The subjects of scientific excellence, and the gender pay gap and funding, receive little coverage (18% and 11% respectively).

**Table 71 : Association with other topics**

| | % |
|---|---|
| Horizontal segregation | 35.1 |
| Vertical segregation | 53.4 |
| Pay and funding | 11.1 |
| Stereotypes and identity | 25.0 |
| Science as a labour activity | 25.4 |
| Scientific excellence | 17.9 |
| Gender in research content | 27.0 |
| Policies towards gender equality in research | 100.0 |

*Trend in the number of publications between 1980 and 2009*

With an annual average figure of one publication per year, it can be stated that virtually no publications dealing with policies towards gender equality appeared over the period 1980-1989. From 1990 to 2004, the number of publications continued to grow (from 8 publications per year to 48 per year). Thereafter, the annual number of publications declined, until it reached 27 publications over the period 2008-2009.

**Table 72 : Average number of publications per year**

| | Average |
|---|---|
| 1980-1984 | 1.4 |
| 1985-1989 | 1.4 |
| 1990-1994 | 8.0 |
| 1995-1999 | 18.6 |
| 2000-2004 | 48.0 |
| 2005-2007 | 37.3 |
| 2008-2009 | 26.5 |

### 2.8.2. Summary of the key literature on "Policies towards gender equality in research"

*Key Issues*

This section examines national, regional and local policies and programmes to promote gender equality in the fields of science and research. Consequently, this subject refers to the various topics we have discussed above.

The European Commission's report on "Gender Challenge in Research Funding" provides an instructive classification based on the context of gender equality in each country. Countries are subdivided into (1) pro-active countries that encourage and oversee gender equality in research, using pro-active measures; and (2) comparatively inactive countries, characterised by few measures and initiatives. For the most part, the continental countries (Austria, Dutch-speaking Belgium, Germany, the Netherlands, Switzerland) are to be found in this first group, and are listed here as "newly active countries with few women in research". Luxembourg is the only continental country in the second group, i.e. that of "relatively inactive countries" (Castaño et al., 2010 - Topic report: policy towards gender equity in science anf research).

According to the report produced by Castaño et al., (2010) (Topic report: policy towards gender equity in science anf research) Germany, Austria and Switzerland have taken major initiatives to improve the level of women's participation at all levels of science and research. They offer the most comprehensive literature on the topic of "Policies towards gender equality in research".

**Research areas**

- Initiatives to advance science careers for women and the gender dimension in science (including research and higher education)
- Ways in which measures have been implemented and their effectiveness
- Collecting best practice

*Research questions*

- What initiatives have been undertaken for supporting career progress for women.?
- What initiative have been undertaken to increase the number of women scientists?
- Are the gender policies effective?

*Research approach*

From the 1990s onwards, initiatives taken to combat segregation of men and women working in the fields of science and research became a significant area of study. In the light of the current situation of women in universities, research institutions and at school, the research emphasises the need to introduce positive measures.

The approaches used to deal with policies towards gender equality are shown in Tables 73, 74, 75 and 76.

Table 73 shows that, to a significant extent, the methods used are based on state-of-the-art reviews of the literature (65%). Several studies rely on compilation of statistics (34%) or are conceptual (31%). Qualitative (23%) and quantitative (18%) empirical studies are used less frequently.

**Table 73 : Methodological approach**

| Approach | % |
|---|---|
| Conceptual | 33.9 |
| State-of-the-art | 64.7 |
| Compilation of statistics | 31.3 |
| Building gender indicators | 4.0 |
| Empirical research. Quantitative techniques | 18.3 |
| Empirical research. Qualitative techniques | 23.4 |

Table 74 shows that most studies of policies towards gender equality in research (67%) are non-empirical. Qualitative and quantitative empirical studies account for 15% and 9% of publications on this topic respectively. 9% of publications are based on both quantitative and qualitative techniques.

**Table 74 : Empirical research techniques**

| Empirical research | % |
|---|---|
| Non-empirical research | 67.2 |
| Empirical research. Quantitative techniques | 9.4 |
| Empirical research. Qualitative techniques | 14.5 |
| Empirical research. Quali-quantitative techniques | 8.9 |
| Total | 100.0 |

On the basis of Table 75, we find that in the majority of cases, quantitative empirical studies are based on a representative sample (65%) and on micro-economic data (57%). Multivariate analyses are carried out in 17% of cases but few studies are longitudinal (6%).

**Table 75 : Quantitative research techniques**

| Quantitative techniques | % |
|---|---|
| Representative sample | 65.3 |
| Micro-data | 57.4 |
| Longitudinal/cohort | 5.9 |
| Multivariate analysis | 16.8 |

Table 76 shows that the qualitative technique most widely used in studies of policies towards gender equality in research is the interview (68%). Case studies and content analysis are used in 20% and 24% of publications respectively. The other techniques are little used: observation (11%) and biographical research (9%).

**Table 76 : Qualitative research techniques**

| Qualitative techniques | % |
|---|---|
| Biographical research | 9.3 |
| Case studies | 24.0 |
| Content analysis | 20.2 |
| Interviews | 68.2 |
| Observations | 10.9 |

*Findings*

Part of the literature considers the introduction of equal opportunity policies in colleges and universities (VLR-Werkgroep Gelijke Kansen, 2002, Vlaams Raad, 2000 – Belgium). The Austrian literature has made a major contribution to the understanding of these legal measures aimed at combating discrimination (Furst, 1997; Ulrich, 2003; Holzleithner, 2002, Aichhorn, 2000). This research offers a critical view of this type of measure. Similar studies have been performed in other national contexts. In Germany, for example, Degen (2001) criticises the lack of laws passed, and the lack of sanction mechanisms accompanying equal opportunity policies. Van Emmerik et al. (2002) analysed the effects of equality policies at the University of Utrecht in the Netherlands. In this institution, the failure to adhere to equal opportunity policies is justified either by an absence of candidates or a lack of posts. They conclude that without a strong commitment on the part of the university, equality policies have little chance of success. These conclusions are corroborated by the study by Timmers et al. (2007).

Several research studies refer to projects and programmes aimed at supporting career progress for women. Four measures in particular emerge from the continental literature:

- subsidies and study grants to promote career development for women in the academic world. This type of measure has been investigated in Germany (Castano et al., 2010 – Topic report: policy towards gender equity in science anf research), in the Netherlands (Donselaar, 2006; Visser et al., 2003) and in Austria (Wroblewski et al., 2007). Kirscher's study (2004) gives a detailed insight into the measures put in place in Bavaria to promote career advancement for women. Kirscher (2004) shows that in general, subsidies are perceived more favourably than other career support measures, such as quotas for women. It compares "normal" study grants (DFG stipends) with career promotion subsidies (HWP scholarships). He concludes that there is a risk that funding committees will encourage women to turn to HWP scholarships, thus indirectly favouring men in the granting of (more prestigious) DFG stipends (Castaño et al., 2010 - Topic report: policy towards gender equity in science and research).

- Work-life balance policies. People's attempts to reconcile their private life with professional life is a subject that has attracted the lawmakers' attention. Measures to this end have been discussed, in Switzerland and Germany (Castano et al., 2010 – Topic report: policy towards gender equity in science and research).

- Mentoring and networking programme. "*Mentoring programmes across Europe constitute one of the most widespread and popular measures for promoting the incorporation and advancement of women in science. The website of the German parent organisation of mentoring initiatives lists around 75 mentoring programs across a variety of universities and faculties of applied sciences in Germany. In Switzerland, 39 separate mentoring projects have been funded between 2000 and 2007. EU projects such as eument-net or TANDEMplusIDEA also bear witness to the importance of mentoring schemes on a European level. In contrast to this evident popularity, the absence of research targeted on mentoring for women in science is striking. The few publications included in the GSD database concern mainly (self-)evaluation studies of certain mentoring initiatives."* (Castano et al., 2010, p.38). The evaluation and results of mentoring and networking programmes have been discussed in the literature emanating from Switzerland (Muller et al., 2007), Germany (Castano et al., 2010 – Topic report: policy towards gender equality in science and research), Austria (Wroblewski et al., 2007), and the Netherlands (Timmers et al., 2007).

- Training measures and programmes. In Germany, the *Anstoss zum Aufstieg* training programme (running from 2001 to 2005), seeking to bring about a permanent increase in the number of women in leadership positions at universities and research institutions. This programme was evaluated in Lind and Lother's study (2006). The study by Wrobleski et al*.* (2007) reports on a series of coaching seminars known as f FORTE in Austria, attempting to boost the importance of women scientists in European research projects.

School is perceived as a key area for introducing policies to increase the number of women scientists, because their under-representation may be viewed as a reflection of educational segregation (Bourven, 2007). The study by Aebischer and Valabregue (1995) evaluates the effects of measures aimed at giving girls greater confidence in their own abilities and thus increasing their interest and participation in the scientific fields at secondary school level in France. The results showed that in the short run, pupils can be made aware of inequalities, but it is much harder to change their career orientation. Wrobleski et al*.* (2007) review the initiatives taken to encourage girls to opt for technical studies in Austria. The introduction of single-sex degree courses at university in applied sciences (industrial engineering option) in Germany has been described by Knapp and Gransee (2003).

**Box 30 : place in the decision-making process: promoting diversity**

Women still occupy a weak position in the top levels of higher education and public research, and this position becomes even more vulnerable in the case of executive jobs. The specific processes and obstacles that explain this under-representation are very similar across all professional environments, and refer mainly to educational and socio-cultural factors underlying the status and role of women engaged in professional activities, as well as the choices they make to follow non-scientific courses of study and university training, rather than setting their sights on *Grandes Écoles* (elite higher education colleges). Similar organisational practices that penalise women operate within public, private, political and social organisations, such as various differences that manifest themselves at the time women are recruited, and continue throughout their career. Finally, the behaviour and career strategies adopted by women themselves hinder their progress towards positions of authority. A gender balance needs to be promoted in decision-making positions because it is illusory to hope that time alone will remedy this situation. To achieve an equitable balance, it is necessary to use the European legal framework and economic arguments as an incentive, and emphasise the managerial and societal issues at stake, in order to propose positive discrimination measures. Work also needs to be undertaken on the vocational guidance provided to girls, so as to achieve a balanced representation within political organisations, equal access to higher positions in the civil service and a favourable context for gender diversity in company management.

Bourven M. 2007, *La place des femmes dans les lieux de décision : promouvoir la mixité*, Éditions des journaux officiels, Paris –France

*Gaps*

Research into equality policies is a recent subject. It focuses mainly on the university sector and takes little account of the role of government and other institutions. Research into the reasons why certain policies are not implemented or are not effective needs to be investigated more fully.

Empirical research is quite sparse. This would however provide a better understanding of how career advancement policies for women are perceived, both by women and men.

# Conclusion

Gender segregation as a caracteristic of the continental labour market has been largely studied in the literature. However, specific studies on science and research have appeared only over the last three decades.

This report is based on the literature gathered in the gender and science database. It gives a review of the different topics related to continental countries which have been studied in the literature.

The evidence on horizontal and vertical segregation shows that these phenomena are a common feature of the field of science and research. Women's position in science does not reflect the increase in the female student population that took place over the last decades.

Gender stereotypes and the socialisation processare set forth in the literature as the main explanatory factor of girl's/women's and boys'/men' "choice" of study and career. The masculine culture of science that tends to define the ideal worker as one who leads a man's life is an important obstacle to women's career progression. The process of evaluation of the scientific worker, the lack of gender aspects in research and education content, the exclusion of women from the history of science are as many factors that maintain the male hegemony in science. These factors have attracted policy makers' attention. However, the analysis of the literature on policies towards gender equality in science and research shows that a lot remains to be done in order to improve gender equality.

The questions that are left unanswered in the gender and science literature are summarised below.

**General missing items**

- Lack of empirical research :
    - Quantitative studies would help to better understand the factors which explain gender discrimination in science and research. Futher more, collecting longitudinal data would be necessary to track change over time;
    - Qualitative research is necessary to understand women's perception of their situtation;
- Lack of studies on fields considered to be female such as health services, humanities, arts and social services;
- Lack of studies on sectors other than higher education: too little research has examined women's and men's experiences in the government sector and even less in private sector organisations(business and non-profit).

**Horizontal segregation**

- There is an apparent imbalance between the topics investigated: educational segregation has been the subject of considerably more research than professional segregation. What is more, a comparison of the reasons why pupils/students refrain from pursuing scientific courses of study, and the reasons lying behind women's career choices, would greatly help in furthering our understanding of horizontal segregation.
- Research needs to be carried out on girls/women who opt for non-traditional (male) courses of study and occupations, so as to reveal their experiences, performance and attitudes.
- Horizontal segregation has been explained solely in terms of comprehending the representation of women in scientific fields. There has been no research attempting to understand why men are under-represented in "female disciplines" such as social sciences and human sciences.

**Vertical segregation**

- One may readily conclude that studies dealing with occupational sectors other than academia are relatively few.
- The link between vertical segregation and horizontal segregation has not been addressed directly. Yet, horizontal segregation could to some extent compound the effects of the glass ceiling (Fassa, 2008).
- As far as we know, the characteristics of women and men who manage to reach senior positions have never been compared with those of women and men who experience a flatter career profile. It would therefore be interesting to undertake this exercise so as to gain a deeper insight into the issue;

**Pay and funding**

*Pay gap*

In the context of publications relating to the gender pay gap, we find that authors focus primarily on understanding the phenomenon rather than quantifying it.

Several elements also appear to be absent from the literature, or covered very little:

- The impact of part-time work on the gender pay gap;
- The role of the social partners in pay negotiations and consequently their impact on equal pay for men and women;
- The effects, on the scientific professions, of policies aimed at reducing pay inequality between men and women.

In general terms, empirical research into the factors explaining the gender pay gap should be carried out for the employment market of each continental country and for each scientific profession. Using similar approaches would enable a comparison to be made between the different countries and would highlight best practice. Special attention should be paid to the relationship between the number of publications, mobility options, social networks, etc. and the gender pay gap. This type of analysis would provide a more comprehensive picture of pay inequality between men and women in the fields of science and research.

*Funding*

In general terms, a wide variety of institutions are responsible for awarding research funding. Nevertheless, authors usually concentrate on a limited number of institutions (one or two). Based on the available data, we cannot conclude that women experience systematically lower success rates than men. Moreover, the existence of a number of contradictory studies on the subject merely emphasises the need for work to be undertaken more systematically and exhaustively on the subject of inequalities in research funding (see Table 19).

It is apparent that certain crucial points are not sufficiently addressed in the continental literature.

- Differences between the types of subsidies/amounts granted to men and women;
- A comparison of the characteristics of the men and women who manage to obtain this type of subsidy, and those who do not;
- Initiatives that might be taken to restore parity.

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